INVESTIGATION OF STRUCTURAL AND BIOMOTORIC FEATURES OF YOUNG VOLLEYBALL PLAYERS AND DETERMINING THE POSITION BY DISCRIMINANT ANALYSIS

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Abstract

The aim of this study is to analyze structural and biomotoric features of male and female setter and smasher volleyball players in 15-17 age group. The study was carried out in Afyonkarahisar City Center; measurements were made on totally 113 volunteer volleyball players. There were 29 smashers and 15 setters from 5 male teams participated in Youth Group Volleyball Matches; while there were 49 smashers and 20 setters from 8 female teams. T-test was used for comparing young volleyball players' structural and biomotoric features according to sex and position. Relation between variables of structural and biomotoric features were determined by correlation analysis. On the other hand, discriminant analysis was carried out in order to classify players according to position in terms of biomotoric features and to determine the important/unimportant variables in this classification. At the end of the research, it was determined that flexibility values of setters were higher than smashers while smashers were better than setters in terms of other biomotoric features. There were found to be significant relation between biomotoric features (except flexibility) and height-weight. Additionally, in the classification of players as setter and smashers, the most significant variable for female players were found to be left hand grasping power and flexibility, while for male players the most significant variable was right hand grasping power.

Key words: Biomotoric feature, structural feature, volleyball, smasher and setter, discriminant analysis.

INTRODUCTION

It is a widely known fact that sports activities that individuals make during their physical development process have significant effects on their physical, structural and biomotoric features. It is especially revealed by many researches that (C. Açıkada, 1990, M.H. Rice, et al, 2000, H. Köylü, 2001, N. Apostolidis, et al, 2004, A.Özkan, et al, 2005,G. Wulf, 2007,J. Sheppart, et al, 2007, A. G, Faigenbaum, 2007, S. Jakovljević, 2010) structural and biomotoric development of young individuals have direct relations with performance no matter what the sports branch is. Training science is based on maximizing the performance and keeping the maximum performance level (F. Kılınç, et al, 2011). G. Wulf (2007), stated that the aim of all kinds of sports is to develop biomotoric features of the related sports branch by permanent metabolic adaptation thus increase the performance of player. Biomotoric features that reflects the basic movement feature in players includes many variables such as; strength, speed, flexibility, jumping and endurance (F. Ergül, 1995, I. Mihajlović, 1996,Y. Akkoyunlu, et al, 2010) and these are the significant issues in volleyball like in other sports branches.

Volleyball has become one of the most favorite sports branch with increasing interest in volleyball in recent years. There are millions of active sportsmen in International Volleyball Federation (FIVB) which was established by 14 founder countries with the congregate on 18-20 April 1947 in Paris and the Federation includes more than 200 countries. When volleyball is played at a professional level, it requires many features such as quick power, jumping, hit, sprints, endurance, speed, dynamism, coordination, technique and reflex (M.E. Öztürk, et al, 2005). Especially modern volleyball includes individual movements that require many synchronous combinations with highly dynamic activities (D. Bonacin, et al, 2009).

Strength is a significant feature that should be taken into consideration in making technical movements special to volleyball. W. Hollman (1972), said that strength is the endurance ability of muscles when they face any resistance; S. Plisk (2003), stated that it is the ability to use power in maximal efforts and to repeat the sub-maximal efforts. These definitions put forward the volleyball players' leg and especially grasping power biomotoric features. Besides this, jumping, which has a direct relation between hit, block and hit service, is a significant biomotoric feature (J. Sheppart, et al, 2007). On the other hand, flexibility and dynamism of joints (T. Siatras, et al, 2003, S.B. Thacker, et al, 2004) are the basic determinant factors in making different movements in all positions with warm-up (W. Cornelius, et al, 1992, A.G. Nelson, et al, 2005, M. Çolak, et al, 2010). In addition to these, watching the environment, guessing the speed and distance of ball, making the right movement on the right time besides motivation, coordination, quickness and balance are the important features of volleyball which is a technical game.

The aim of this study is to analyze structural and biomotoric features of male and female setter and smasher volleyball players in 15-17 age group.

