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Morphological Characteristics, Technical and Situation Efficacy of Young Female Volleyball Players

Zoran Grgantov[1], Ratko Katić[1] and Vladimir Janković[2]

[1] Faculty of Natural Sciences, Mathematics and Kinesiology, University of Split, Split, Croatia
[2] Faculty of Kinesiology, University of Zagreb, Zagreb, Croatia

A B S T R A C T

The aim of the study was to identify differences in morphological variables and variables for quality assessment of volleyball techniques in young female volleyball players according to age and situation efficacy, and to estimate the effect of technique quality on situation efficacy. A set of 13 morphological measures and 6 technique elements were used in a sample of 246 female volleyball players divided into four age groups: 32 players aged 12–13, 147 players aged 14–15, 50 players aged 16–17, and 17 players aged 18–19. The quality of performance was assessed as a criterion variable. Analysis of variance showed the female volleyball players of various age groups to differ significantly according to the variables assessing the longitudinal skeleton dimensionality, and body mass and volume, as well as in all tests used on volleyball technique evaluation. Analysis of variance within particular age groups additionally clarified the process of modification in all study variables. Regression correlation analysis indicated the set of variables for the 6 evaluated techniques to be a rather good predictor of situation efficacy in all age groups, with service technique as the best predictor of performance quality in youngest players aged 12–13 and 14–15; spike and block techniques in players aged 16–17; and field defense technique in players aged 18–19.

Key words: *female volleyball players, morphological variables, technique and performance quality*

Introduction

The right time for orienting girls toward volleyball is at the age of 9–10 years. All girls who want it and are free from respective health restrictions should preferably be offered an opportunity to practice volleyball. Selection is a process rather than an instantaneous action. It implies continuous follow up of girls at sports schools and in volleyball groups alike. Volleyball talent should be assessed by use of the measures and tests relevant for volleyball performance rather than by training, which may or may not have a major impact.

Weimin[1] points to specificities in female training, related to mental characteristics (emotionality, less pronounced tendency to grouping as compared with men) and physiologic features (better articular mobility, lesser muscle strength, higher fat percentage, etc.). On training, attention should in particular be paid to the prevention of knee and shoulder joint injuries, as these are more common in women than in men.

Results of some studies in female and male junior and senior volleyball players[1–17] suggest the longitudinal skeleton dimensionality, coordination (agility) and explosive strength of the vertical-jump type to have greatest positive impact on volleyball performance. Subcutaneous adipose tissue is the only feature with unfavorable effect on volleyball performance.

The morphological factor defined by skeleton development accompanying the development of muscle tissue is the basis of the overall morphological development, and has been isolated in previous studies in girls aged 7, 8 and 9 (e.g., Katić et al.[18]; Katić[19]).

Toriola et al.[2] investigated anthropometric characteristics of Nigerian male volleyball players (n=15), basketball (n=15) players and nonathletes (n=20). Ectomesomorphy was found to predominate in athletes and endomesomorphy in nonathletes, due to the significantly

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higher amount of adipose tissue in the latter. In a sample of 50 Italian female volleyball players, Viviani and Baldin[3] found a predominance of the endomorphic and mesomorphic somatotype components. In a sample of 234 male and 244 female volleyball players (members of the first and second Italian division), Gualdi-Russo and Zaccagni[4] found the mesomorphic somatotype component to prevail in both sexes. Because of the greater amount of adipose tissue and less developed musculature, the endomorphic component was more pronounced in female than in male volleyball players. The ectomorphic component was greater in first-division male and female volleyball players as compared with those from second division. The ectomorphic somatotype component was more pronounced, and the mesomorphic and especially endomorphic component less pronounced in first- and second-division female players than in amateur female players. The authors conclude that the data obtained could prove useful in the selection of female volleyball players as well as on designing plans and programs of training for specific player positions[4,5].

Stamm et al.[6] investigated the relationship of some anthropologic status dimensions with performance in a sample of 32 female volleyball players aged 13–16. The performance was assessed on the basis of data collected during competition by use of the Game software. The authors found that, among others, anthropometric characteristics had a significant impact on performing all technical-tactical elements in volleyball, spike and block in particular.

The main aim of the present study was to identify the morphological status of female volleyball players aged 12–13, 14–15, 16–17, and 18–19, and to determine the relationship of these status with technique quality and situation performance.

