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Original research article

ANTHROPOMETRIC CHARACTERISTICS AND MOTOR ABILITIES IN 13-15 YEAR OLD FEMALE VOLLEYBALL PLAYERS

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Abstract. *The goal of this research was to determine whether there is a difference in the manifestation of measured anthropometric characteristics and tested motor abilities of female volleyball players that are 13-15 years old. The sample of participants consists of 62 female volleyball players divided into three groups according to their age. The sample of variables has two sub-samples: 18 variables belonging to anthropometric space and 14 variables belonging to the space of motor skills. A variance analysis has indicated significant intragroup differences in all the analyzed variables, except the variable for assessment of flexibility in the shoulder angle region. The results of a post hoc test - the Boniferroni procedure - have determined that the level of differences between the groups, in relation to the examined variables, ranges from those that have statistical significance of p<0,05, for variables of anthropometric space (Body weight, arm span, Body mass index, the Single arm reach test, Both arm reach test, Upper arm and forearm volume) and the same value for the motor skills space (Hip joint flexibility, Squat jump with arm swing, Counter-movement jump with, and without the arm swing), to those that reach p<0,00 for variables of the anthropometric space (Sitting height, Body mass, Chest Volume , Waist volume, Hips, Upper leg, and Lower leg volume) and for variables of the space of motor skills (the Long jump, Medicine ball throw, "Sit and reach" test, the 5,15 and 20 meter run, T-test, Squat jump without arm swing and Squat jump with arms in the block position). Because the applied instruments validate the assumption that these instruments can be used to isolate dimensions in experimental sample, and because these dimensions are significant for success in a motor activity such as volleyball, the results of this research will have broad application, and thus are of both theoretical and practical importance.*

Key words: *anthropometric characteristics, motor abilities, females, volleyball.*

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INTRODUCTION

Nowadays school age girls are involved in diverse volleyball schools and clubs, they actively participate in competitions, and this participation has become an integral part of their lives. As a result, there is a notable trend in expanding children's sport competitions, both at the national and international level. A natural consequence of this trend is the necessity for selection in the sense of the optimal selection of health, structural and other characteristics of a young person, which are adapted to the needs of volleyball games. This is a pre-condition for later guiding and top training of a potential female volleyball player (Kenny & Gregory, 2011).

Hence, it is necessary to enable these girls to develop, from childhood to a successful volleyball player, while taking all the measures not to jeopardize their health. Beginning with the premise that volleyball demands a certain level of anthropological features so players could successfully act in situational conditions, and having in mind that in science, an interdisciplinary approach is the basis of methodological orientation, the subject of scientific research in sport, hence, is anthropological status (Nešić, 2005). Since there are specific issues to certain sport games (Ćopić, Dopsaj, Ivanović, Nešić & Jarić, 2014), there is continuous need for permanent theoretical research and practical testing of the above mentioned specific issues (Aleksandrović, Georgiev, Okičić, Madić & Malezanov, 2007). In volleyball, it means testing specific anthropological characteristics.

The idea behind this study is for it to be a test – one that should examine what previous practice has shown which is: a) that there are, to a bigger or smaller extent, particular differences in anthropological dimensions and in motor abilities that were analyzed in this research on female volleyball players , and b) the efficiency of the realization of tests is affected directly and indirectly by numerous factors belonging not only to the space of motor skills but also to the area of the entire anthropological status of female volleyball players.

The goal of this research was to determine the actual state of anthropometric characteristics and motor abilities and to determine whether there is a difference in the manifestation of those characteristics and abilities of the girls according to their age which ranges from 13 to 15.

METHOD

Non-Experimental Research Methods as a part of a transversal study were applied in this study.

The sample of participants

The sample of participants consists of 62 female volleyball players, the members of the "Eaton Srem Tempo" VC from Sremska Mitrovica. The participants were divided into three groups according to their age. In the group of 13-year-old participants, there were 22 volleyball players, in the group of 14-year-old participants there were 20 volleyball players, while in the group of 15-year-old participants there were 20 volleyball players.

The sample of variables

The total number of measured variables is 32. Out of this number, 18 were variables of anthropometric space which primarily referred to longitudinal and circular body dimensions

of the participants. Besides anthropometric variables, 14 variables of the motor space were also measured, and the variables chosen were those that can estimate abilities that are significant for the performance of specific tasks in the game of volleyball.

