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Somatic and Physical Characteristics of Adolescent Female Volleyball Teams at Different Success Levels

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ABSTRACT The purpose of this study is to compare anthropometric characteristics and physical performance of girl volleyball players who are adolescent girls aged around 14 years old, and participated in national championships with different success levels. The subjects of the study consisted of 60 volunteering girl volleyball players. Anthropometric measures were used for anthropometric and somatotype characteristics. Hand strength test, leg and back strength test, flexibility, knee-bend sit-up, vertical jump test, 20,-meter sprint test and bruce test for maximal oxygen consumption were used for measuring physical performance. As a result, the endomorphy values of the 2nd group's players were significantly higher ($p<0.05$) than those of the 1st group's volleyball players. The new regression formula developed from this study is as follows: % fat=0.126(thight skf.) + 0.626(triceps skf.) – 0.637(biceps skf.) + 0.955(BMI) – 13.144 (R=0.836 and SEE=1.33%). Successful girl volleyball players had a dominant somatotype profile, ectomorph structure, and lower ratio of body fat.

INTRODUCTION

Today, sporting events have reached high levels. Whilst the social phenomenon of sport societies has become a part of human life as sports promote prestige, scientific developments have brought a new dimension to sports. Sports scientists, who first examined the effects of sports on human health (Gutin et al. 2001; Hollman et al. 1981), now research on how to help increase the athletes' performance (Gualdi-Rosse and Zaggagni 2001; Gutin et al. 2001; Hakkinen 1993; Hassapidou and Manstrantoni 2011; McArdle et al. 2009). The human body, in terms of structure and function, bares features that can adapt to sports with training sessions. With regular training sessions, the athletes' lean body mass (FFM) increases, resulting in a reduction in percentage of body fat (%BF). Body fat percentage values change according to both, the athlete's gender as well as the type of sport played (Civar et al. 2001; Siri 1961). In addition, the athlete's somatotype structure is very important in deciding which branch of sport is most appropriate. This assessment can be done by comparing the athlete's anthropometric measurements to the physical measurements (Civar et al. 2001). Physical structure and performance-related studies are outdated (Bale et al. 1994; Hakkinen 1993; Kovaleski et al. 1980; Puhl et al. 1982; Spence et al. 1980). For many years it was thought that the appropriate body type played an important role in sports performance (Adriaanse and Crosswhite 2008; Bayios et al. 2006; Gualdi-Rosse and Zaggagni 2001; Thissen et al. 1991; Khasawneh 2015; Perroni et al. 2015). The first studies being performed today for anthropometric measurements and somatotype are essential in determining ability. Different body types require special athletic skills for maximum performance. In many sports, usually the sports industry determines whether or not the athlete's body type is appropriate. Somatotype profile is very important for determining the suitability of an athlete in a specific branch of sports. Throughout the world, anthropometric characteristic studies have investigated which body types are most appropriate in which sports, and to what extent it plays a role in the selection of talent within the infrastructure. In order to increase performance levels, the overall results of the research applied show that people must first have certain characteristic features. These characteristics also change from sport to sport (Bale et al. 1994; Bayios et al. 2006; Gaurav et al. 2010; Gutnika et al. 2015).

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In order to research future potential talent, this study examined female volleyball players' physical and anthropometric characteristics and their effect on this specific area of sports. Current literature lacks information on this exact topic. Volleyball sports have been subject to these researches, however, the existing literature is restricted to the individual performance and anthropometric characteristics. In order to more accurately define the talent criteria, further research on the volleyball players' full anthropometric profiles is needed. In recent years, researchers have shown more interest in studying the relationship between physical performance and anthropometric characteristics, and its influence on performance of players. If one wants a more accurate assessment of physical performance and anthropometric characteristic effects on performance, further research is needed. In the literature, there have been many researches on the importance of physical performance, the selection of physical performance tests, the correlation between different physical performance tests, and the relationship between performance of players and physical performance. So far there is no data in an age group that indicate whether physical performance of players is under the influence of their anthropometric characteristics, or whether some specific physical performance may impact anthropometric characteristics of players. Moreover, there have rarely been any studies that compared physical performance of the volleyball players. Due to the lack of research on the girl volleyball players of this age group, this research may constitute as a resource for sports scientists and trainers. Considering somatotype measures alone cannot provide enough evidence, and hence volleyball-specific physical fitness tests were used.

The purpose of this study is to compare anthropometric characteristics and physical performances of girl volleyball players who are adolescent girls aged around 14 years old, and participated in national championships with different success levels and previously developed anthropometric regression formula based on the anthropometric data collected in this study.

