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Intra-Positional and Inter-Positional Differences in Agility Tests among Youth Female Volleyball Players

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Abstract

In their structure, indoor sports require quick changes of movement direction. Players should possess a high level of ability to change the direction and speed of movement in response to a stimulus, which is one of the major prerequisites for a high level of performance. During a volleyball match, players are involved in different defensive and offensive activities in which agility plays an important role. The aim of this study was to determine the differences between less successful and more successful youth female volleyball players, as well as their inter-positional and intra-positional differences in agility. The study was conducted on a sample of 204 youth female volleyball players whose mean chronological age was 14.11±0.84 years. The players were divided into 5 subgroups according to their playing position (setters, opposite players, passer-hitters, middle blockers, and libero players). The variable sample used to assess agility consisted of 3 tests: Side steps, 9-3-6-3-9 test, and Step-hop test. Methods of data analysis included the determination of metric characteristics for all three agility tests. The analysis of covariance revealed a significant impact of biological age indicators on all agility tests. Furthermore, discriminant analysis of differences showed that more successful volleyball players achieved better results in all three agility tests. High reliability of the test was determined by Cronbach's Alpha coefficient (0.87-0.96). The results of this study showed a positive effect of agility tests in differentiating less successful and more successful players regardless of their position. More successful players achieved better results than less successful players in all tests. Greater biological maturity and training experience represent great competitive advantage in this age group. The obtained inter-positional and intra-positional differences and the influence of the biological age indicator on inter-positional and intra-positional differences in agility tests imply that higher biological maturity and training experience are great competitive advantages in this age group. The primary goal of training in younger age groups should not be the current success in the competition, but rather the preparation for achieving the best possible results in senior competition..

Keywords: *team sport, discriminant analysis, skill, reactive agility, movement structure, biological age*

Introduction

Volleyball is a team sport played by men and women. According to the number of registered members, volleyball is one of the most popular sports game in the world (Varhagen, Van der Beek, Bouter, Bahr, & Van Mechelen, 2004). Furthermore, volleyball is part of the curricular and extracurricular program of physical education for students of both elementary schools and high schools (Podvalej & Gošnik, 2001). Volleyball is a complex sports game in which top performance is achieved through many years of training. In player specialization, it is necessary to consider the specifics of individual playing roles and make use of anthropological abilities

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and characteristics (Vujmilović, 2012). Determining inter-positional differences, but also the differences between more successful and less successful players in a certain playing position can improve the quality of the training process, primarily by developing those abilities and skills that are crucial for successful play in certain positions (playing role) (Milić et al., 2017). Selection for individual playing roles and training individualized according to those playing roles in volleyball should begin to be applied in the U15 age group (Vujmilović, 2012).

Agility is a skill that plays an important role in achieving success in all segments of play (Schaal, Ransdell, Simonson, & Gao, 2013). In volleyball, agility comes to the fore in movement structures that are an integral part of matches during rapid changes of movement direction, acceleration, sudden stops, and jumps (Katić, Grgantov, & Jurko, 2006; Sekulić, Spasić, Mirkov, Ćavar, & Sattler, 2013; Lima, Rico-González, Pereira, Caleiro, & Clemente, 2021). Agility has a reactive and a planned component (Krolo et al., 2020). The reactive component of agility is extremely important in volleyball because players must react quickly and accurately to visual and auditory stimuli during the game (Šimonek, Horička, & Hianik, 2016). Lloyd et al. (2013) emphasize the importance of first developing the preplanned agility in prepuberty and puberty. The authors suggest that the focus in prepuberty should be on fundamental movement skills to achieve a proper movement pattern. In later development, the focus should shift to reactive agility training. However, in children, agility training should vary with consideration to the growth and development of children to reduce the risk of injury (Lloyd et al., 2013).

Previous studies were mainly conducted on a sample of senior players or did not analyze inter-positional and intra-positional differences mainly due to the small sample (Bojikian 2003; Gabett & Georgieff, 2007; Milic, Grgantov, & Katic, 2013). It is characteristic for the age group of youth players (14-15 years) that some players are still in the phase of accelerated growth and development, while others are already near the end of that phase or have finished it. Therefore, in analyzing inter-positional and intra-positional differences, it is necessary to control the possible influence of biological age (Malina et al., 2005). All of the above implies an increase in the number of studies conducted in younger age categories.