Testing protocol

All of the tests were performed in the morning hours (09.00 till 12.00) according to the procedures in the Helsinki declaration. The first step was to measure and estimate the anthropometric status of the female volleyball players (the training period and number of training sessions at a weekly level were noted during the assessment of morphological status). After the standard 10-min warm-up and 5-minute break during which a detailed explanation and demonstration of each test was presented, all the participants, dressed in sport equipment, were tested. All the tests were realized by the same instructors. During the testing, the air temperature was between 18 and 22 degrees Celsius. The protocols in this study were approved by the Ethics Committee of the Faculty of Sport and Physical Education of the University of Belgrade. 48 hours prior to the testing, all the participants had one training session per day, with 90 minutes of light intensity aerobic exercise.

Anthropometric characteristics body height (**BH**), sitting height (**SH**), the arm span (**AS**) were measured according to the standard protocols using standard equipment. The single arm reach test (**MROA**) and Both arms reach test (**MRBA**) **–** anthropometer, according to Martin. The results were obtained with an accuracy of 0.1 centimeters. Body weight (**BH**) **–** medical scales (*Tanita Body Inner Scan, BC – 601).* The results were obtained with an accuracy of 0.1 kilograms. The Body mass index (**BMI**) was determined according to the TM/TV^2 formula. Volumes (**VUA –** upper arm, **VFA –** forearm, **VC –** chest, **VW –** waist, **VH –** hips, **VUL –** upper leg, **VLL –** lower leg) were measured with a centimeter ribbon. The results of the estimated fatty tissue (**PFT**) were determined according to the Jackson Pollock 7 Caliper Method.

The motor abilities were estimated using standard protocols and standard tests. The Standing long jump (**SLJ**), the test for the assessment of the explosiveness of the lower limbs was conducted according to the protocol described by Nešić, Obradović, Sikimić, Ilić, Majstorović & Đurić, 2013; Milić, Nejić & Kostić, 2008. The result was read with an accuracy of 0.5 cm. The Medicine ball throw (**MBT**), a test for the assessment of explosiveness of the shoulder area was conducted according to the protocol described in Nešić et al., 2013. The results were obtained with an accuracy of 1.0 cm. The Sit and reach (**SR**) test for assessment of hip joint flexibility and lumbar part of a spine was conducted according to the procedure described by Martin, Jackson & Morrow, 1998. The result were read with an accuracy of 0.1 cm. The Shoulder Circumduction Test (**SCT**) for the assessment of flexibility in the shoulder joint was conducted according to protocols described in Grujic et. al., 2011. The results were obtained with an accuracy of 0.5 cm. The Hip joint test (**HJT**) for the assessment of flexibility in the hip joint area was conducted in accordance with Jovović, 2007. The results were obtained with an accuracy of 1°.

Three tests, the 5 m sprint (**5m**), 15 m sprint with a flying start (**15m**) and 20 m sprint (**20m**) were used for measuring starting speed, maximal speed and overall speed in running. The measuring was conducted in accordance with protocols described in Bjelica & Fratrić, 2011, Sporis et al., 2007 and Milošević et al., 2013. The result were obtained with an accuracy of 0.1 sec.

Agility was assessed using the T-test (**T-test**). The measuring was conducted in accordance with protocols described in Grbović, 2013; Jakovljević, Karalejić, Pajić, Macura

& Erculj, 2012. It is important to note that the measuring of the time needed was conducted using photocells (PAT 01, *Uno lux*, NS).

Several tests were used for the assessment of the jumping ability and explosive power of the lower limb muscl extensors under different conditions using a sensor mat (PAT 01, *Uno lux*, NS): the Squat jump without an arm swing (**SJ**), Squat jump with an arm swing **(SJA),** Squat jump with arms in the block position (**SJB**), the Counter-movement jump without an arm swing (**CMJ**), Counter-movement jump with an arm swing (**CMJA**) The measuring was conducted in accordance with the protocols described in Hoffman, Ratamess, Faigenbaum, Mangine & Kang, 2007; Markovic, Mirkov, Knezevic, Jaric, 2013. Markovic, Dizdar, Jukic & Cardinale, 2004; Moir, Shastri, & Connaboy, 2008.

RESULTS

The statistical methods used for data processing provided us with information that enabled us to understand the problem and subject matter of this research.