MATERIAL AND METHODS

Subjects

The subjects of the study consisted of 60 girl volleyball players as volunteers. Each team consisted of 10 volleyball players. The volleyball teams were devided into two groups by their ranking. There were 28 teams in the competition. The 1st, 2nd and 3th ranking teams formed the 1st group (age mean: 13.62±00.76 years, height mean: 165.84±04.38cm, weight mean: 52.71±05.26kg) and the 26th, 27th and 28th teams formed the 2nd group (age mean: 13.08±00.49 years, height mean: 164.37±04.76cm, weight mean: 52.96±06.32kg). All players participated in the league matches according to their age groups and performed three training sessions per week. All players and their parents were informed about the procedures of the measurements and gave written consents for participation.

Experimental Design

All participants made two visits to the laboratory on separate days. On the first visit, anthropometric measurements and underwater weighing measurements were collected. During the second visit, residual volume and bruce test for maximal oxygen consumption measurements were collected. Each participant was given a set of written guidelines to adhere to before their designated testing date. The guidelines included the following:

1. No large meals for four hours before the test
2. No vigorous exercise for 12 hours before the test
3. Empty bladder 30 minutes before the test
4. Consumption of liquids limited to one percent of body weight 2 hours before the test.

Subjects participated in the measurements after staying hungry for a period of one night. The following tests for physical performances were used. Hand strength test, leg and back strength test, flexibility, knee-bend sit-up, vertical jump test, 20-meter sprint test and Bruce test to determine maximal oxygen consumption. Hand strength was tested using the hand dynamometer, leg and back strength were tested using the leg and back dynamometer, flexibility was tested with the sit and reach test, vertical jump was tested using a jumpmeter, the 20 meter sprint test was tested using a photocell, and the Bruce test was tested with a SensorMedics Spectra 229LV analysis system. The laboratory temperature was maintained at a constant temperature for all tests. Testing was administered at the same time of the day for all subjects.

Procedures

Anthropometric Measurements

Standard anthropometric methods were used to determine body mass, body height and all the skinfold and circumference measurements. All the anthropometric measures were based on the Anthropometric Standardization Reference Manual (Lohman et al. 1988). The holtain skinfold caliper (Holtain United, Dyfed, UK) was utilized for skinfold measurements.

Somatotype was determined using the following equations (Heath and Carter 1990):

Endomorphy = - 0.7182 + 0.1451(X) - 0.00068 $(X)^2$ + 0.0000014$(X)^3$

Where,

X = sum of supra-spinale, subscapular and triceps skinfold and corrected for stature by multiplying the sum of skinfolds by 170.18/Body Height in cm.

Mesomorphy = (0.858 x Humerus width) + (0.601 x Femur width) + (0.188 x Corrected arm girth) + (0.161 x Corrected Calf Girth) - (Body Height x 0.131) + 4.5

Where,

Corrected Arm Girth = Arm girth-Biceps skinfold

Corrected Calf Girth = Calf Girth-Calf skinfold

Ectomorphy = (HWR x 0.732)-28.58

Where,

HWR = (Body Height in cm)/ (weight in kg)$^{0.33}$

Hydrostatic Weighing

The Hydrostatic Weighing (HW) method was administrated according to the method described by McArdle et al. (2009). Briefly, the procedure was performed in a cylinder tank that was approximately 160 cm deep and 120 cm width. The chair was calibrated prior to each test while it was unloaded and at 0.0 kg prior to each measurement, the subject took a deep breath, exhaled approximately one-half tidal volume into the air, placed his head completely under the surface of the water, and continued to expel air as long as possible. When the subject had expelled as much air as possible, he signaled to the experimenter, and a measure of underwater weight was taken. This procedure was repeated 10 times, and the mean of the 3 highest weightings was used in subsequent calculations. Body density was then calculated according to the following formula: BD=BW/[(BW-WW)/WD-(RV+100)]. In this formula, BD represents body density g/cm^3, BW represents body weight in grams, WW represents underwater weight in grams, WD represents density of water at measured temperature, and RV represents residual volume in milliliters. Percent body fat was then calculated according to the formula developed by Siri (1961), wherein percentage of body fat is =495/BD-450.

Residual Volume

The residual volume measures taken were applied in accordance with the open circuit nitrogen washout technique (Vmax SPECTRA 229LV, Sensormedics Corporations 22705 Savi Ranch Parkway, Yorba Linda, California 92687). The residual volume measures were applied twice in laboratory environments and at similar stands during the underwater tests. When the difference between the measures taken exceeded five percent by means of their values, a third test was applied. The subjects used nose clips and a customized single-use mouthpiece during the residual volume measures test.

