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Original Article

Anthropometric and physiological characteristics of 13–14-year-old female volleyball players in different playing positions

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Abstract
Introduction: Despite the differentiation of anthropometric and physiological demands according to the technical and tactical requirements of each playing positionin adults, only few studies have examined this issue in young female volleyball players. Thus, the aim of this study was to investigate the effects of playing positions and age on anthropometric characteristics and exercise performance in young female volleyball players. **Material and Methods:**A total of 389 healthy females (n = 389, 14.2 ± 5.5 years old, body mass of 57.05 ± 9.48 kg, height of 1.67 ± 0.07 m, and body mass index of 20.28 ± 2.76), who are high-level volleyball players, volunteered to participate in this study. Participants were divided into six groups according to their playing position [i.e., setters (n = 66), outside-hitters (n = 125), middle blockers (n = 66), opposites (n = 37), liberos (n = 25), and without a specific position (n = 70)] and into two age groups [i.e., 13 (AG13, n = 127) and 14 (AG14, n = 262) years old]. All athletes were assessed for anthropometric characteristics and physical performance. Specifically, athletes completed overhead medicine ball throw (MBT), standing long jump (LJ), countermovement jump (CMJ), spike jump (SJ), flexibility, agility T-test, and sit-ups (SU) trials. **Results:**There was a significant difference ($p < 0.05$) among playing positions in terms of anthropometrics and exercise performance. Specifically, volleyball players without a specific playing position had a smaller body morphology and lower exercise performance (in MBT, LJ, CMJ, SJ, SRT, AT, and UP) compared to other playing positions. However, physiological characteristics were similar ($p>0.05$) among volleyball players with specific playing positions. Regarding age, there was a significant effect on exercise performance, and the mean values of LJ, CMJ, SPJ, MBT, and agility test were higher in olderathletes than in younger ones; whereas sit-ups values were higher in younger players than in older ones. Significant correlations were observed between jumping ability and anthropometric characteristics. **Conclusion:** The results of this study can be used as reference values duringthe talent selection process to provide specific playing position data for this age-group category.The lack of physiological differences among playing positions confirms that anthropometric characteristics can be an adequate identification factor for the primary talent selection for this age group.
Key words:morphological parameters, exercise performance, specialization, skills

Introduction

Volleyball is known as a high technical-tactical intermittent team sport that consists of repeated combinations of short periods ofhigh-intensity offensive and defensive power, i.e dynamic upper and lower limp, activities (blocking, spiking, diving, sprinting, and changes of directions), separated by intervals of low-intensity activities and recovery (Tsoukos et al., 2019a, Malousaris et al., 2008, Gabbett et al., 2007).In the last years, volleyball has been significantly changed and coaches tend to select taller players with advanced morphological characteristics and jumping performance abilities (Palao et al., 2014). It is well known, that anthropometric characteristic isnot influenced by systemic training, thereby,only physiological and technical abilities can be improved substantially (Balyiet al., 2005). The youth participation in well-organized long-term athlete development volleyball programs is the decisive factor during the training process, and the period between 13 and 15 years old in which boys and girls reach height peak velocity (PHV), young participants may further enhance muscle strength, flexibility, and speed, following appropriate for their biological maturation training programs, in parallel with the basic technical skills of the sport (Lidor&Ziv 2010, Balyi et al., 2005). Anthropometric characteristics (stature height, body mass, arm span) andphysical performance (jumping ability, agility, speed) are gradually enhanced with growth and maturation (Milic et al., 2017, Katic et al., 2006) and seem to affect the technical skills such asblockingand spiking (Palao et al., 2014, Lidor&Ziv 2010). It is

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suggested that the above-mentioned anthropometric and physical performance variables could provide important normative data information for volleyball talent selection (Tsoukos et al., 2019b), distinguish elite from novice volleyball players (Pion et al., 2015), and identify players with specific abilities appropriate for different volleyball playing positions (Milic et al., 2017).