Table 1 The basic descriptive parameters with the results of the ANOVA and the post hoc analysis - Bonferroni procedure results - of tested volleyball players' longitudinal dimensions, body weight and body mass index.

Variable	Age	Mean	SD	min - max	ANOVA	
					F relation	P value
BH (cm)	13	158,97	10,525	143-177	12,429	**,000**
	14	169,18**	6,166	159-181		
	15	172,30$^{\blacklozenge\blacklozenge\blacklozenge}$	9,860	150-187		
SH (cm)	13	83,10	5,267	75-91	17,787	**,000**
	14	88,55**	2,623	84-93		
	15	91,32 $^{\blacklozenge\blacklozenge\blacklozenge}$	5,194	80-99		
AS (cm)	13	163,95	9,658	149-181	9,053	**,000**
	14	172,63**	5,974	160-181		
	15	174,89$^{\blacklozenge\blacklozenge}$	9,921	151-193		
BMI ($kg \cdot m^{-2}$)	13	19,32	2,989	16-29	6,051	**.004**
	14	19,32	2,054	16-25		
	15	21,57$^{\blacklozenge\blacklozenge,\#}$	1,876	19-25		
BM (kg)	13	49,40	11,966	33-77	13,809	**,000**
	14	55,28	6,009	46-67		
	15	64,38$^{\blacklozenge\blacklozenge\blacklozenge,\#\#}$	8,499	43-78		
MROA (cm)	13	206,45	14,557	180-230	7,122	**,002**
	14	217,18	13,107	193-235		
	15	223,87$^{\blacklozenge}$	16,145	186-242		
MRBA (cm)	13	204,13	14,395	179-229	6,273	**,003**
	14	214,82	14,225	185-235		
	15	220,42$^{\blacklozenge}$	15,399	185-240		

13 vs 14, * - p < 0.05, ** - p < 0.01, *** - p < 0.000
13 vs 15, $^{\blacklozenge}$ - p < 0.05, $^{\blacklozenge\blacklozenge}$ - p < 0.01, $^{\blacklozenge\blacklozenge\blacklozenge}$ - p < 0.000
14 vs 15, $^{\#}$ - p < 0.05, $^{\#\#}$ - p < 0.01, $^{\#\#\#}$ - p < 0,000

Table 1 shows the results of the descriptive statistics of longitudinal dimensions, the body weight and body mass index along with the calculated mean value, standard

deviation, minimum and maximum values of each group of participants. Based on the processed results obtained by a statistical analyses of variance (ANOVA), it can be concluded that a statistically significant difference in the mean values does exist between the groups in all the measured variables. From the results that were processed by the post hoc analysis – Boniferroni procedure - the following can be concluded: within all three variables of longitudinal body dimensions (body height, sitting height, arm span), the participants that are 13 years old have significantly lower values than those participants who are 14 and 15 years old, with a statistical significance - body height = ,002 and p=,000; sitting height p=,001; arm span p=,007 and p=,001.

The participants that are 15 years old have statistically significantly higher values of the body mass index and body mass in relation to the participants that are 13 years old (BMI: p=,009; BM : p =,000) and in relation to the participants that are 14 years old (BMI: p=,011; BM : p =,008). The results of the maximal reach tests with one and both arms increase with the participants' age, while the differences between the groups of adjacent age groups are not statistically significant (MROA: 13<14, p=,053;14<15 p=,315 MRBA 13<14 p=,055; 14<15 p=,446).

Table 2 The basic descriptive indicator with ANOVA results and the results of post hoc analysis – Bonferroni procedure - of female volleyball players' circular dimensions