MATERIAL AND METHODS

The data group of the study were structural

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(height, weight, sports age) and motoric features (jumping, flexibility, leg strength, right grasping strength, left grasping strength) of 15-17 aged male and female players in setter and smasher positions who attended Youth Group Volleyball Games in Afyonkarahisar city center. Totally 113 volleyball players voluntarily attended the study. 29 smashers and 15 setters from 5 male teams attended the study (*Antalya Karatay High School, Isparta Anatolian High School, Denizli Çivril High School, Kayseri Aydınlık Evler High School and Burdur Private Alpaslan Ali Can High School*) while 49 smashers and 20 setters from 8 female teams attended the study (*Kocaeli Private Karşıyaka High School, Isparta Fine Arts and Sports Girls High School, Kayseri Atatürk Girls' Vocational High School, Nevşehir Hacı Bektaş Girls' Vocational and Technical High School, Denizli Anatolian High School, Antalya Konyaaltı High School, Karaman Akçaşehir High School, Burdur Anatolian Teacher High School*).

In terms of structural features of volleyball players, height and weight measurements were made with Seca 769 electronic height meter adult scales. Body Mass Index –BMI- was calculated by dividing the body weight (kg) to the stature in square meters. In measuring right and left hand grasping strength biomotoric features, Takei hand dynamometer that measures 0-100 kg strength was used. During measurements, players were standing up and their hands were at the position of 45 degree angle with their bodies and they were required to squeeze the dynamometer with maximum force without touching their body with their hands. Seat-Reach test flexibility table was used for measuring flexibility; electronic Jump-meter (Takei Physical Fitness Test Jumping) was used for measuring vertical jumping; back and leg dynamometer was used for measuring leg strength. Measurements were done 3 times for each player at intervals and the best values were determined.

SPSS 14.01 package program was used for analyzing the data of the study. T-test was used for comparing young volleyball players' structural and biomotoric features according to sex and position. Pearson correlation analysis was used for determining relation between the variables of structural and biomotoric features of volleyball players.

Discriminant analysis was carried out in order to classify male and female players according to their positions (setter and smasher) in terms of biomotoric features and to determine the important/unimportant variables in this classification. Classification function of discriminating each sex into positions were determined that can be used as alternative in grouping the new members.

The aim of using discriminant analysis is firstly to determine effective variables in classification of two or more groups in terms of analyzed features; to find discrimination function/functions according to these variables and to put new members into a group with minimum mistake. Discriminant analysis is divided into two basic groups as linear and quadratic discrimination analysis. Discriminant analysis' linear discrimination function for both groups can be calculated with the formulas mentioned below (K. Özdamar, 2004):

Covariance matrixes of two group linear diskriminant analysis are equal ($S_1=S_2$) and common covariance matrix is (S);

$$S = \frac{(n_1 - 1)S_1 + (n_2 - 1)S_2}{n_1 + n_2 + 2} \quad (1)$$

calculated with this formula. Classification functions of both groups are written as (Y_i);

$$Y_i = b_{i0} + b_{i1}X_1 + b_{i2}X_2 + \ldots + b_{ip}X_p$$

$$(2)\ (b_{i0} = -(1/2)\overline{X}_i' S^{-1}\overline{X}_i \ ;\ b_{ij} = S^{-1}\overline{X}_i)$$

In equality; i=1,2 stands for group number, b_{i0} stands for constant, b_{ij} (j=1,2…p) stands for linear component (canonic variables) and p stands for variable number.

RESULTS

Comparison of some structural features of young volleyball players attended in the study in terms of sex and each sex group according to position variable is given in Table 1. Comparison of their biomotoric features is given in Table 2. According to these data, it was determined that there was a meaningful difference between players' structural features according to sex ($p<0.05$); male players' average values were higher than female players for all variables. Besides this, it was determined that there weren't significant differences between male players' height, weight and body mass index according to position ($p>0.05$); male setters' ($\overline{X}=6.53$) sports age were significantly higher than smashers ($\overline{X}=5.0$). As an exact opposite of this situation, female volleyball players' sports age didn't have a significant difference according to position ($p>0.05$), and female smashers' height, weight and body mass index were higher than setters.