Volleyball players are classified into different playing positions according to the player's role. In literature, volleyball playing positions are known as middle blockers, hitters/outsiders, setters, libero, and opposite (Palao et al 2014; Malousaris et al., 2008). It is known that the different playing positions are distinguished by specific functions and responsibilities. Specifically, setters are responsible for setting, blocking, and defense, middle blockers for spiking, blocking and defense, hitters/outsiders for reception, spiking, blocking and defense, opposite for spiking, blocking and defense, and liberos are responsible for reception and defense (Milic et al., 2017; Paolo et al., 2012; Lidor&Ziv 2010; Malousaris et al., 2008). So, the development of specific anthropometric characteristics, physiological features, and technical abilities is a determinant of game performance (Cosmin et al., 2017; Milic et al 2017; Lidor&Ziv 2010; Malousaris et al., 2008). Previous studies have demonstrated that anthropometric and physiological characteristics were different according to the playing position and training level in volleyball players (Martin-Matillas et al., 2014;Palao et al., 2004, 2014, Sheppard et al., 2009; Malousaris et al., 2008; Duncan 2006). In particular, stature height, body mass, and body mass index (BMI) hasbeen reported to be different across middle blockers, opposites,outsiders-hitters, and setters. Furthermore,middle blockers, outside-hitters, and opposites are characterized as the tallest players with greater jumping abilitycompared to other playing positions due to blocking and spiking duties.In contrast, setters and liberos had lower stature height and muscle leg power than the other playing positions due to the defensive and game organization duties(Martin-Matillas et al., 2014, Sheppard et al., 2009; Malousaris et al., 2008; Duncan 2006, Palao et al., 2004, 2014).It is worth mentioning that the majority of the above-mentioned studies had performed on elite, adults, male volleyball players. Thus, whether the effects of playing positions on anthropometric and physiological characteristics existed to younger and female volleyball players remain unknown.

In recent years, exercise physiologists emphasized to the long-term athlete development model, which means that team sports such as volleyball require a generalized approach to early training stages. In particular, athletes should have developed first the fundamental movement and sports skills by the age of 12-15 years old and then the specific technical-tactical skills at middle adolescence (Kliethermes et al., 2019; Myer et al., 2016). However, coaches still over-emphasize on immediate results, and the training preparation is based on the short-term outcome of winning, and as a result, athletestend tobe familiarized earlier with skillsrelated to their playing position (Myer et al., 2015). This could be detrimental in the progressive establishments of the fundamental volleyball kinetic patterns and overallsuccess (Coutinho et al., 2015). However,only few studies have evaluated thephysical performance variables of young female volleyball players and have found conflicting results (Tessutti et al., 2019; Milic et al., 2017, Eler&Eler 2017; Nicolescu & Rada 2017). Eler and Eler (2017) have found a significant difference in exercise performance such as jumping ability and speed among playing positions with the higher performance were observed in hitters and liberos, respectively, whereas other studies have found no differences among playing positions in female volleyball players aged 13-15 yrs (Tessutti et al., 2019; Milic et al., 2017, Eler&Eler 2017; Nicolescu& Rada 2017).

To the best of our knowledge, there are no many studies that have investigated the effect of playing position and age on anthropometric characteristics and exercise performance in young female volleyball players. Therefore, the purpose of this study was to evaluate the morphological characteristics and exercise performance according to playing positions in 13-14 years old female volleyball players. Furthermore, we investigated possible correlations between anthropometric parameters and physiological characteristics such asjumping ability in selected young female volleyball players.We hypothesized that anthropometric characteristics would be different across playing positions, whereas exercise performance would be similar across playing positions in young female volleyball players. Furthermore, older volleyball players would have distinctive differences in anthropometry and physiological variables. Anthropometric characteristics could affect jumping performance in young female volleyball players. The findings of this study may help trainers in team selections with specific anthropometric and physiological characteristics according to the playing positions and appropriatetraining program design.