Variable	Age	Mean	SD	min-max	ANOVA	
					F relation	P value
VUA(cm)	13	23,36	3,083	20-33	4,987	**,010**
	14	23,67	2,115	20-30		
	15	25,60$^{\blacklozenge,\#}$	1,923	22-29		
VFA(cm)	13	21,97	1,930	19-28	6,658	**,002**
	14	22,38	1,129	20-26		
	15	23,56$^{\blacklozenge\blacklozenge,\#}$	1,091	22-25		
VC(cm)	13	76,57	7,661	65-100	10,588	**,000**
	14	80,41	3,447	77-82,02		
	15	84,59$^{\blacklozenge\blacklozenge\blacklozenge}$	4,340	74-86,68		
VW(cm)	13	65,15	6,587	55-83	12,327	**,000**
	14	66,55	4,032	61-68,44		
	15	72,39$^{\blacklozenge\blacklozenge\blacklozenge,\#\#}$	2,980	66-73,83		
VH(cm)	13	83,46	19,056	80-110	8,417	**,001**
	14	91,17	4,960	83-102		
	15	98,95$^{\blacklozenge\blacklozenge\blacklozenge}$	6,166	81-110		
VUL(cm)	13	51,24	5,746	43-66	8,725	**,000**
	14	52,57	3,722	46-60		
	15	56,93$^{\blacklozenge\blacklozenge\blacklozenge,\#}$	3,840	48-63		
VLL(cm)	13	33,17	3,347	28-42	9,409	**,000**
	14	34,91	2,444	31-40		
	15	36,91$^{\blacklozenge\blacklozenge\blacklozenge}$	2,394	30-40		

13 vs 14, * - p < 0.05, ** - p < 0.01, *** - p < 0.000
13 vs 15, $^{\blacklozenge}$ - p < 0.05, $^{\blacklozenge\blacklozenge}$ - p < 0.01, $^{\blacklozenge\blacklozenge\blacklozenge}$ - p < 0.000
14 vs 15, $^{\#}$ - p < 0.05, $^{\#\#}$ - p < 0.01, $^{\#\#\#}$ - p < 0,000

Table 2 shows the results of the descriptive statistics of circular body dimensions with the calculated mean value, standard deviation, as well as with minimum and maximum

values of each age group of the participants. Based upon processed data that were obtained by applying the statistical analysis of variance (ANOVA), it can be concluded that a statistically significant difference does exist between the groups in all the measured variables. From the results that were processed in the post hoc analysis - the Bonferroni procedure - the following can be concluded: upper arm volume of the 15-year-old participants is statistically higher in relation to the 13-year-old participants p=,012 and in relation to the 14-year-old participants p=0,42.

The forearm volume of the 15-year-old participants is statistically significantly higher in relation to the 13-year-old participants p=,002 and in relation to the 14-year-old participants p=,033. The value of the chest volume increases with age; however, the difference is not statistically significant between the age-adjacent groups (13<14 p=.074; 14<15 p=,058).

The upper arm volume of the 15-year-old participants is statistically significantly higher in relation to the 13-year-old participants p=,000 and in relation to the 14-year-old participants p=,001. The values of hip volume increase with age; however the difference is not statistically significant between the adjacent age groups (13<14 p=,112; 14<15 p=,118). The upper leg volume of the 15-year-old participants is statistically significantly higher in relation to the 13-year-old participants p=,000 and in relation to 14-year-old participants p=,010. The values of the lower leg volume increase with age; however, the difference is not statistically significant between the adjacent age groups (13<14 p=,118; 14<15 p=,068).

Table 3 shows the results of the estimated fatty tissue of the participants, calculated with the help of the Jackson Pollock 7 caliper method, including: percentage of body fat, quantity of body fat (Kgs of Body Fat), quantity of lean body weight and entire body mass. Based on the presented results, it can be noted that 14-year-old participants have lower values in the percentage of body fat and lower values regarding the quantity of fat components in body composition.

Table 3 Results of estimated fatty tissue

	Age	Body Fat	Kgs of Body Fat	Lean Body Weight	Body Mass
	13	17,47%	8,63	40,77	49,40
PFT	14	15,51%	8,57	46,71	55,28
	15	18,46%	11,88	52,50	64,38

Table 4 shows the results of the basic descriptive indicators of motor variables for the assessment of power and flexibility with the calculated mean value, standard deviation and minimum and maximum values of each group of participants. Based upon the processed data obtained from the statistical analysis of variance (ANOVA), it can be concluded that a statistically significant difference does exist between the groups in almost all the measured variables. The sole exception is the Shoulder Circumduction test variable with a statistical significance at the level of p=, 288. From the results that were processed in the post hoc analysis - the Bonferroni procedure - the following can be concluded: the results achieved for the long jump increase with age and the differences between the ages are statistically significant (13<14 p=,021; 14<15 p=,002). The results achieved in throwing the medicine ball increase with age and the differences between the ages are statistically significant (13<14 p=,037; 14<15 p=,000). Participants that are 15

years old have statistically significantly higher values of achieved results in the "sit and reach" test (they are less flexible) in relation to the 14-year-old participants p=,002 and in relation to 13-year-old participants p=,000. The difference between the age groups of 13 and 14 is not statistically significant p=,866. The values achieved on the Shoulder Circumduction test decrease with age (the flexibility improves); however, the difference is not statistically significant between the age-adjacent groups (13<14 p=,697; 14<15 p=,727). The participants that are 15 years old have statistically significantly lower values of results achieved for the hip flexibility test (they are more flexible) in comparison to 14-year-old participants p=, 037 and in comparison to 13-year-old participants p=,003. The difference between the 13 and 14 year-old groups of participants is not statistically significant p=,688.