The Bruce Treadmill Test for Maximal Oxygen Consumption

During the experimental exercise session, each subject performed treadmill walking. All subjects completed the exercise workloads in the following order: Protocol of Bruce; the protocol is performed in a treadmill. The test starts at 2.75km/hr (1.7 mph) and at a gradient of ten percent. At three-minute intervals, the incline of the treadmill increases by two percent and the speed increases as shown in the Table 1. Heart rate

Table 1: Protocol of Bruce test

Stage	*Time*	*km/hr (Min.)*	*Slope (in percent)*
1	0	2.74	10
2	3	4.02	12
3	6	5.47	14
4	9	6.76	16
5	12	8.05	18
6	15	8.85	20
7	18	9.65	22
8	21	10.46	24
9	24	11.26	26
10	27	12.07	28

(HR) was measured continuously throughout the exercise test with electrodes (Vmax SPECTRA 229LV, Sensormedics Corporations 22705 Savi Ranch Parkway, Yorba Linda, California 92687). A warm-up period of 3 minutes followed resting heart rate measurements. The subjects' heart rate was continuously monitored during the test using an electrocardiogram. The test was considered maximal if maximal volume of oxygen uptake (VO^2 max) increased by <150 ml/min or <2.1 ml/kg/min with an increase in work rate or if a maximal respiratory exchange ratio (RERmax) of $\geq$1.15 and a HRmax greater than or equal to the age-predicted maximal value were achieved. The data obtained during the tests were saved automatically. Calibration with two standard gas mixtures (26% of oxygen + N2 balance, %4 of carbon dioxide + 16% oxygen + N2 balance) was first applied before the residual volume measures were taken and before the Bruce test was applied.

Statistical Analyses

Statistical analyses were performed using SPSS 11.0 for Windows (SPSS Inc, Chicago, IL). All values are expressed as mean ± standard deviation (SD). In order to detect differences between groups, an independent sample t-test was used. Statistical significance was established at $p<0.05$. In order to obtain the test retest reliability of anthropometric measurement and HW, the intra-class correlation coefficients (ICC's) were calculated. Pearson correlation coefficients were used to determine relationships between variables. Also, stepwise regression was performed in order to develop new regression formula for estimation of HW.

RESULTS

In order to determine the test-retest reliability, all 30 subjects were each measured, twice and at various times for their height, weight, anthropometic measurements, height measurements, skinfold thickness measurements, diameter measurements, girth measurements, underwater weighing measurements. The intraclass correlation coefficient (ICC) values, at a confidence interval rate of ninety-five percent and the p-values of results obtained from the re-test measurements are presented in Table 2.

The physical characteristics of this study's participants are presented in Table 3. In the 1st group, the average age of the girl players was 13.62±00.76 years, average height was 165.84±04.38 cm, and average weight was 52.71±05.26 kg. In the 2nd group, the average age was 13.08±00.49 years, average height was 164.37±04.76 cm, and average weight was 52.96±06.32 kg. There were no differences between the groups in terms of the age, height, weight, and body mass index (BMI) ($p>0.05$). The 2nd group's percentage of body fat was higher than the 1st group's value. There was a significant difference between the values of both groups ($p<0.05$).

The results of the tests applied to detect performance features and the comparison between the two groups can be seen in Table 4. According to the performance tests applied, the left and right grip strength, the flexibility, the sit ups, the strength of the back, the strength of the legs, the 20-meter sprint, the vertical jump and the VO^2 max values of the 1st group has been detected to be higher than the 2nd group. There were significant differences between the values of both groups ($p<0.05$).

The participants' anthropometric measurements and inter-group comparisons can be seen in Table 5. According to the results of the skinfold measurement, the 1st group's skinfold value was lower than the 2nd group's value. Statistically, there were significant differences between the groups' triceps, biceps, subscapular, and calf skinfold values ($p<0.05$). There was no significant difference between the groups' suprailiac skinfold values ($p>0.05$). According to the results of the bone diameter measurements, no significant difference was found between the groups' femur and humerus diameter ($p>0.05$), however there was a significant difference between the groups' biacromial diameters ($p<0.05$). According to the results of the girth measurements, with the exception of biceps, calf, and abdomen ($p<0.05$), there was no significant difference between the groups' other girth measurements ($p>0.05$). While there were significant differences between the groups by means of their length of fathom ($p<0.05$), it was seen that there were no significant differences between the groups by means of their values of hand and foot lengths ($p>0.05$).

Table 6 summarizes the descriptive statistics of the somatotyping components. Endomorphy values of 2nd group players were significantly higher ($p<0.05$) than those of 1st group volleyball

Table 2: The intraclass correlation coefficient, 95% confidence interval and p values of the test re-test measurements