Material &Methods

Participants

A group of 389 female, high-level volleyball players, preselected from 12 different Greek regions and 108 teams volunteered to participate in this study. Their mean (± SD) age, stature height, body mass, and body mass index were 14.18±5.45 years old, 1.67±0.07 m, 57.05±9.48 kg, and20.28±2.76, respectively. All players were members of sports clubs participating in the Greek national championship of these age groups. They hadan all-around training history of at least 5 years and during the last two years were trained 3 times per week for 90 min in volleyball. Participants were divided into two age groupsi.e., year of breath 2006(AG13, n =127) and 2007 (AG14, n =262) and into six groups according to their playing position(setters: n=66, liberos:n = 25,

middle blockers: n = 66, outside-hitters: n = 125, opposites: n = 37, without a specific position: n = 70). It is worth mentioning that athletes without a specific playing position were all-around players without any specialization yet. Participantswere informed about the purpose and the risks of the exercise protocol. Moreover, their parents signed informed consent after taken detail written information. All measures of the protocol were conducted in accordance withHelsinki declaration as revised in 2012 and approved by the Ethical Review Board of the School Medicine, National and Kapodistrian University of Athens.

Procedure

All measurements were performed during a training camp organized by the Hellenic Volleyball Federation, aiming to detect 60 young females aged 13-14 years old to participate in the selection of the final procedure for the cadet national team.Participants visit the examination indoor hall once and performedanthropometric assessmentand selected physiological exercise testing. Experienced trainers after being previously trained by University researchers were used as examiners. All athletes performed, firstly, anthropometric characteristics assessment, and then evaluated for exercise performance in a randomized order. Prior to the physiological performance assessment, participants performed a 10-min warm-up, consisting of 5 min jogging at player's own pace followed by 5 min of dynamic stretching. Before each test players were instructed in detail for the testing procedure and the examiners gave them two to three familiarization trials. Two trials were performed for each test, and the best trial was kept for statistical analysis. A 30 sec of rest was allowed between trials and 5 min rest between tests.

Measure

Anthropometric Characteristics

Body mass (BM) was measured to the nearest 0.1 kg (SECA 770, Germany), stature height (HT),and arm height (AH) were measured to the nearest 0.5 cm (Seca213 Stadiometer, Germany). Arm span (AS) was assessed using a flexible tape at the level of the extended hands of the participants.All anthropometric assessmentsare conducted according to the International Society for the Advancement of Kinanthropometry guidelines (Marfell-Jones et al., 2012). Body mass index (BMI) was calculated from the participants' height and weight as follows: *BMI*= Body mass/Stature height^2 (kg/m^2). Body surface area (BSA) was estimated according to the Du Bois and Du Bois (1916) formula (BSA = (weight$^{0.425}$*height $^{0.725}$)*0.007184, where the weight is in kilograms and the height is in centimeters.

Exercise Performance Test

Medicine Ball Throw (MBT) Seated (1 kg)

Upper-body muscle strength and explosive power were assessed through a 1-kg overhead medicine ball throw. Children, while seated, were required to pull the medicine ball behind their head with both hands and forcefully throw it forward over the maximum possible distance. Distance of the best effort wasrecorded to the nearest 0.1 m from the seated position to the landing point. The interclass correlation coefficient (ICC) for test-retest reliability for the medicine-ball throw was 0.91 ($p<0.001$).

Jump Performance

Lower body muscle power and explosive force were assessed with three different jump trials: a) standing long jump (LJ), b) countermovement jump (CMJ),and c) spike jump (SJ) tests. Especially, for the standing long jump, players were instructed to initially stand on a standardized starting point and to bend their knees (the depth of the flexion was self-selected) and bring the arms behind the body. Then, with a powerful drive, they extended their legs, while swinging their arms forward, jumped as far as possible, and landed with both feet. The distance from the starting point to the landing point at heel contact was used for statistical analysis. All trials were measured to the nearest 0.01 m. Countermovement jump (CMJ) involves a vertical jump from a standing position with the hands on hips and with a preliminary countermovement. The spike jump consisted of the step approach (medium, long-short steps) that precedes a vertical jump. It was evaluated by using a Vertec Device (Sports Imports, Columbus, OH, USA) by subtracting the height of the extended arm in standing position from the jumping height. The hands must not interrupt the rhythm. The more powerful are the steps, the more effective is the hitting approach. Spike jump was calculated as previously described by others (Sheppard et al., 2009). All jump trials were performed three times with 30-60 sec rest among efforts and the highest value was recorded for analysis. The mean ICC for standing long jump test, countermovement jump, and spike jump were0.94, 0.92, and 0.93, respectively ($p<0.001$).