Table 4 Results of the basic descriptive indicators with ANOVA results and post hoc analysis results - the Bonferroni procedure - of motor variables for the assessment of the participants' power and flexibility

Variable	Age	Mean	SD	min-max	ANOVA	
					F relation	P value
SLJ (cm)	13	146,85	21,649	110-180	19,703	**,000**
	14	167,50*	21,646	126-205		
	15	194,85$^{\blacklozenge\blacklozenge\blacklozenge,\#\#}$	29,010	132-234		
MBT (m)	13	4,89*	1,349	3-9	24,251	**,000**
	14	6,04	1,231	4-8		
	15	8,10 $^{\blacklozenge\blacklozenge\blacklozenge,\#\#\#}$	1,816	4-11		
SR (cm)	13	18,40	6,373	2-29	9,761	**,000**
	14	19,48	6,148	7-36		
	15	27,05$^{\blacklozenge\blacklozenge\blacklozenge,\#\#}$	7,877	16-40		
SCT (cm)	13	79,36	10,041	57-97	1,270	,288
	14	76,50	10,071	56-95		
	15	73,75	13,829	49-100		
HJT (°)	13	78,45	10,187	63-95	6,267	**,003**
	14	75,30	13,692	45-97		
	15	65,40$^{\blacklozenge\blacklozenge,\#}$	13,100	40-90		

13 vs 14, * - p < 0.05, ** - p < 0.01, *** - p < 0.000
13 vs 15, $^{\blacklozenge}$ - p < 0.05, $^{\blacklozenge\blacklozenge}$ - p < 0.01, $^{\blacklozenge\blacklozenge\blacklozenge}$ - p < 0.000
14 vs 15, $^{\#}$ - p < 0.05, $^{\#\#}$ - p < 0.01, $^{\#\#\#}$ - p < 0,000

Table 5 shows the results of basic, descriptive indicators of motor variables for the assessment of speed and agility with a calculated mean value, standard deviation and highest and lowest values for each group of participants. Based upon the analysis of the data obtained from statistical analysis of variance (ANOVA), it can be concluded that a statistically significant difference in the mean values does exist between the groups in all the measured variables. From the results that were processed in the post hoc analysis - the Bonferroni procedure - the following can be concluded: participants that are 14 years old achieved best results in the 5 meter sprint. The results of this particular age group are statistically significantly better in relation to the results of the 13-year-old participants p=,000 while the difference in relation to the 15-year-old participants is not statistically significant p=,128. The participants that are 13 years old achieved the weakest results on

the 15 meter sprint. The results for this age group are statistically significantly weaker in relations to the results of the 14-year-old participants p=, 000. The difference in the achieved results between the 14 and 15-year-old participants exists (in favor of the 15-year-old group) but is not statistically significant p=,650. As within the previous test, the 13-year-old participants achieved the lowest results for the 20 meter sprint. The results of this age group are statistically significantly weaker in comparison to the results of the 14-year-old participants p=, 000. The difference in the achieved results between the 14 and 15-year-old participants is almost non-existing (in favor of the 15-year-old group) p=,919. Participants that are 15 years old achieved best results on the "T-test". The results of this age group are statistically significantly better in relation to the results of the 14-year-old participants p=,000. The difference in the achieved results between the 13 and 14-year-old participants does exist (in favor of the 14-year-old group) but it is not statistically significant p=,195.