According to the findings in Table 2, it can be seen that there were significant difference between volleyball players' biomotoric features except flexibility ($p>0.05$), in terms of sex ($p<0.05$); and there were significant differences between biomotoric features between sex groups ($p<0.05$). When average values of groups were analyzed, it was seen that male and female players' flexibility values were very close; besides this, male players had obvious superiority in terms of all other biomotoric features, as expected. On the other hand, setters' flexibility values were higher than smashers in both male and female groups; in terms of other biomotoric features (jumping, leg strength, right and left hand grasping strength), smashers were better than setters.

Correlation matrix that gives the relation of players' structural and biomotoric features' values are presented in Table 3. According to this, there weren't found to be any significant relation between structural features of players and flexibility ($p>0.05$). In addition, from structural features; there wasn't found to be a

significant relation between sports age and jumping, flexibility, leg strength ($p>0.05$). There were found to be significant relation between sports age and right-left hand grasping strength; the relation was weak ($0.20<r<0.39$) and positive ($p<0.05$). The correlation matrix in Table 3 shows that there were significant relations between biomotoric features (except flexibility) and height-weight-BMI. The biomotoric feature that had the highest level of relation with these variables was right hand grasping strength. When biomotoric features' relation within one another were analyzed, there was found to be a significant weak negative relation ($r=-0.256$) between flexibility and jumping. There were found to be medium, strong and very strong significant relations between other variables of biomotoric features ($p<0.05$).

Results of discriminant analysis in classification of young male and female volleyball players' biomotoric features according to their positions and determination of important/unimportant variables are given in Table 4. According to this, the group covariance matrixes were homogenous (Box's $M=25.204$ and 26.760; $p>0.05$) which shows that two groups linear discriminant analysis is applicable. It was determined that units can be divided in both groups by one discriminant function and discriminant power of this function is significantly high (Wilks' Lambda=0.771 and 0.719; $p<0.05$). In other words, discriminant function has an important role as a discriminator in determining the positions of players. Canonical correlation values are $r=0.479$ for female, $r=0.530$ for male.

When significant variable structure matrixes that are given in Table 4 are analyzed, the most significant variables in classification of players in smasher and setter positions are left hand grasping strength and flexibility for female players; while they are right hand grasping strength and left hand grasping strength for males. The least important variables in discriminating players as setter and smasher are leg strength for female; flexibility for male.

At the end of the analysis, it was determined with two groups linear discriminant function that female can be classified at 81.0% and male at 87.3% ratios according to their positions in terms of biomotoric features.

Discussion and conclusion

In this study, young players' structural and biomotoric features were analyzed and the obtained data were associated to present literature and evaluated. When the sampling of the research (15-17 aged young players' structural features) was analyzed, it was seen that male players' average values were higher than females as expected. The average height and weight of male players were 1.79 m and 74.16 respectively while female players' average height and weight were 1.67 m and 57.86 kg. The values determined by the study were very close to the values in literature while female values were a little lower. G. Helveci (2005), found that average height of young female players is 1.72 m body mass index is 58.04 kg. P. Demirel (2005), found that average height of young female players is 1.70 m and 62.56 kg. F. Kılınç, et al (2006), determined that young female national team players' average height is 1.82 m while their average weight is 67.6 kg. In his study about adolescence period (9-14 ages) of children volleyball players, E. Sönmez (2006), determined that female volleyball players' average height value is 1.44 m, while this value for male players is 1.47 m. Average weight of female players is 36.4 kg, wile this value of male players is 35.4 kg. E. Kutlay, et al (2003), determined 13-15 age group female volleyball players' average height in the middle of season is 1.67, while these value is 1.70 at the end of season. In their study, M. E. Öztürk, et al (2005), found that 16-18 age group male volleyball players' average height is 1.77 m and their body mass is 67.58 kg.