Sit and reach test (SRT)

The sit and reach test was used for the assessment of flexibility, especially low back and hamstring muscles flexibility (Wells & Dillon 1952). Players took a seated position with legs stretched out straight ahead along the measuring line as far as possible and feet were placed flat against a standardized sit and reach box (Baseline 12-1086 Sit n' Reach Trunk Flexibility Box, Deluxe)and reached forward with both hands as far as possible, not allowing knees to flex. No ballistic movements were allowed and both hands were parallel along the measuring line on the YMCA sit and reach box (foot-line at 22cm). The measuring position was maintained for at least two seconds. ICC was 0.91, ($p<0.001$).

Agility T-test (AT) The T-test measured players' ability to rapidly accelerate, decelerate forward and backward and accurately change direction laterally. Four cones were set at the starting position, after 10 yards(9.14 m)

distance and after 5 yards (4.57 m) to the right and the left, respectively at a 90° angle. Players were instructed to accelerate forward as quickly as possible along withthe 10-yard distance, shuffle sideways (total distance of 20 yards), and then run backward (10yards) to the starting cone, covering a total T-shape distance of 40 yards. A manual stopwatch was used to determine participants' time. The ICC was 0.94 ($p<0.001$).

Sit-Ups Test (SU)

Endurance of the abdominal and hip-flexor muscles was assessed with sit-ups test in 30 seconds. Especially, participants had to perform as many sit-ups as they can in 30 seconds. They lie on the mat with the knees bent at right angles, with the feet flat on the floor and held down by a partner. The fingers are to be interlocked behind the head. Players must raise the chest so that the bent hands touch the knees with the body in a vertical position and then return to the floor. For each correct sit up the back must return and be in touch withthe floor. The 30-sec sit-up test was performed once taking into consideration the intensity of the test and the maximal number was recorded

Statistical analysis

Data presented as means± standard deviations. For the statistical analysis, the SPSS v.23 was used. Shapiro-Wilks and Kolmogorov-Smirnov tests were used for assessing data normality. No violations of normality distribution were found ($p>0.05$). The possible differences between the age groups were evaluated with independent T-test. Moreover,two-way ANOVA with repeated measurement on each factor (age group and playing position) was used to evaluate possible differences among playing positions and age groups. Post-hoc significant between groups differences for each age group and playing positions were investigated with one way ANOVA. Pearson r was used to identify correlations between anthropometric and physiological parameters. Partial eta squared was also evaluated, to determine the magnitude of effect size (ES) of comparisons (small: 0.01–0.059, moderate: 0.06– 0.137, and large >0.138). The level of significance was set at $p \leq 0.05$.

Results

Effect of age on anthropometric and physiological characteristics

No significant main effect of age was observed for anthropometric characteristics between the two age groups (AG13 and AG14). The mean value of stature height was 1.66±0.07 m and 1.67±0.08 m ($p=0.227$), body mass 56.68±010.24 kg and 57.18±9.11 kg ($p=0.132$), body mass index 20.38±2.94 and 20.33±2.50 m ($p=0.286$), body surface area 1.58±0.33 m^2 and 1.63±0.15 m^2($p=0.841$), arm height 2.15±0.10 m and 2.15±0.10 m ($p=0.670$), and arm span 1.68±0.11 m and 1.68±0.08 m ($p=0.165$) for AG13 and AG14group,respectively. There was a significant main effect of age on exercise performance between the two age groups. In particular, jumping height in LJ (AG13: 1.64±0.28 m vs. AG14: 1.69±0.24, $p=0.05$), CMJ, (AG13: 0.31±0.40 m vs. AG14: 0.36±0.21, $p=0.001$), and SJ (AG13: 0.37±0.10 m vs. AG14: 0.41±0.08, $p=0.000$) was greater in the older compared to the younger group. Furthermore, medicine ball throw (MBT) and agility test (AG) performance were significantly different between the age groups with the mean values were higher in older (MBT: 3.96±1.10 m, AG:12.06±1.05 sec) than younger (MBT:3.59±1.09 m, AG:12.35±0.92 sec) volleyball players, whereas the number of repetition during sit-ups test was significantly greater ($p=0.000$) in younger (36.81±10.87) compared to older (32.42±10.04) ones.