Table 5 The results of basic descriptive indicators with ANOVA results and post hoc analysis results - Bonferroni procedure - of variables of the motor space for the assessment of speed and agility

Variable	Age	Mean	SD	min-max	ANOVA	
					F relation	P value
5m (s)	13	1,3682	,12475	1,15-1,59	9,702	**,000**
	14	1,2317***	,07431	1,14-1,37		
	15	1,2944	,09324	1,15-1,47		
15m (s)	13	2,6670	,19917	2,40-3,17	14,915	**,000**
	14	2,4722***	,11075	2,19-2,62		
	15	2,4298$^{\blacklozenge\blacklozenge\blacklozenge}$	,12134	2,24-2,77		
20m (s)	13	4,0495	,27546	3,55-4,69	16,602	**,000**
	14	3,7228***	,13833	3,48-4,00		
	15	3,7483$^{\blacklozenge\blacklozenge\blacklozenge}$	,16860	3,50-4,18		
T-test (s)	13	13,17	,855	12-15	13,812	**,000**
	14	12,79	,678	12-15		
	15	12,05$^{\blacklozenge\blacklozenge\blacklozenge,\#\#}$	,487	11-13		

13 vs 14, * - p < 0.05, ** - p < 0.01, *** - p < 0.000
13 vs 15, $^{\blacklozenge}$ - p < 0.05, $^{\blacklozenge\blacklozenge}$ - p < 0.01, $^{\blacklozenge\blacklozenge\blacklozenge}$ - p < 0.000
14 vs 15, $^{\#}$ - p < 0.05, $^{\#\#}$ - p < 0.01, $^{\#\#\#}$ - p < 0,000

Table 6 shows the results of the basic descriptive indicators of the motor variables for the assessment of jumping ability with calculated means, standard deviation and highest and lowest values for each group of participants. Based upon the processed data obtained from the statistical analysis of variance (ANOVA) it can be concluded that there is a statistically significant difference between the groups in all the measured variables. From the results that were processed in the post hoc analysis - the Bonferroni procedure - the following can be concluded: the participants that are 13 years old achieved the lowest results for the "Squat jump". The results of this age group are statistically significantly lower in comparison to the results of the 14-year-old participants p=,074. The difference in the achieved results between 14 and 15-year-old participants exists (in favor of the 15-year-old participants) but it has no statistical significance p=,115. The participants that are 13 years old also achieved the lowest result for the "Squat jump A" test. The results

of this age group are statistically significantly weaker in relation to the results of the 14-year-old participants p=,031. A difference in the achieved results between the 14 and 15-year-old participants exists (in favor of the 15-year-old participants), but it is not statistically significant p=,887. The results achieved for the "Squat jump B" increase with age and the differences among the age groups are statistically significant (13<14 p=,028; 14<15 p=,066). The participants that are 13 years old achieved the lowest results for the "Counter movement jump". The results of this age group are statistically significantly lower in comparison to the results of the 14-year-old participants p=,002. The difference in the achieved results between the 14 and 15-year-old participants hardly exists (in favor of the 14 year old group) p=,970. The participants that are 13 years old also achieved the weakest result on the "Counter movement jump A" test. The results of this age group are statistically significantly weaker in comparison to the results of the 14-year-old participants p=,029. The difference in the achieved results between the 14 and 15-year-old participants hardly exists (in favor of the 14-year-old participants) p=,998.

Table 6 The results of basic descriptive indicators with ANOVA results and post hoc analysis results - Bonferroni procedure - of the variables of the motor space for the assessment of jumping ability

Variable	Age	Mean	SD	min-max	ANOVA	
					F relation	P value
SJ	13	19,51	3,739	15-26	9,292	**,000**
	14	22,68	5,609	15-35		
	15	25,62$^{♦♦♦}$	4,314	19-35		
SJA	13	23,67	4,181	18-30	5,595	**,006**
	14	27,60*	5,726	18-41		
	15	28,32$^{♦♦}$	4,662	22-37		
SJB	13	20,45	3,958	14-27	12,431	**,000**
	14	24,45*	6,258	14-39		
	15	27,99$^{♦♦♦}$	4,276	21-38		
CMJ	13	21,17	4,978	14-30	8,242	**,001**
	14	26,08*	4,200	20-35		
	15	25,74$^{♦}$	3,911	19-34		
CMJA	13	27,75	6,453	19-45	4,595	**,014**
	14	31,85*	4,686	25-41		
	15	31,76$^{♦}$	3,342	24-41		

13 vs 14, * - p < 0.05, ** - p < 0.01, *** - p < 0.000
13 vs 15, $^{♦}$ - p < 0.05, $^{♦♦}$ - p < 0.01, $^{♦♦♦}$ - p < 0.000
14 vs 15, $^{\#}$ - p < 0.05, $^{\#\#}$ - p < 0.01, $^{\#\#\#}$ - p < 0,000