Variables (n=30)	*Intraclass correlation Coefficient (ICC)*	*95% confidence interval Lower Limit-Upper Limit*	*P*
Height (cm)	0.9999	0.9999-0.9999	0.000
Weight (kg)	0.9964	0.9967-0.9987	0.000
Length Measures (cm)			
Sitting height	0.9472	0.9319-0.9762	0.000
Fathom	0.9999	0.9999-0.9999	0.000
Hand	0.9999	0.9999-0.9999	0.000
Foot	0.9999	0.9999-0.9999	0.000
Skinfold Measures (mm)			
Triceps	0.9785	0.9457-0.9875	0.000
Biceps	0.9884	0.9868-0.9994	0.000
Supscapula	0.9922	0.9685-0.9879	0.000
Suprailiac	0.9968	0.9934-0.9975	0.000
Abdominal	0.9979	0.9956-0.9987	0.000
Midaxillar	0.9995	0.9987-0.9989	0.000
Forearm	0.9982	0.9967-0.9969	0.000
Thigh	0.9907	0.9875-0.9971	0.000
Calf	0.9993	0.9969-0.9986	0.000
Chest	0.9990	0.9964-0.9977	0.000
Diametric Measures (cm)			
Humerus	0.9999	0.9999-0.9999	0.000
Femur	0.9999	0.9999-0.9999	0.000
Biacromial	0.9999	0.9999-0.9999	0.000
Bitrochanter	0.9999	0.9999-0.9999	0.000
Biiliac	0.9999	0.9999-0.9999	0.000
Girth Measures (cm)	0.9974	0.9954-0.9983	0.000
Chest	0.9925	0.9887-0.9971	0.000
Waist	0.9937	0.9969-0.9989	0.000
Abdomen	0.9954	0.9934-0.9967	0.000
Hip	0.9932	0.9921-0.9986	0.000
Thigh	0.9983	0.9657-0.9973	0.000
Knee	0.9949	0.9876-0.9982	0.000
Calf	0.9979	0.9955-0.9984	0.000
Ankle	0.9985	0.9962-0.9997	0.000
Biceps	0.9978	0.9961-0.9984	0.000
Forearm	0.9969	0.9974-0.9982	0.000
Wrist	0.9836	0.9467-0.9871	0.000
Neck	0.9926	0.9877-0.9972	0.000
Underwater measures	0.9954	0.9918-0.9989	0.000

Table 3: Physical characteristics of girl volleyball players

Mean ± S.D.	*Min.*	*Max.*		*Mean ± S.D.*	*Min.*	*Max.*	*t-value*
1st group (n=30)				*2nd group (n=30)*			
13.62 ± 00.76	12.90	14.70	*Age (year)*	13.08± 00.49	12.50	14.30	2.481
165.84 ± 04.38	151.00	171.00	*Height (cm)*	164.37± 04.76	153.00	173.00	1.586
52.71 ± 05.26	42.50	68.00	*Weight (kg)*	52.96± 06.32	40.50	70.50	-0.008
20.27 ± 02.36	18.00	27.00	*BMI (kg/cm^2)*	20.93± 02.47	17.00	28.00	-0.667
22.27 ± 01.54	19.50	26.50	*Body Fat%*	24.68± 03.75	18.20	32.10	-1.261*

*p<0.05

players. In relation to mesomorphy and ectomorphy, no significant differences were observed between the two groups.

Table 7 is a stepwise regression analysis used to develop a new regression formula for HW from anthropometric data collected in this study. In

Table 4: The comparison of physical performance values

	1st Ggroup (n=30)	*2nd group (n=30)*	
	Mean± S.D.	*Mean± S.D.*	*t-value*
Right hand grip strength (kg)	29.47± 03.21	24.86± 04.25	3.873*
Left hand grip strength (kg)	28.61± 03.23	22.89± 03.55	5.333*
Sit-reach (cm)	39.85± 04.09	23.90± 05.44	10.480*
Sit-up tTest	25.40± 02.50	17.25± 04.06	7.642*
Back strength (kg)	71.10± 08.43	58.65± 09.68	4.341*
Leg strength (kg)	72.50± 05.19	59.64± 09.78	5.643*
20 m sprint (Sec.)	03.36± 00.13	03.73± 00.22	-6.530*
Vertical jump (cm)	49.05± 04.14	37.25± 04.62	8.512*
VO^2max ($ml.kg^{-1}.dk^{-1}$)	48.14± 04.32	41.58± 04.71	5.687*