Table 1. Anthropometric characteristics of female volleyball players according to their playing position

Playing Positions	N	HT (m)	AHT (m)	BM (kg)	BMI	AS (m)
Setters	66	1.67±0.05*¥	2.16±0.08*¥	57.2±9.04	20.35±2.63	1.68±0.06*¥
Liberos	25	1.57±0.06*	2.04±0.09*	50.22±9.00[a,d]	20.20±3.22	1.59±0.08*
Outside Hitters	125	1.67±0.05*ɪ	2.17±0.08*ɪ	57.39±8.71[b,c,d]	20.32±2.61	1.69±0.10*ɪ
Middle Blockers	66	1.73±0.05	2.23±0.07	61.71±9.74[b,c]	20.58±2.90	1.75±0.06
Opposites	37	1.70±0.07*¥ɪ	2.20±0.09*¥ɪ	59.74±10.00[a,b,c]	20.39±2.44	1.72±0.08*¥ɪ
Without Position	70	1.61±0.06*	2.06±0.09*	51.76±6.61[d]	20.20±2.40	1.63±0.07*
Total	389	1.67±0.07	2.15±0.10	57.02±9.49	20.35±2.65	1.69±0.09

Values are means ± SD from 389 females. HT: stature height; AHT: arm height; BM: body mass; BMI: body mass index; AS: arm span;* Significant differences among middle blockers, setters, liberos, outside hitters, middle blockers, opposite and without specific playing position ($p<0.001$). ¥Significant differences among liberos, setters, and opposite ($p<0.001$).ɪSignificant differences among players without specific position, outside hitters and opposites ($p<0.001$).aSignificant differences among setters, liberos, and opposites ($p=0.01$). bSignificant differences between liberos and outside hitters ($p=0.004$). cSignificant differences among players without specific playing positions, outside hitters ($p=0.001$), middle blockers ($p=0.000$) and opposites (=0.000). d Significant differences among middle blockers, liberos ($p=0.000$), outside hitters ($p=0.05$) and without specific position ($p = 0.000$).

Effect of playing position on anthropometric and physiological characteristics

There was a significant main effect of playing position on anthropometric characteristics (Table 1). In particular, middle blockers were the tallest players with the higher arm height and arm span, as well, in comparison to other playing positions (p=0.000), liberos were significantly shorter than setters and opposites (p=0.000), while the group without a specific playing position was also shorter than outside-hitters and opposites (p=0.000). Furthermore, setters volleyball players were heavier than liberos and opposites (p=0.01). Liberos were lighter than outside-hitters (p=0.004), middle blockers (p=0.000) and opposites (p=0.001). The volleyball player without a specific playingposition was lighter than outside-hitters (p=0.001), middle blockers, and opposites (p=0.000). Finally, the middle blockers group was heavierthanliberos (p=0.000), outside hitters (p=0.05), and the group without specific playing position (p=0.000).BMI was not different across playing positions. There was a significant main effect of playing position on exercise performance (Table 2).In particular, volleyball players without a specific position had the lowest performance inLJ (p = 0.02) and sit-ups tests compared to all specific playing positions. Furthermore, players without a specific position had the lowest flexibility than setters, outside-hitters, middle blockers, and opposites. However, exercise performance was similar among volleyball players with specific playing positions.

Correlations. Interestingly, the performance in countermovement jump was significant correlated with body mass (r = -0.127, p = 0.023), body mass index (r = -0.148, p = 0.008) and arm height (r = -0.157, p = 0.005). Furthermore, spike jump correlated with body mass index (r = -0.116, p = 0.02).

Table 2. Physiological characteristics of female volleyball players according to their playing position

Playing Positions	N	SPJ (m)	CMJ (m)	LJ (m)	STR (cm)	SU (n)	MBT (m)	AG (sec)
Setters	66	0.40±0.08	0.35±0.09	1.70±0.22	13.6±11.4[a]	37.9±10.00[a]	3.81±1.10	12.30±1.04
Liberos	25	0.38±0.08	0.35±0.09	1.67±0.23	14.6±13.2	38.2±9.00[b]	3.30±0.97	12.25±0.81
Outside Hitters	125	0.40±0.10	0.34±0.14	1.70±0.26[c]	15.10±11.20[c]	35.4±9.61[c]	3.93±1.16	12.05±1.01
Middle Blockers	66	0.42±0.10	0.36±0.14	1.67±0.28	16.00±14.1[d]	35.1±9.70[d]	3.88±1.26	12.30±1.06
Opposites	37	0.40±0.10	0.34±0.14	1.70±0.30	14.54±9.72[e]	38.10±10.60[e]	3.91±1.41	12.05±1.00
Without position	70	0.38 ±0.06	0.35±0.13	1.58±0.19	6.00±7.14	22.21±3.28	3.82±0.67	12.60±1.04

Values are means ± SD from 389 females.