In this study, although female players' average flexibility value (27.86 cm) was determined to be higher than males (26.18 cm), this difference wasn't found to be statistically important. Besides this, male values were determined to be higher in all other motoric features as expected. S. Akarsu (2008), determined that 14-18 age group male players' average flexibility is 25.84 cm, female players' average flexibility is 25.61 cm; A. Kalkavan, et al (1996), determined that 16 aged young male volleyball players' average flexibility 19.6 cm; R. Kürkçü, et al (2008), determined that 10-11 age group male volleyball players' average flexibility 20.40 cm; E. Sönmez (2006), determined that adolescence female volleyball players' flexibility is 31.3 cm, male players' flexibility is 26.3 cm; H. Koç, et al (2007), determined that average flexibility of 21 volleyball players in handball and volleyball leagues whose training age are 5 or above is 18.3 cm. T. O. Bompa (2000), determined that flexibility varies according to age and sex, young female players at a certain level are more flexible than males; besides this, maximum flexibility level is reached at the age of 15-16 but inadequacy of muscle strength can have a negative effect on flexibility. M. Matvienko (2002), mentioned that there are many factors that affect strength and flexibility which should be evaluated separately; D.S. Özer, et al (2000), said that anatomical and functional changes in joints affect the flexibility measurements. On the other hand, according to the results, both male and female volleyball players in setter positions are more flexible and their jumping is lower when compared to smashers. This result can be explained as a setter position requires dynamism for multi dimensional pass against any kind of bump. At the end of analysis of volleyball games in terms of jumping percentages, it was determined that there were 100-150 jumping was done 1/3 of which was attack, 2/3 was block (M. Letzelter, et al, 1982, A. Kalaycı, 1996). This situation can be explained with the fact that smasher who are more active at the top of the net attack and block organizations have more capacity of jumping.

In the study, young female volleyball players' average linear jumping height was found to be 44.77 cm while average male value was 27.0 cm. average linear jumping height of Ankara first league team female volleyball players was found to be 47.5 cm by H.U. Önder (2007), elite female volleyball players' linear jumping height was determined to be 27.0 cm; M. Thissen, et al (1991), found that this value for female volleyball players in high schools are 43.6 cm;

F. Kılınç, et al (2006), determined this value to be 48.5 for young national team female volleyball players. G. R. Nalçakan (2001), in his study with female players found that minimum linear jumping height is 40 cm while maximum height is 61 cm. male volleyball players' average linear jumping height was found to be 65.72 cm by M. E. Öztürk, et al (2005), 104.6 cm for university student players by K. Göral, et al (2009), 34 cm for 12-15 age group male players by A. Kalkavan, et al (1996). In the study, while female average leg strength was determined to be 91.36 kg, this value for male players was 139.09 kg. In his study on determining the leg strength of 14-18 age group young male players in different branches, S. Akarsu (2008), found that the value is 160.04 kg, while the value for female players is 93.44 kg. This value for university student male players was determined to be 155.7 kg by K. Göral, et al (2009). A. Kalkavan, et al (1996), determined that 12-15 aged male players' leg strength is 70.3 kg.

Jumping is an ability that includes complicated movements and related to the strength of leg muscles, explosive force, muscular contraction speed, development of muscle strength, flexibility of muscles in jumping action and jumping technique (M. Letzelter, et al, 1982, M. Günay, et al, 1994, A. Kalaycı, 1996). Jumping, one of the basic movements in volleyball requires the need for leg strength. T. Housh, et al (1988), said that muscular strength quickly increases in male players starting from adolescence but this is not the same for female players. He also mentioned that 15-16 aged females have 2/3 of male muscular strength. As can be seen from the above mentioned similar studies, strength factor has a bigger role in male players' linear jumping when compared to female players.

In this study, right hand grasping strength of female volleyball players were found to be 29.03 kg, while left hand grasping strength of volleyball players were found to be 28.23 kg; these values for males' right hand were determined to be 43.41 kg, while for left hand, these values were 40.82 kg. Male volleyball players' right hand grasping strength was found to be 44.12 kg, left hand grasping strength was found to be 37.62 kg by M. E. Öztürk, et al (2005), young male volleyball players' right hand grasping strength was found to be 32.7 kg by A. Kalkavan, et al (1996), right hand grasping strength was found to be 40.02 kg, left hand grasping strength was found to be 35.44 kg by K. Göral, et al (2009), 10-11 aged male volleyball players' right hand grasping strength was found to be11.28 kg while their left hand grasping strength was found to be 11.28 kg by R. Kürkçü, et al (2008), young female volleyball players' right hand grasping strength was found to be 28.10 kg while their left hand grasping strength was found to be 27.08 kg by P. Demirel (2005), M. Pense (2002), found out that hand grasping strength of female basketball players' are 25.69 kg.