*p<0.05

Table 5: The comparison of anthropometric characteristics

	1st group (n=30)	*2nd group (n=30)*	
	Mean± S.D.	*Mean± S.D.*	*t-value*
Skinfold Measurement (mm)			
Triceps	6.48± 1.26	7.87± 2.16	2.491*
Biceps	7.66± 1.29	10.38± 2.82	3.925*
Subscapular	8.41± 1.19	10.94± 4.47	-2.924*
Suprailiac	8.14± 1.79	10.15± 4.76	-1.726
Calf	8.70± 1.97	12.70± 3.51	4.511*
Diametric Measurements (cm)			
Bitrochanteric	30.38± 1.99	30.11± 1.58	0.487
Femur	8.32± 0.47	8.30± 0.42	0.183
Humerus	5.61± 0.43	5.45± 0.21	1.598
Biacromial	35.93± 1.68	34.88± 1.66	2.012*
Girth Measurements (cm)			
Waist	66.25± 3.95	68.15± 6.22	-2.161
Biceps	23.60± 2.32	23.66± 2.68	1.134*
Calf	33.12± 2.39	33.41± 2.56	-1.356*
Knee	35.47± 2.19	35.25± 2.14	0.347
Wrist	15.31± 0.74	15.59± 2.68	-0.482
Ankle	22.13± 1.22	22.17± 1.71	-0.094
Chest	84.18± 5.32	84.88± 5.93	-0.397
Hip	87.97± 7.08	90.62± 5.89	-1.284
Abdomen	70.23± 5.37	74.83± 9.01	-3.962*
Shoulder	90.35± 5.05	88.78± 4.44	1.059
Thigh	51.75± 4.72	50.46± 4.98	0.846
Length Measurements (cm)			
Fathom	164.83± 5.48	160.86± 6.86	3.081*
Hand	17.38± 0.71	17.43± 0.74	-0.241
Foot	23.71± 0.82	23.92± 1.18	-0.658

*p<0.05

Table 6: The comparison of somatotypes values

	1st group (n=30)	*2nd group (n=30)*	
	Mean± S.D.	*Mean± S.D.*	*t-value*
Endomorphy	2.79±00.51	3.79±01.64	-2.532*
Mesomorphy	2.41±01.19	2.55±00.94	-0.443
Ectomorphy	3.19±01.07	2.83±01.09	1.051

*p<0.05

the stepwise regression analysis, thigh, triceps, biceps skinfold measurements and BMI were the only significantly contributing parameters ($p<0.05$) included in the model, which is follows:

% BF=0.126(thigh skf) + 0.626(triceps skf) – 0.637(biceps skf) + 0.955(BMI) – 13.144

Where, skf = skinfold.

The result of the multible regression analysis are R=0.836 and SEE=1.33 for the stepwise model. According to the stepwise model, the vari-

Table 7: Stepwise regression analysis to develop a new equation

	Regression coefficient	*Standart error for coefficient*	*Tolerans*	*VIF*	*t*	*P*
Intercept	-13.144	3.845			4.214	0.000
Thigh skf	0.126	0.048	0.906	1.104	-3.419	0.001
Triceps skf	0.626	0.184	0.470	2.126	2.602	0.012
Biceps skf	-0.637	0.329	0.465	3.406	3.406	0.001
BMI	0.955	0.227	0.675	1.481	-1.939	0.028
R	R^2	SEE				
0.836	0.742	1.33				

ables thigh, triceps, biceps skinfolds and BMI accounted for seventy four percent of the variability in HW.

DISCUSSION

The research has been performed on adolescent girls playing volleyball. In this study, the subjects in both the 1st and 2nd groups were of average weight and height according to Turkey's changing (Neyzi et al. 2006) norms of growth and development. The 1st group had an average height of 165.84 cm in the 90 percentile, and an average weight of 52.71 kg in the 50-75 percentiles. The 2nd group had an average height of 164.37 cm in the 75-90 percentiles, and an average weight of 52.96 kg again in the 50-75 percentiles.

When looking at the physical characteristics of each group's participants in terms of age, height, weight, and body mass index (BMI), both groups are close to each other. In the 1st group of female volleyball players, the average age was 13.62±00.76 years, average height was 165.84±04.38 cm, and average weight was 52.71±05.26 kg. In the 2nd group of female volleyball players, the average age was a 13.08±00.49 year, average height was 164.37±04.76 cm, and average weight was 52.96±06.32 kg. One group's age could be more or less than the other, taller or shorter, and in terms of body weight could be lighter or heavier, consequently raising concerns about the positive or negative effects on the sport's success. However, since in this study there was an insignificant difference ($p>0.05$) between the physical characteristics of the participants in the 1st and 2nd groups, that condition has been eliminated. In the literature, studies by Thissen et al. (1991) examined volleyball players at an average age of 15.65 years, studies by Duncan et al. (2006) at an average age of 17.5 years, by Tsunawake et al. (2003) at an average age of 17.4 years and studies by Puhl et al. (1982) at an average age of 21 years. Research looking at height values, Thissen et al.'s (1991) study of volleyball players averaging a height of 167 cm found. Duncan et al. found an average height of 190.0 cm (2006). Tsunawake et al. found an average height among volleyball players to be 168.7±5.89 cm (2003). Puhl et al. found an average height among elite volleyball players to be 192.7±3.9 cm (1982). They were lower than Duncan et al. (2006) and Puhl et al. (1982), however they were close to Thissen et al. (1991) and Tsunawake et al. (2003). Related studies on athletes' height differences found those of varying height, ability levels, and genetic structure to play in different leagues. Looking at the weight values, Thissen et al.'s studies reported an average of 50.7kg (1991), Duncan et al. reported 71.30±9.2 kg (2006), and Tsunawake et al. (2003) reported 59.70±5.73 kg. In this current study, the athletes' weight was lower than Duncan et al. (2009) and Tsunawake et al. (2003), however higher than Thissen et al. (1991).