SPJ: spike jump; CMJ: counter movement jump; LJ: standing long jump; STR: sit and reach; SU: sit-ups test; MBT: medicine ball thrown; AG: agility T-test. [a]Significant difference between setters and no position players (p<0.005), [b]Significant difference between libero and no position players (p<0.005), [c]Significant difference between outside hitters and no position players (p<0.005), [d]Significant difference between middle blockers and no playing positions (p<0.005) and [e]Significant difference between opposites and no position players (p<0.005).

The normal values in physiological characteristics of 13 and 14-year-old female volleyball playersare shown in Tables 3 and 4, respectively.

Table 3. Normal distribution and percentiles of 13-year-old female volleyball players (AG13) on anthropometric and physiological characteristics.

	AG13 Percentiles						
	5	10	25	50	75	90	95
Stature Height (m)	1.52	1.58	1.62	1.67	1.71	1.76	1.78
Body Mass (kg)	41.81	44.01	49.55	56.95	63.00	69.95	79.75
BMI	16.12	16.67	18.50	20.15	21.72	23.77	26.32
Arm Height (m)	1.96	2.04	2.10	2.16	2.22	2.28	2.32
Arm Span (m)	1.51	1.58	1.62	1.69	1.75	1.80	1.81
Spike Jump (m)	0.22	0.26	0.31	0.38	0.44	0.50	0.54
CMJ (m)	0.04	0.17	0.26	0.33	0.39	0.46	0.50
Long Jump (m)	1.22	1.36	1.51	1.70	1.80	1.95	2.10
Sit & Reach (cm)	-1.95	1.05	7.00	14.00	21.00	27.90	34.80
Sit-Up	20.00	25.00	30.00	38.00	45.00	50.00	56.90
MBT (m)	2.10	2.30	2.80	3.30	4.39	5.40	5.80
Agility Test (sec)	10.87	11.24	11.76	12.39	12.98	13.53	13.81

Values are from 389 females. BMI: body mass index; CMJ: countermovement jump, MBT: overhead medicine ball thrown

Table 4. Normal distribution and percentiles of 14-year-old female volleyball players (AG14) on anthropometric and physiological characteristics.

	AG14 Percentiles						
	5	10	25	50	75	90	95
Stature Height	1.58	1.61	1.65	1.69	1.74	1.78	1.80
Body Mass (kg)	45.00	47.00	53.00	57.80	63.00	70.00	76.00
BMI	16.65	17.36	18.88	19.96	21.80	23.80	24.98
Arm Height (m)	2.02	2.06	2.12	2.18	2.24	2.29	2.32
Arm Span (m)	1.57	1.61	1.66	1.71	1.75	1.80	1.82
Spike Jump (m)	0.28	0.31	0.37	0.42	0.48	0.54	0.56
CMJ (m)	0.20	0.26	0.31	0.37	0.41	0.51	0.57
Long Jump (m)	1.35	1.47	1.63	1.75	1.88	2.00	2.02
Seat & Reach	1.00	2.00	7.00	13.00	20.00	30.00	38.00
Sit-Up	20.00	21.00	30.00	36.00	42.00	47.00	49.00
MBT (m)	2.40	2.65	2.95	3.78	4.90	5.70	6.30
Agility Test	10.26	10.80	11.37	12.00	12.84	13.32	13.76

Values are from 389 females. BMI: body mass index; CMJ: countermovement jump, MBT: overhead medicine ball throw

Discussion

We investigated the possibleplaying position- and age-related differences in anthropometricand exercise performancevariables of young female volleyball players. The main finding of this study was that anthropometric characteristics were similar between age groups 13 (AG13) and 14 (AG14) years old, whereas physiological parameters, such as muscle strength and power of lower and upper body were significantly greater in older(AG14) volleyball players. Furthermore, anthropometric characteristics were significantly different among playing positions, whereas exercise performance was similar among specific playing positions. Anthropometric characteristics could play an important role in determining jumping performance.Finally, we provided reference values in anthropometric and physiological characteristics that could be useful in talent identification and development systems.