In this study, relation between structural and biomotoric features of sportsmen were analyzed and there were determined to be significant relations between biomotoric features (except flexibility) height-weight. There are some studies in literature which determined that hand grasping strength is physiological variable that is affected from various factors such as age, sex and body size and there is a strong relation between hand grasping strength and some anthropometrical features such as weight, height, and hand length (R. M. Malina, et al, 1987, S. Chatterjee, et al, 1991, C. H. Ross, et al, 2002). J. T. Viitisalo, et al (1992), and MJ. Duncan, et al (2006), determined in their studies that body structure and composition of children affect the linear jumping distance and linear jumping increase according to low body fat percentage in volleyball players.

Physical structure has a big significance on maximum physiological strength. If the physiological structure is not proper for the sports branch, it impossible to have a complete performance (C. Açıkada, et al, 1986). Especially performance and strength development have a direct relation with height, body mass index, length of arm, leg and other body parts besides joint mobility and flexibility level (M. Günay, 1998). Height and weight are some of the anthropometrical preconditions that are needed for choosing and development of players (Y. Sevim, et al, 1993). The relation between development and performance are generally related to anthropometrical factors and contribute to development of performance (D. G. Baktaal, 2008). It is determined that jumping abilities are well in case height values that are effective in determining the performance in volleyball are high in male (in terms of sex) and in smashers (in terms of position). In other words, there is determined to be a significant relation between linear jumping success and height (M. Sayın, et al, 1995).

In our study, a positive relation was found to be between variables of biomotoric features except flexibility. Block, hit and net movements that are in basic techniques of volleyball require jumping namely explosive force (N. Ergun, et al, 1994). In this context, the necessity of volleyball players' jumping many times in a game shows that there is a positive relation between jumping and leg strength. Although weak, a negative relation was found to be between flexibility and jumping. When it is taken into consideration that that setters are more flexible and their jumping level is lower (Table 2), it wouldn't be false to say that this result is expected.

Diskriminant analysis was carried out in order to classify players according to their positions (setter and smasher) in terms of biomotoric features and to determine the important/unimportant variables in this classification. According to these analyses, the most important variables in discrimination of females as setter and smashers were found to be left hand grasping strength and flexibility while the most important variables in discrimination of male players as setter and smashers were found to be right and left hand grasping strength. On the other hand, it is found out that by using the obtained discriminant function and biomotoric features, it is possible to classify female with 81.0% ratio and male with 87.3% ratio. In the study carried out in this context, it can be possible to determine new players' positions by measuring their biomotoric features with the discriminant function that can be identified by other studies on measuring anthropometrical and biomotoric features. More

clearly, the study can be an important source of information and even a basic determinant in choosing the position of a player as smasher or setter. This is why, it can be suggested that statistical techniques such as discriminant analysis which gives the opportunity to use evaluation of more than one variable simultaneously rather than only one variable.

Table 1. Comparison of structural features according to sex and position

Structural Features	Sex	n	$\overline{X}$	s.d.	p	Position	n	$\overline{X}$	s.d.	p
Height(m)	Female	69	1.67	0.07	0.000***	Setter	20	1.63	0.05	0.002**
						Smasher	49	1.69	0.07	
	Male	44	1.79	0.06		Setter	15	1.77	0.05	0.132
						Smasher	29	1.80	0.07	
Weight(kg)	Female	69	57.86	7.49	0.000***	Setter	20	52.25	5.01	0.000***
						Smasher	49	60.14	7.15	
	Male	44	74.16	13.32		Setter	15	75.13	16.39	0.732
						Smasher	29	73.66	11.73	
BMI(kg/m^2)	Female	69	20.61	2.16	0.000***	Setter	20	19.56	1.68	0.004**
						Smasher	49	21.04	2.21	
	Male	44	23.05	3.86		Setter	15	23.80	4.61	0.354
						Smasher	29	22.65	3.43	
Sports age(year)	Female	69	4.22	1.83	0.002**	Setter	20	4.30	1.53	0.793
						Smasher	49	4.18	1.95	
	Male	44	5.52	2.35		Setter	15	6.53	1.85	0.038*
						Smasher	29	5.00	2.43	