DISCUSSION

The goal of this research was to precisely determine the difference between the anthropometric characteristics and motor abilities of female volleyball players that are 13, 14 and 15 years old. With the help of a high number of measured variables and obtained data, the modal characteristics of female volleyball players of the afore mentioned ages were determined. When longitudinal body dimensions are concerned, and because

puberty in girls starts earlier and ends around the age of 15 (Ugarković, 1996; Nešić, 2002), the older girls were, in most cases, close to their final height. Therefore, a statistically almost insignificant increase in height between the groups of participants aged 14 to 15 is expected. A similar set of results for the rest of the measured longitudinal dimensions was also anticipated and dependent on body height. The reach test and sitting height, like body height, decrease growth after the age of 13 (Stojanović, Nikolić & Nešić, 2006). Concerning the period of intensive growth and development of the participants, statistically significant differences in the anthropometric characteristics of diverse groups are to be anticipated. The results concerning the differences between the participants' body masses can be explained with the fact that puberty in girls usually ends when they reach the age of 14 and 15, and changes in body height are minor in that period. On the other hand, as a consequence of the regular and relatively intense physical activity they are engaged in, girls of the age of 15 and older develop muscles and strengthen their body, and because of that, they have statistically significantly greater body mass than younger participants. The data that shows that 15-year-old girls "stand out" from the remaining two groups in terms of the parameters of the body-mass index, which can be also explained by the fact that growth is finalized in this age (longitudinality), while progressive growth of the body continues (muscularity, mass growth). Hence, the body mass index increases with statistical significance (Table 1)

Based upon the seven measures of circular dimensionality, it can be concluded that body volume follows body growth and development, and that highest values are noted in the oldest group of participants (Table 2). In most cases, this difference is statistically significant in comparison to younger participants, which can be explained by the fact that in that very period muscularity of the body increases, as well as the percentage of fat, while all of that contributes to the increase in the volume of body parts that were observed/studied. Recent studies regarding the estimated percentage of fatty tissue in body composition show that the percentage of fat decreases from 25% at the age of 13 (Prokopec, 2003) to 17,2 ± 3,8 % (Thissen-Milder & Mayhew, 1991) at the age of 16, while the results of our research show a minor discrepancy from the above mentioned percentages. This is because there were minor differences in this very parameter between participants of different ages (Table 3).

Based upon three flexibility tests, the results imply that 15-year-old participants are significantly more flexible in comparison to the other two groups of participants, in all of the tested joints (Table 4). These data can be explained by the fact (there is the possibility of a small statistical error regarding the influence of growth and development) that volleyball training positively affects the growth of flexibility (Dopsaj, Koropanovski, Vučković, Blagojević, Marinković & Miljuš, 2007), and that female volleyball player spend more time stretching in comparison to numerous other similar sports (Levine et al., 1987).

In the group of tests estimating speed and agility, the achieved results are consistent and lead to the conclusion that 14 and 15-year-old participants have better developed abilities to accelerate, to maintain maximal speed and to quickly change directions than do 13-year-old participants (Table 5). This agrees with the results of the measuring of the school aged population in our region, according to which the highest increasing in speed is between the ages of 7 to 10, and also between the ages of 13 and 15. It is also known, and confirmed by many studies, that the longitudinal dimension of the skeleton, explosive power (like the high jump and kicking), coordination and above all agility

(Gortsila, Theos, Nešić & Maridaki, 2013) have the strongest influence on the success in volleyball.

If we analyze the results obtained for the jumping ability tests (Tables 4 and 6) it can be noted that it increases with age. Participants that are 13 years old have the lowest results regarding jumping abilities for all the tests, while for most of the tests this difference has a statistical significance. These results were anticipated considering that it is only at the ages of 14 and 15 that the critical period arrives for the development of muscle power (that has a dominant influence on the manifestation of jumping ability). The improvement in the results of jumping ability tests can be explained as the consequence of moving and locomotion during the training of specific motor abilities (Nešić**,** Ilić, Majstorović, Grbić & Osmankač, 2013). Hence, it is a response to volleyball training that contains a high number of jumps and load for the lower limbs extensors (Stojanović, Nešić & Stojanović, 2011). Moving and locomotion manifested on this occasion are on the horizontal level, that is, sudden changes in direction and course of movement (running back and forward, to the side…) are notable. This is adequate for the manifestation of agility and most certainly contributes to the development of explosiveness of the lower limbs extensors - in the case of the horizontal level, which is important for the standing long jump in this case (Dopsaj et al., 2007; Milišić, 2003).