In this study, the 2nd group's percentage of body fat value was higher than the 1st group's value. With regular exercise programs, the body composition changes. Cardio respiratory training and weight training decreases body weight. Fat mass and body fat also decrease in both men and women. In many studies, aerobic endurance training has a determining effect on body composition (Gutin et al. 2001). Hassapidou and Manstrantoni studied elite athletes in different branches of sports. In volleyball players they found a percentage of body fat value of 19.7±3.7 (2011). In study by Duncan et al. (2006), 12.9±3.4 percentage of body fat in volleyball players was found. Thissen et al. (1991) reported 19.6 percent. Tsunawake et al. (2003) found 18.4±3.29 percent. Melrose et al. (2007) reported 21.64±4.26

percent. The results of this study were found to be higher than these results. But results in the study of Melrose et al. (2007) were higher than the 1st group, and lower than the 2nd group volleyball players. Kitagawa et al. (1974) and Wilmore (1983) indicated that the body composition greatly affects the energy-related physical strength and skill in various sports. Percentage fat has been determined by the underwater weighing method at 19.5 percent in college students by Kovaleski et al. (1980), 17.9 percent in college students by Puhl et al. (1982), among volleyball players. According to Tsunawake et al. (2003) the optimal percentage fat in female volleyball or basketball players is estimated to be sixteen to twenty percent. The researchers can say that the differences found in the researches applied and the research examined in the literature may be of cause due to the genetic structure and the training programs applied. The duration of the training, the frequency and the strength are all factors which decrease the ratio of the body fat (Wilmore 1983).

The human body consists of different ratios and densities of muscles, fat and bones. These factors affect the performance of the body at various rates according to the types of sports realized. Effective test programs detect whether the bodies of those realizing the sport is appropriate or not to the sport applied. Thus, the sport scientists have included the studies of the body compositions and physical profiles into their research besides examining the physiological profiles of those occupied in sports. Physical compatibility also brings along the sufficiency required for those sportsmen and as long as such parameters are present, they also provide physical sufficiency. The parameters, which constitute physical compatibility, are the heart resistance, muscle resistance, the body composition, strength, velocity, balance and agility.

The physical structure of a sportsman is of great importance for him to realize physiological strength at maximum means. If such physical structure is not compatible with the branch of sport realized, a fully satisfying performance cannot be put forward. Besides, studies that state that the body composition features greatly affect the capability and energy related to inner physical strength at great means (Bale et al. 1994), sportive performance, mental development, physiological functions, illnesses and behavioral problems also are said to be bound to each other in many studies (Duncan et al. 2006; Lee et al. 1989; Thissen et al. 1991).

According to the performance tests applied to the volleyball players who volunteered in the study, the left and right grip strength, the flexibility, the sit ups, the strength of the back, the strength of the legs, the 20-meter sprint, the vertical jump and the VO^2 max values of the 1st group has been detected to be higher than the 2nd group. In Koley et al.'s (2010) study, values for hand grip strength of volleyball players were 24.21 kg (right hand) and 23.36 kg (left hand), while Melrose et al. (2007) found 34.5±5.5 kg (right hand), 31.60±4.56 kg (left hand) and leg strength values of 77.4±18.1 kg. In this study, the results of 2nd group were similar to those of Koley et al. but results of the 1st group were higher than Koley et al. (2010). In this study, results of leg strength were lower than Melrose et al. This study's 1st group found flexibility levels of 39.85±4.7 cm, while the 2nd group's levels were 23.90±3.5cm. Thissen et al.'s (1991) flexibility values for female volleyball players were 17.01±6.09cm, Melrose et al. (2007) found 38.7±7.1 cm and Duncan et al. (2006) found 37.0±10.7cm. The results of flexibility tests of 1st group in this study were higher than those of Thissen et al. (1991), Melrose et al. (2007), and Duncan et al. (2006). But results of flexibility tests of the 2nd group were lower than Melrose et al. (2007) and Duncan et al. (2006). The difference is due to genetic factors as well as time allocated for flexibility in training. The vertical jump values in this study were detected as 49.05±04.14cm for the 1st group and 37.25±04.62 cm for the 2nd group. Research applied by Puhl et al. (1982) had detected the vertical jump value as 45.9±6.3 cm whilst Thissen et.al. (1991) detected it as 43.6 ± 5.6 cm, Lee et al. found (Lee et al. 1989) 52.8 cm, Melrose et al. (2007) 35.5±6.2 cm and Gabbet and Georgieff (2007) found 45.7±1.6 cm. In this study, results of vertical jump of 1st group were higher than Puhl et al., Thissen et al. (1991), Melrose et al. (2007), Gabbet and Georgieff (2007), however lower than Lee et al. (1989). Results of 2nd group were higher than Melrose et al. (2007), however lower than Puhl et al. (1982), Thissen et al. (1991) and Lee et al. (1989).