Grgantov, Milić & Padulo (2016) analyzed inter-positional and intra-positional differences among female volleyball players using the Step-hop agility test and found no significant differences. Additionally, they found differences between more successful and less successful players in some playing positions. Afterward, the same authors concluded that there are differences between less and more successful female players in all playing positions using one agility test (Katić et al., 2006; Gabbett & Georgieff, 2007; Melrose, Spaniol, Bohling, & Bonnette, 2007; Milić, et al., 2017). There can be found other studies that indicate these inter and intra-positional differences but without controlling the influence of biological age indicators (Schaal et al., 2013; Paz et al., 2017).

Therefore, the aim of this study is to determine the differences in non-specific and specific agility in less successful and more successful female volleyball players. Furthermore, the aim is to examine the relationship between their playing position and individual performance level by controlling the influence of biological age indicators, due to the fact that it is a period of accelerated growth and development and that the tempo of growth and development of young volleyball players is not the same.

Methods

Sample of participants

The study was conducted on a sample consisting of 204 youth Croatian female players whose mean chronological age was 14.11±0.84 years and mean biological age indicator was 14.12±0.76 years. Players' mean body height was 170.10±7.41 cm, body mass 58.92±9.28 kg, and body mass index (BMI) 20.3±2.67 kg/m2. The players are divided into two groups, less successful (119) whose mean chronological age was 13.89±0.79 years with a mean biological age indicator was 13.82±0.65 years and more successful (85) players whit chronological age of 14.43±0.81 years and mean biological age 14.53±0.70. The competitive performance of the players was determined on a Likert scale from 1 to 5. For the representativeness of the sample, volleyball players from all regions, with emphasis on the highest quality clubs at the state level, were included. The players were divided into 5 subgroups according to their playing roles (setters, opposite players, passer-hitters, middle blockers, and libero players). The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the declaration of Helsinki and has been approved by the research Ethics Committee of the Faculty of Kinesiology, University of Split, Croatia (approval No.:2181-205-02-05-18-002 as of January 8, 2018).

Research procedure

The variable sample used to assess agility consisted of 3 tests: Side steps, 9-3-6-3-9 test, and Step-hop test. In all tests, measurements were performed three times, and the average result was used as the final result. More detailed descriptions of the tests can be found in previous studies (Grgantov, Milić, & Padulo, 2016). Biological age was calculated by a method adopted from Mirwald et al. (2002): age at peak height velocity (PHV) and mean PHV were calculated for all participants and then summed up with or subtracted from the chronological age to define the biological age indicator variable (Milić, 2014). Body height, body weight, body mass index were also measured.

Statistical analysis

Data analysis methods included the determination of metric characteristics for all three agility tests and the calculation of descriptive indicators: arithmetic mean (AM) and standard deviation (SD). The Kolmogorov-Smirnov test (KS test) was used to test the normality of distribution.

The inter-positional and intra-positional differences were determined by applying the analysis of covariance (ANCOVA) with a post hoc test of differences (Tukey Unequal N HSD test).

Discriminant analysis was used to analyze the differences in agility tests between less successful and more successful youth female volleyball players. The data were analyzed by the Statistica Ver.12.0 computer program and a PHV calculator (http://taurus.usask.ca/growthutility/phv_ui.cfm?type=2). The statistical significance for all tests was set at $p<0.05$.

Results

The reliability of the tests was confirmed by Cronbach's alpha (CA) coefficient of internal consistency between items presented in Table 1. In all tests, there was a trend of improving the results during three consecutive performances. Inter item variability was analyzed using the coefficient of variation (CV) and the inter-item homogeneity of the applied agility tests was analyzed by the F-test The normality of distribution

was determined by the Kolmogorov-Smirnov test, whose critical value was 0.12. There are no significant deviations from the normal distribution in any of the variables, which means that all tests are suitable for further multivariate parametric statistical analysis. The minimum value was used as the final result of the agility tests.