CONCLUSION

The success in playing volleyball, and success in playing other sports depends upon numerous anthropological dimensions. In order to determine any valid differences between the anthropological characteristics of female volleyball players of different ages, and with the goal to program training and enable success monitoring, wider studies are required. Because the applied instruments validate the assumption that by these instruments it is possible to isolate dimensions in the experimental sample and because these dimensions are significant for success in a motor activity such as volleyball, the results of this research will have a wide spectrum of application. Thus they will have both a theoretical and practical importance. In this case it is possible to individualize the programming of the training process while considering the individual's degree of development of his/her manifest dimensions. Depending upon the model of dimensions for a particular sport activity, it would be possible to guide and regulate the transformational training process.

Besides the above mentioned possibilities, the test battery is also available for use for the purpose of orientation and selection of candidates for volleyball. In other words, based upon the potential abilities of athletes and considering the predictive meaning of manifest and latent dimensions, it would be possible to predict the development path of particular female volleyball players. The objective measurement of data concerning athletes can serve not only for control purposes, guidance and regulation, but can also serve as a reference point for the coach's subjective perceptions. In addition to that, and based on the results of this study, it is possible to compute a line of comparative analyses of the dimensions of athletes between specific sport activities, and to compute comparative analyses in relation to the degree of development and dimension structure in a wider population.

The results of this research can be meaningful for volleyball schools that perform selection for further training processes, while they can also be important for those athletes and coaches that have already been selected. The possibility of applying these results in

theory is connected to the possibility of comparing these data with the data obtained by other authors. Bearing in mind that most coaches seem to attribute a great deal of attention to monitoring the motor abilities of young athletes (Nešić, Sikimić, Majstorović, Grbić & Osmankač, 2014), the results of this very research can serve as a unique model for improving the training process.

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ANTROPOMETRIJSKE KARAKTERISTIKE I MOTORIČKE SPOSOBNOSTI ODBOJKAŠICA STAROSTI 13-15 GODINA

Cilj ovog istraživanja bio je da se odredi da li postoji razlika u manifestaciji izmerenih antropometrijskih karakteristika i testiranih motoričkih sposobnosti odbojkašica uzrasta 13-15 godina. Uzorak ispitanika činilo je 62 odbojkašica podeljenih u tri pod-grupe, zavisno od godina starosti. Uzorak varijabli sastojao se od dve pod-grupe: 18 varijabli pripadalo je antropometrijskom prostoru a 14 varijabli pripadalo je prostoru motoričkih sposobnosti. Analizom varijanse utvrđena je značajna razlika između grupa u svim analiziranim varijablama, izuzev varijable za procenu fleksibilnosti u predelu ramena. Rezultati post-hoc testa - Boniferroni test – su ukazali na razlike koje postoje između grupa u pogledu analiziranih varijabli, na nivou statističke značajnosti p<0,05, za varijable antropometrijskog prostora (težina tela, raspon ruku, BMI, dohvat jedne ruke, dohvat obe ruke, obim nadlaktice, obim podlaktice), za prostor motoričkih sposobnosti (fleksibilnost kuka, skok iz čučnja sa zamahom, CMJ sa i bez zamaha rukom), do praga značajnosti p<0,00, za varijable antropometrijskog prostora (visina u sedu, telesna masa, obim grudnog koša, obim struka, kukova, nadkolenice i podkolenice) i za varijable prostora motoričkih sposbnosti (skok u dalj, bacanje medicinke, sed do hvata, trčanje na 5,15 i 20 metara, T-test, skok iz čučnja bez zamaha rukom i skok iz čučnja sa rukama u bloku). Iz razloga što su primenjeni instrumenti pokazali da se mogu primeniti kako bi se izdvojile dimenzije u eksperimentalnom uzorku, i zato što su ove dimenzije značajne za uspeh u motoričkim aktivnostima kao što su odbojka, rezultati ovog istraživanja imaju široku primenu, i samim tim i teorijski i praktični značaj.

Ključne reči: *antropometrijske karakteristike, motoričke sposobnosti, žene, odbojka*.