With its anaerobic and aerobic components, volleyball has the characteristics of an interval sport. In volleyball, high-skills and technical performance levels such as physical characteristics, speed, and vertical jump, affect performance. In the context of physical appropriateness, volleyball players' anthropometric characteristics and jumping skills were an important factor to overall team success (Galal El-Din et al. 2011). In the study, the 1st group's VO_2max levels were 48.14±02.32 ml.kg^{-1}.dk^{-1}, while the 2nd group's levels were 41.58±02.71 ml.kg^{-1}.dk^{-1}. In studies by Tsunawake et al. (2003), the volleyball players' maximal oxygen consumption levels were 46.5±2.90 ml.kg^{-1}.dk^{-1} (Tsunawake et al. 2003). Kovaleski et al. (Kovaleski et al. 1980) reported 55.5 ml.kg^{-1}.dk^{-1}, Spence et al. (1980) 41.7 ml.kg^{-1}.dk^{-1} and Puhl et al. (1982) reported 50.6 ml.kg^{-1}.dk^{-1}. This study's VO_2max values were higher than those of Toyoda et al., Tsunawake et al., and Spence et al. However, they were lower than the values of Kovaleski et al. (1980) and Puhl et al. (1982). According to the research results reported by Tsukawake et al. (2003) on the top teams' volleyball players, the VO_2max levels per kilogram were found to be 41-56 ml.kg^{-1}.dk^{-1} (Tsunawake et al. 2003). According to these reports, the volleyball players in the 1st group of this study had average VO_2max levels of 48.14 ml.kg^{-1}.dk^{-1}. However, it was observed that the 2nd group volleyball players, while they should be in the same range, were the lowest. The differences between the groups in this study such as genetic structure, training type and intensity are thought to be the reason for varying results.

According to the results of anthropometric measurements, the 1st group's skinfold thickness levels were less then those in the 2nd group. Statistically, there was a significant difference between triceps, biceps, sub capular and calf skinfold levels ($p<0.05$). According to the results of bone diameter measurements, there was a significant difference between the groups biacromial diameter value ($p<0.05$). According to the results of the girth measurements, with the exception of bicep girth, calf girth and abdomen girth ($p<0.05$), there was no significant difference between groups ($p>0.05$). While the difference between the groups in means of the measures of their fathom length ($p<0.05$) was detected as reasonable it was detected that the difference seen in the length of hands and feet between the groups were not of any significant difference ($p>0.05$). There is a parallel relationship between the length of fathom and the height. It is considered that the fact that the length of the fathom in the 1st group was higher compared to the 2nd group may be due to the fact that the heights of the attendants in the 1st group were higher as well. However, when the height values of the groups were examined between the groups and despite the fact that the values of the 1st group were higher compared to the 2nd group values, it was seen that the difference detected was not meaningful statistically ($p>0.05$). It is believed that the fact that the sportsmen in the 1st group with higher measures of shoulders, arms and fathom may have been effective over their thoughts for the selection made at first instance for the specific branch as such features may have been inherited genetically. The fact that the biacromial diameter measures taken in diametric measures and that the measures were detected to be higher in the 1st group also provided the difference detected to meaningful supporting the idea mentioned above. The foundings detected in the research by such means revealed to be in parallel cohesion.

When the somototype profiles were examined in the research it was detected that the structural values of the 1st group were 2.79-2.41-3.19 while the values for the 2nd group were 3.79-2.55-2.83. Endomorphy values of the 2nd group's players were significantly higher ($p<0.05$) than those of 1st group's volleyball players. In relation to mesomorphy and ectomorphy, no significant differences were observed between the two groups. Viviani and Baldin (1993) had separated the volleyball players into two groups as juniors (age<18) and seniors (age>18) and had detected their soma type scores as 4.9-3.8-2.6 and 4.7-3.9-2.3 (Viviani and Baldin 1993). The somatotypes of volleyball players differ according to their positions and levels of performance and depending on the technical and tactical demands placed on the players. In the research applied by Duncan et al. (2006), the average soma type values of the junior players for setters and centers were 2.6-1.9-5.3 and 2.2-3.9-3.6, respectively (Duncan et al. 2006). Many studies have suggested that differences exist in somatotypes between various sports, and at different performance levels (Gualdi-Rosse and Zaggagni 2001; Viviani and Baldin 1993; Makaza et al. 2012; Nikolaidis et al. 2015). However, few of them have examined the whole spectrum of morphological characteristics within each sport (Bayios et al. 2006; Mala et al. 2015). In addition, there has not been enough information about the somatotypes of players and their roles in games in the literature, especially about volleyball players. Bayios et al. discovered that in both the varsity and the junior varsity groups, endomorphy was the dominant somatotype, and mesomorphy value was greater than ectomorphy. Thus, the groups of varsity and junior varsity women volleyball players were characterized as mesomorphic endomorphs. The mean somatotype for the groups of varsity and junior varsity was 4.2-3.7-3.3 (Bayios et al. 2006).