Table 1. Metric characteristics of specific and non-specific agility test

	Mean±SD	CA	CV	IIR	F-test	p
Side steps (s)	8.83±0.87	0.96	0.03	0.88	48.68	0.00
9-3-6-3-9 test (s)	8.33±0.56	0.87	0.04	0.73	23.19	0.00
Step-hop test (s)	9.74±0.99	0.93	0.04	0.83	235.45	0.00

Legend: (CA – Cronbach Alpha, IIR – inter-item-correlation, F-test among trials)

Descriptive indicators, i.e., arithmetic means and standard deviations of less successful and more successful youth volleyball players, as well as the results of discriminant analysis (discriminant function, canonical correlation coefficient, Wilks' lambda coefficient, degrees of freedom, discriminant function significance test, and group centroids) of the defined subgroups of participants are presented in Table 2.

Table 2. Discriminant analysis of agility tests in less successful and more successful youth female volleyball players (N=204)

Variables	Less successful N=119	More successful N=85	DF
	AM±SD	AM±SD	
Side steps ¥ (s)	9.02±0.86	8.59±0.982	0.64
9-3-6-3-9 test ¥ (s)	8.50±0.58	8.12±0.45	0.91
Step-hop test ¥ (s)	10.01±0.98	9.37±0.90	0.87
Centroids	-0.32	0.45	CanR = 0.36
Wilks' lambda = 0.87			p=0.00

Legend: N – number of participants, AM – arithmetic mean, SD - standard deviation, ¥ - inversely scaled variable, DF – coefficients of correlation between the discriminant function and the variables, CanR – coefficient of canonical correlation, Wilks' lambda – Wilks' lambda coefficient, p – statistical significance level of the discriminant model.

Discriminant analysis of the differences between less successful and more successful youth volleyball players revealed one significant discriminant function, whose coefficient of canonical determination is 0.36.

Based on the value and sign of the group centroids, as well as the value and sign of the projections of individual motor skill variables on the discriminant function, it can be concluded that more successful volleyball players achieved better results in all the applied tests.

The results of inter-positional differences obtained by applying ANCOVA and using the biological age indicator as a covariate on the total sample of participants are presented and more successful in Table 3. Post-hoc analysis (Tukey's Unequal N HDS test) was additionally applied to the tests that significantly affect inter-positional differences. The analysis of the results of inter-positional differences shows a significant influ-

Table 3. Analysis of inter-positional covariance (ANCOVA) with post-hoc analysis of agility tests in the total sample (N=204) and in the sample of more successful volleyball players (N=85), covariate: biological age indicator

Variables (total sample)	Setters N=35	Opposite players N=33	Passer-hitters N=57	Middle blockers N=43	Libero players N=36
	AM±SD	AM±SD	AM±SD	AM±SD	AM±SD
Side steps ¥ (s)*a	8.84±0.78	9.02±0.94	8.50±0.69‡†	9.00±0.96°	9.01±0.91°
9-3-6-3-9 test ¥(s)*a	8.31±0.54	8.48±0.53	8.16±0.44	8.46±0.66	8.37±0.61
Step-hop test ¥ (s)*a	9.91±1.18	9.84±0.97	9.55±0.93	9.71±0.98	9.82±0.98
Variables (more successful)	**Setters N=12**	**Opposite players N=13**	**Passer-hitters N=30**	**Middle blockers N=22**	**Libero players N=8**
	AM±SD	AM±SD	AM±SD	AM±SD	AM±SD
Side steps ¥ (s) *b	8.55±0.60	8.69±0.97	8.36±0.51	8.92±1.09	8.41±0.81
9-3-6-3-9 test ¥ (s)*b	8.06±0.45	8.17±0.31	8.00±0.31	8.29±0.64	8.07±0.45
Step-hop test ¥ (s)*b	9.72±1.32	9.75±0.81	9.69±0.80	9.92±0.99	9.75±0.49

Legend: N – number of participants, AM – arithmetic mean, SD - standard deviation, ¥ - inversely scaled variable, * – significant inter-positional difference between variables obtained by analysis of covariance (ANCOVA), level of significance p≤ 0.05. a - the covariate has no significant difference in relation to the applied motor variables; b- the covariate has significant difference in relation to the applied motor variables; Post hoc analysis Tukey Unequal N HDS test, level of significance p≤ 0.05: ° - significant difference in relation to passer-hitters; ‡ - significant difference in relation to middle blockers; † - significant difference in relation to libero players;

ence of the covariate biological age indicator on all agility tests on the total sample of youth female volleyball players.