*$p<0.05$; **$p<0.01$; ***$p<0.001$ *BMI: Body Mass Index*

Table 2. Comparison of biomotoric features according to sex and position

Biomotoric Features	Sex	n	$\overline{X}$	s.d.	p	Position	n	$\overline{X}$	s.d.	p
Jumping(cm)	Female	69	44.77	5.77	0.000***	Setter	20	42.60	3.34	0.012*
						Smasher	49	45.65	6.32	
	Male	44	58.29	8.54		Setter	15	54.73	8.80	0.045*
						Smasher	29	60.13	7.94	
Flexibility(cm)	Female	69	27.86	5.33	0.180	Setter	20	30.40	3.84	0.009**
						Smasher	49	26.82	5.54	
	Male	44	26.18	7.85		Setter	15	29.33	4.02	0.018*
						Smasher	29	24.55	8.85	

Leg strength(kg)	Female	69	91.36	21.30	0.000***	Setter	20	84.45	14.52	0.040*
						Smasher	49	94.18	23.05	
	Male	44	139.09	29.52		Setter	15	126.60	21.01	0.042*
						Smasher	29	145.55	31.47	
Right hand grasping strength(kg)	Female	69	29.03	3.97	0.000***	Setter	20	27.25	3.59	0.016*
						Smasher	49	29.76	3.92	
	Male	44	43.41	6.57		Setter	15	40.40	5.50	0.027*
						Smasher	29	44.96	6.62	
Left hand grasping strength(kg)	Female	69	28.23	3.86	0.000***	Setter	20	26.10	3.38	0.003**
						Smasher	49	29.10	3.73	
	Male	44	40.82	6.55		Setter	15	38.00	5.08	0.039*
						Smasher	29	42.27	6.82	

*$p<0.05$; **$p<0.01$; ***$p<0.001$

Table 3. Correlation matrix of structural and biomotoric features

Variables	Jumping	Flexibility	Leg strength	Right hand grasping strength	Left hand grasping strength
Height	0.488**	-0.099	0.559**	0.631**	0.591**
Weight	0.448**	-0.070	0.500**	0.596**	0.568**
BMI	0.272**	-0.043	0.289**	0.368**	0.355**
Sports age	0.165	-0.040	0.160	0.221*	0.228*
Jumping	-	-0.256**	0.638**	0.646**	0.556**
Flexibility	-	-	-0.163	-0.149	-0.122
Leg strength	-	-	-	0.672**	0.613**
Right hand grasping strength	-	-	-	-	0.900**
Left hand grasping strength	-	-	-	-	-

*$p<0.05$; **$p<0.01$

Table 4. Discriminant analysis result of classification according to position

Variables	For female				For male			
	The structure matrix of important variable in discriminant	Canonical discriminant function coefficients	Linear discriminant function coefficients		The structure matrix of important variable in discriminant	Canonical discriminant function coefficients	Linear discriminant function coefficients	
			Setter	Smasher			Setter	Smasher
Jumping	0.456[4]	0.391	1.318	1.400	0.509[4]	0.412	1.008	1.073
Flexibility	-0.590[2]	-0.585	1.173	1.037	-0.488[5]	-0.450	0.707	0.631

Leg strength	0.391[5]	0.003	-0.029	-0.029	0.517[3]	0.474	0.119	0.140
Right hand gr.st.	0.551[3]	0.045	0.614	0.628	0.565[1]	0.030	0.125	0.131
Left hand gr.st.	0.696[1]	0.647	1.403	1.614	0.526[2]	0.586	0.918	1.038
Constant	-	-	-72.017	-78.005	-	-	-66.139	-75.786
	Box's M=25.204; p=0.096 Canonical correlation (r)=0.479				*Box's M=26.760; p=0.086 Canonical correlation(r)=0.530*			
	Wilks' Lambda=0.771; Chi-square =16.840; p=0.005				*Wilks' Lambda=0.719; Chi-square=13.043; p=0.023*			
	Group centroids: Setter= -0.843 Smasher=0.344				*Group centroids: Setter= -0.850 Smasher=0.440*			
	Correctly classification ratio=81.0%				*Correctly classification ratio=87.3%*			

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