Optimal physique is apparently an advantage to volleyball performance. In this study it was observed that the performance recorded for the 1st group was much better due to their physical features. It was pointed out that the fact that features seen in the 1st group by means of speed, vertical jumps and strength tests applied also revealed to be due to the fact that their endomorphic structures were much less compared to the 2nd group. When comparing the percentages of body fat, the highest percentage of fat in the 1st group was 26.5 percent and the lowest was 19.5 percent. In the 2nd group, the highest percentage of body fat was 32.1 percent and the lowest was 18.2 percent. The average percentage of body fat for the 1st group was lower than the 2nd group's average. There was a significant difference between the 2nd group's percentage of body fat ($p<0.05$). It was seen that the 1st group's endomorphic values were less than the values obtained from the 2nd group during the somatype measurements applied. Therefore, such fact revealed that the distribution of fat in the 1st group's members were less than those compared to the 2nd group's members. The researches applied state that junior players had almost the same somatotype structures (Spence et al. 1980; Viviani and Baldin 1993; Ska and Mridhab 2015). Therefore, it is found necessary to consider the ages of the persons starting sports and that degrees should be applied in accordance to the age and thus that researches applied in great accordance with the components functionally shall be densely carried out.

During the period of 9-14 years of age, significant changes can be seen in composition, such as endocrine, due to exercise related changes. During this period, the follicle stimulating hormone (FSH) and luteinizing hormone (LH) secretions are at a higher level. In females, FSH and LH secretion cause the release of estrogen and ovary delevopment (Wilmore 1983). Physical structure is important in order to reach maximal physiological strength levels. So much so that a particular physical structure may not be able to perform well in specific branches of sports. Physical structure is not enough in sports, as early onset of fatigue can make it difficult to achieve the highest performance levels and desired technical capacity, due to disrupted nerve-muscle coordination. The studies applied reveal the affects of the anthropometry over performance. Especially performance and the constitution of strength are directly related with height, weight, length of arms and legs, mobility of joints and levels of flexibility (Astrand and Rodahi 1986). In volleyball, technical and tactical skills, antropometric characteristics and individual physical performance capacities are most important factors and contribute to the success of a team in competitions (Hakkinen 1993).

For high performance in volleyball competitions, branch specific physical requirements and the player's ability to respond to these requirements need to be considered. The combination of technical and tactic abilities with physical form should be considered for the ability to reach optimal performance. For success in volleyball, a different anatomical structure is most desired. Young people and mental illness are closely related. Physical stability and physical activity levels should parallel. It is seen that the volleyball players are different from players of other sports such as football, basketball and handball in means that they are taller and have a different somototype profile. It is always known and accepted that height is an effective factor in volleyball. However, while choosing the most capable volleyball players, height alone may not be sufficient. Other anthropometric parameters and features must be among the features also to be considered. Whilst the studies state that volleyball players should be tall and have developed muscles with a more dominant mesomorphic structure, the latest foundings point to the importance of ectomorph structural features. Physical structures and physical performance are important factors in reaching peak success in many sport branches.

In this study's more successful volleyball group, physical fitness, percentage of body fat, and somatotype levels were better in terms of features. Therefore, the measurement of these characteristics has an effect on success in volleyball players. The researches applied over sports are mainly due to the will of gaining the success desired at matches. The comparison of players, pointing to the stronger or weaker features of players and precautions to be taken before the matches are rather informative. Such informative factors used and the data applied at trainings is surely to affect the performance of players. The fact of being conscious about the physical and physiological features of players has brought many innovations to sports by means of the trainings applied. Coaches find the chance to develop their trainings in accordance with such information and also constitute unique strategies for themselves.

The results of the multible regression analysis are R=0.836 and SEE=1.33 for the stepwise model. According to the stepwise model, the variables thigh, triceps, biceps skinfolds and BMI accounted for seventy four percent of the variability in HW. This equation needs to be cross-validated on a new group of athletes.

CONCLUSION

In the research applied, the researchers aimed to examine the anthropometric characteristics and physical performances of girl volleyball players with different degrees of success, and detected that from the two groups, they constituted as successful and unsuccessful after an official match applied, the factors related to age, height and weight had no significant difference. When such observation was examined in accordance to the results of the anthropometric results the researchers found that the successful group players had lower values of skinfold structures and thus lower values of body fat percentages. Furthermore, they had larger shoulders and thus a wider length of their fathom, and a wider mass of muscle in their biceps, calf and abdominal areas. It was also detected that players with success in their somatotype structures also had a considerable ectomorphy structure. All these parameters are significantly effective on the physical performance characteristics of successful volleyball players.

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