On the total sample (N=204), the Side step test was found to have a significant inter-positional difference using covariance analysis. Further, post-hoc analysis (Tukey's Unequel N HDS test) a significant difference was found between passer-hitter and middle blocker (F=12.43; p=0.016) and between passer-hitter and libero player (F=12,51; p=0.014). And the Side step test has no significant difference with the applied biological age variable.

The motor variables 9-3-6-3-9 test and the Step hop test have a significant inter-positional difference on the total sample, but additional post hoc analysis did not establish a difference between the playing positions. The covariate biological age indicator has no significant difference in relation to the 9-3-6-3-9 test and the Step hop test.

Analyzing the results of ANCOVA on a sample of more successful female volleyball players (N=85) using analysis of covariance, a total significant inter-positional difference on the Side step test and 9-3-6-3-9 test was obtained. While the Step hop test has no significant difference by covariance analysis. The covariate biological age indicator has a significant difference in relation to all three applied motor tests. With further post hoc analysis (Tukey's Unequel N HDS test) no significant difference was found in the relationship between the playing positions.

The obtained results show that the indicator of biological age has a significant difference in relation to the applied motor tests in the sample of more successful volleyball players (n=85) which is not determined in the total sample.

The results of intra-positional differences in agility tests between less successful and more successful youth players obtained by applying ANCOVA with the biological age indicator as a covariate are presented in Table 4.

Table 4. Analysis of intra-positional covariance (ANCOVA) of agility tests between less successful and more successful youth female volleyball players (N=204), covariate: biological age indicator

Variables	Setters				Opposite players			
	Less successful N=23	More successful N=12			Less successful N=20	More successful N=13		
	AM±SD	AM±SD	F-test	p	AM±SD	AM±SD	F-test	p
Side steps ¥ (s) D	8.99±0.83	8.55±0.60	1.68	0.11	9.24±0.88	8.69±0.97	0.13	0.43
9-3-6-3-9 test ¥ (s)	8.44±0.54	8.06±0.45	4.32*	0.04*	8.68±0.55	8.17±0.31	6.85*	0.01*
Step-hop test ¥ (s)	10.16±1.09	9.44±1.26	1.93	0.09	10.04±0.92	9.17±0.71	0.62	0.28
Variables	**Passer-hitters**				**Middle blockers**			
	Less successful N=27	More successful N=30			Less successful N=21	More successful N=22		
	AM±SD	AM±SD	F-test	p	AM±SD	AM±SD	F-test	P
Side steps ¥ (s) D	8.64±0.83	8.36±0.51	0.75	0.26	9.08±0.82	8.92±1.09	2.78	0.07
9-3-6-3-9 test ¥ (s)	8.34±0.50	8.00±0.31	6.03*	0.01*	8.63±0.68	8.29±0.64	0.44	0.33
Step-hop test ¥ (s)	9.97±0.97	9.17±0.71	7.38*	0.00*	9.93±0.93	9.50±0.99	0.17	0.44
Variables	**Libero players**							
	Less successful N=28	More successful N=8						
	AM±SD	AM±SD	F-test	P				
Side steps ¥ (s) D	9.18±1.088	8.41±0.81	2.86	0.07				
9-3-6-3-9 test ¥ (s)	8.46±0.63	8.07±0.45	2.07	0.08				
Step-hop test ¥ (s)	9.96±1.04	9.35±0.66	1.29	0.14				

Legend: N – number of participants, AM – arithmetic mean, SD - standard deviation, F-test – test value when testing the significance of intra-positional differences of AM, p-value, ¥ - inversely scaled variable * - significant difference at the level of p≤0.05. D - covariate has a significant difference in relation to the applied variable Opposite players; SB - covariate has a significant difference in relation to the applied variable Middle blockers; L- covariate has a significant difference in relation to the applied variable Libero players.

Regardless of their playing position, players that are more successful achieved better results in all three agility tests due to biological maturity.