Anthropometricand morphological characteristicsin combination with motor skills could be a determinant factor of elite volleyball players (Palao et al., 2014). Previous studies have demonstratedthat anthropometric and body composition parameters are different according to relative age (Papadopoulou et al., 2019), performance level (Kutac, & Sigmund, 2015,Palao et al., 2014),divisions (Malousaris et al., 2008, Giannopoulos et al., 2017) and could be discriminate selected from non-selected players (Tsoukos et al., 2019b). Furthermore, linear dimensions and morphological features are age-dependent and modified during growth and development (Malina, 1994). However, in the present study, we did not find any significant differences in anthropometric characteristics between the two age groups. A lack of significant differences in linear body dimensions between AG13 and AG14 years old could be attributed to different intensive pubertal events (Malina 1994). Unfortunately, in this study, it was not possible to evaluate the maturation level of volleyball players which is a limitation of it.The stature height and body mass of the female volleyball players in the current study were comparable to those reported for young volleyball players of similar age (Milic et al., 2017, Tessutti et al., 2019). However, our participants were shorter in comparison to the female volleyball players of a recent study in Greek population (Tsoukos et al., 2019a). In particular, Tsoukos et al. (2019a) reported higher stature height values in young females participated in the later stage process, the final national selections for junior team, dictating thus, the importance of performance level in talent selection. Moreover, a significant finding of our study is that the mean stature height values of the females' volleyball players were classified between 25th and 50th percentile, while all participants in the study of Tsoukos et al. (2019a) were above 90thpercentile.

Exercise performance in selected physiological tests, such as jumpingability, running speed, agility, upper body muscle power, flexibility, and trunk strength could contribute to talent selection and long-term athlete development programs should be conducted to achieve optimal outcomes (Lidor&Ziv 2010, Tsoukos et al., 2019b, Papadopoulou et al., 2019, Sozen 2012).Physical performance variables of this study were significantly different between age groups (AG13 and AG14)as others have also shown (Ortega et al., 2011; Lidor&Ziv 2010). It is worth mentioning that these differences could be attributed not only to age (Ortega et al., 2011) but also to training level(Lidor&Ziv 2010). Therefore, it could be suggested that oneyear of systemic training in combination with the intense pubertal changes could differentiate performance levels even at this training stage which basic kinetic patterns and development of physical skills could bea determinant in a long-training athlete development model (Melchiorri et al., 2017). Thus, female volleyball players aged 14 years old are potentially stronger, flexible, with higher jumping and agility abilities, which means better spike performance that probably affects court performance (Milic et al., 2017, Nesic et al., 2014).

Playing positions is characterized by specific anthropometric and physiological demandsaffecting team volleyball performance (Palao et al., 2014; Lidor&Zir 2010).Indeed,middle blockers, opposites,and outside-hitters are mostly responsible for blocking, spiking, and defense, so the athletesshould be taller with larger lean body mass and greater physical abilities (upper and lower body muscle power) in comparison to other playing positions(Tsoukos et al., 2019b).Physical performance characteristicshave been highlighted according to playing position in adult volleyball players (Malousaris et al., 2008,Palao et al., 2014, Marques et al., 2009).However, the possible playing position-related differences in physiological characteristics in young female volleyball players remain unclear. In the present study, middle blockers players were the tallest than other playing position players, whereasliberoswere shorter than setters and opposites confirming the results of Milic et al. (2017) and Tessutti et al. (2019). The playing position with the shorter stature height was the liberos and setters. These positionsareresponsible mostly for defense and game organization duties.Few studies have evaluated positional differences in young female volleyball players(Tessutti et al., 2019, Milic et al., 2017). Similar stature height was observed, in the current study, in most of the playing positions to the above-mentioned studies, revealing the importance of this parameter in talent selection(Tessutti et al., 2019, Milic et al., 2017).Significant differences in arm span and height among playing positions suggested that talent detection must include all relative linear anthropometric traits that are not affected by training since it seems to bea determinant of volleyball performance (Stamn et al., 2003).In the current study, middle blockers were heavier than liberosand outside hitters. Moreover, middle blockers, outside-hitters,and opposites were heavier than liberos, while setters were heavier than liberos and opposites. Similar differences between middle blockers and outside-hitters and between setters and liberos were also observed in Milic et al. (2017) study. In that study, the middle setters were at the same height but lighter which is an advantage for high-level volleyball performance (Gabbet et al., 2007).RegardingBMI, was similar among playing positionsas others have also shown (Tessutti et al., 2019, Milic et al., 2017). Furthermore, BMI correlated with jumping performance in CMJ ($r = -0.148$, $p = 0.008$) and SJ ($r = -0.116$, $p = 0.02$) tests. It seems that the greater the body mass index, the lower the jumping performance would be. It is suggested thattalent identification and development systems should be based on anthropometric measurementsin young female volleyball playersdue to the lighter players expected to jump higher and this isan important requirement to effectively perform specific technical volleyball kinetic patterns (Gabbet et al.,2007).