A significant intra-positional difference was found in the 9-3-6-3-9 test. ANCOVA revealed that the position of the passer-hitter, according to the performance level criterion, does not differ significantly only in the Side steps test, noting that the F-test coefficients and significance levels were partially corrected under the influence of covariates. The biological age indicator significantly affects the side steps test in middle blockers, whereas in libero players, it significantly affects the Side steps and the 9-3-6-3-9 test.

Discussion

In this study, the analyzed metric characteristics of agility tests had high values. Descriptive indicators and the differences between less successful and more successful players, along with inter-positional and intra-positional differences in all tests, were also analyzed.

The discriminant analysis results showed a positive impact of agility tests in differentiating less successful and more successful players regardless of their playing position which can be compared with similar findings of Gabbett et al. (2007) for male and female volleyball players where they demonstrated differences among different abilities and one of them was agil-

ity. This indirectly emphasizes the importance of universality (versatility) in volleyball players. All positions except libero players participate (to a greater or lesser extent) in the performance of all volleyball elements, both at the net (spike block, lifting for spike) and away from the net (serve reception, field defense, service). Both explosive power and agility are important for the successful performance of these elements (Katić et al., 2006; Milić et al., 2012; Singh, 2016).

The biological age indicator significantly affects inter-positional differences in agility tests across the entire sample of female players. It affects those differences even in a more homogeneous subsample of more successful volleyball players. Therefore, coaches must take into account participants' biological maturity when analyzing positional specifics in terms of agility (Milić et al., 2017).

The analysis of individual playing positions and inter-positional differences among players shows that the players at the passer-hitter position achieve the best results. Similar findings exist in the study of Paz et al. (2017) where hitters were significantly faster than setters and middle blockers. That is confirmed by the fact that 45% of the total actions in the game and 80% of all points in top-level volleyball competitions are won by spike and block (Voight & Vetter, 2003; Stanković, Ruiz-Llamas, Peric, & Quiro-Escudero, 2019) because, in this age group, the play in attack is mainly based on passer-hitters. Besides having to spike very often against a set block, the ability to quickly switch (transition) from serve reception to spiking is very important for the passer-hitters. To be successful in their tasks, they must have good vertical jumping, good starting accelerations, and fast movement direction changes. This study is in agreement with the previous studies of these differences without including biological age indicators (Paz et al., 2017).

The biological age indicator affects the differences between less successful and more successful volleyball players in all positions. More successful volleyball players at all playing positions achieved better results than less successful players in all agility tests. The results are congruent with previous research that used the same individual player performance level (Milić et al., 2012; Grgantov et al., 2013; Milić et al., 2013).

Sudden accelerations and stops, movement direction changes, and vertical jumping are at the basis of quality performance of all technical-tactical elements during a volleyball match (Trajković et al., 2012; Nimphius et al., 2018). These abilities enable reaching the ball in time, which is a prerequisite for successful technical and tactical performance (Katić et al., 2006; Stanganelli et al., 2008; Günay et al., 2019).

This study presents some limitations: (i) The attempt was made to neutralize the influence of the biological age indicator on the inter-positional and intra-positional differences of young volleyball players. The obtained information should not be used as an exclusive criterion for assessing the ultimate potential of young volleyball players. Due to the fact that the dynamics of the development of individual abilities is different for athletes of different biological development. (ii) Although the total sample is large when the entire sample was divided into subsamples by positions and by performance, the resulting subsamples are significantly smaller. (iii) An increase in the results from trial to trial has been observed in the Step hop test because players had a problem caused by two changes in the direction of movement, which were performed with a half turn with the same leg. Therefore, it can be recommended that before the implementation of the test, a training session should be provided to learn correct performance.

Conclusion

The obtained inter-positional and intra-positional differences and the influence of the biological age indicator on inter-positional and intra-positional differences in agility tests imply that higher biological maturity and training experience are great competitive advantages in this age group. However, the primary goal of training in younger age groups should not be the current success in the competition, but rather the preparation for achieving the best possible results in senior competition. If we consider the obtained differences in biological maturity and training experience between less successful and more successful volleyball players in this light, we see a possible problem. During training, not enough attention was paid to biologically younger volleyball players with shorter training experience, and during competition, they do not have enough playtime, which prevents them from gaining the necessary competitive experience. Coaches working with younger age groups need to be aware that greater biological maturity and training experience do not imply a higher level of talent in a particular playing position.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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