Systematic training and pubertal maturity events affect BMIdifferentlyin females (Lidor&Ziv 2010). In both cases, although BMI cannot be the discriminate factor between lean body mass (LBM) and %fat, is an indicative factor of success in volleyball from the early stages of a talent identification process (Milic et al., 2017).A large individualization based on a combination ofdifferent training characteristics, physiological abilities, and physical attributesexists in young female volleyball players that change dramatically during growth and maturation period (Nikolaidis et al., 2012).This information is important for the coachesto designtraining programs for the young female volleyball players taking into consideration the individual needs of each player and the long training system that will match proper training adaptations and the individual abilities dictating from the biological status of the athletes.

Physiological performance is age- and position-dependent in adult volleyball players (Nikolaidis et al., 2012, Tessutti et al., 2019), whereas seems to be mostly age and not playing position-dependent in young female volleyball players (Tessutti et al., 2019). In the present study, physiological performance variables were similar among specific playing position roles as others have also shown (Tessutti et al 2019; Milic et al., 2017). Alack of physiological differences among playing positionswas probably due to the specific training and dictation process that was adapted in talent identification and development system in Greek volleyball academies. It should be noted that the training process for the age group 13-15 years old is mainly focused to understand the role and the game dynamics, rather prepare them forthe physiological demands of each playing position (Palao et al., 2014). It is worth mentioning that in the present study, we included a group of volleyball players without a specific playing position role (GWR) which means thatcoaches used them in more than one playing position according to the tactical needs of the competition. We observed thatGWRplayers had lower stature height, arm height, and spanin comparison with outside-hitters and opposites players. In addition, GWR players were lighter than outside-hitters, middle blockers, and opposites. Furthermore, they had lower performance in long jump and sit-ups compared to other playing positions and lower flexibility and hand-grip compared to setters, outside-hitters, middle blockers, and opposites. In contrast, they had similar jumping height performance in CMJ, overhead medicine ball throw, and agility in comparison to the other playing positions. We suggested that volleyball players without specific playing positions are more suitable for libero duty according to their anthropometric characteristics and exercise performance. It is worth mentioning that coaches should improve technical skills such as spike jump,muscle powerof lower body, and speed that is well known to support players' abilities during competition (Lidor&Ziv 2010).

Conclusion

In conclusion, this study showssignificant differences in physiological performance between age groups, whereas anthropometric characteristics such as stature height, arm height, and arm span were different among playing positions. Furthermore, exercise performance was similar among specific playing position roles.

Theresults of this study can be used as reference values duringthe talent selection process to provide specific playing position data for this age-group category.The lack of physiological differences among playing positions confirms that anthropometric characteristics can be an adequate identification factor for the primary talent selection for this age group.Future longitudinal studies should be conducted with the inclusion of a control group and more specific to volleyball measures to evaluate year by year changes in both anthropometric and physiological parameters to explain up to what extend the growth and maturation events or the quantity and quality of training may affect game efficacy of young female volleyball players.

Conflict of Interest

None of the authors declare that they have no conflict of interest

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