Subjects and Methods

Subject sample

The total study sample consisted of 246 female volleyball players aged 12–19, members of 13 volleyball teams from the Split-Dalmatia, Istria, and Zagreb Counties. The total of 246 study subjects were divided into four age groups: 32 players aged 12–13, 147 players aged 14–15, 50 players aged 16–17, and 17 players aged 18–19.

Twenty players from the above teams did not present for measurement due to injuries, illness or school commitments.

Variable sample

Two sets of variables were used: a set of morphological variables as predictors, and performance of basic volleyball technical elements and assessment of situation performance as criterion variables. Thirteen morphological measures were used on morphological status assessment. All measurements were done according to the procedures proposed by Bourgois et al.[7]

Each variable was measured three times. The following measures were included: standing reach, body height, foot length, body weight, upper arm circumference, abdominal circumference, femoral circumference, elbow diameter, wrist diameter, ankle diameter, subscapular skinfold, triceps skinfold, and suprailiocristal skinfold.

A set of 6 variables were employed for assessment of volleyball technical efficacy:

- Service – volleyball court (9x9 m) is divided into 4 squares (4.5x4.5 m). The player shoots the squares (short parallel, long parallel, short diagonal, long diagonal) from the service line by 4 float services.
- Serve reception – the coach serves two light services from zone 1 to zone 5, then to zone 1 (to 4.5x4.5 m squares marked for service). The player is standing in the zones, trying to receive service by forearm pass into the setting zone. The player only receives the services that are precisely, slight-arch directed.
- Setting – the coach throws four balls from zone 3 (standing at 1-m distance from the net, on the line separating the left and right front squares) to the player for setting. The first ball is thrown to zone 2 and set to zone 4; second ball is thrown to zone 1 and set to zone 4; third ball is set from zone 5 to zone 2; and fourth ball is set from zone 4 to zone 2. All settings are performed in front of the head.
- Spike – the coach throws four balls with both hands from the setting zone upward to zone 4 (for the left-handed to zone 2). Two balls are spiked diagonally and two along the line.
- Block – the player mock block in zone 3, then moves to zone 2, where she blocks the ball directed to her hands by a handball throw by the coach. The coach is standing on the bench on the opposite side of the net. This is repeated once again, followed by block from zone 3 to zone 4 twice.
- Field defense – the coach stands by the net in zone 2 (with his back to the net). The player stands at square center in zone 1. The coach first throws sharply 2 balls to 0.5–1 m in front of the player, who played the ball by sprawl, then throws 2 balls upward in front to zone 2. The player performs right roll followed by left roll.

All participants were first videotaped to avoid any subjective evaluation. Then six independent assessors (professors of kinesiology specialized in volleyball) evaluated their performance on the Likert scale (from poorest 1 to maximal 5) by watching the videotaped material.

The assessors received instructions describing ideal performance of particular volleyball techniques according to their key elements. The assessors were expected to estimate the rate of deviation from the ideal performance according to crucial technique elements in each individual player. This deviation could be estimated as minor, medium or major.

Accordingly, the individual player's performance could be evaluated as follows:

– score 5 – ideal performance in all crucial technique elements
– score 4 – performance with one minor deviation from ideal performance
– score 3 – performance with one medium or two minor deviations from ideal performance
– score 2 – performance with one major, two medium, one medium and two minor, or three minor deviations from ideal performance
– score 1 – more deviations from ideal performance than listed in score 2.

One variable based on team quality and on individual player's quality within the team each were established for assessment of situation performance of female volleyball players:

- Team quality – teams were ranked according to quality into 3 groups (Table 1, column 1) as follows: group 1 including elite teams of the respective age group (with competition ranking as the criterion); group 2 including medium quality teams; and group 3 including low ranking teams.
- Individual player's quality within the team– according to this criterion, the coaches categorize their team players into 3 groups: group 1 including leading team players (1–3); group 2 including the rest of starting players and players entering the game, thus contributing to team result (3–6); and group 3 including players who very rarely or never enter the game.

Using a combination of these assessments, i.e. team quality and individual player's quality within the team, each player's performance is scored 1–5, as illustrated in Table 1.

The players taking active part in national team of the respective age group are scored 5 and 4, even if ranked as group 3 members. Table 1 shows that there is only one combination for a player to be scored 5 and 1, two combinations to be scored 4 and 2, and three combinations to be scored 3; thus, the variable obtained can be presumed to have normal distribution. This method of performance evaluation is simple, reliable and objective, therefore this original approach to quality assessment has also been proposed for use in other sports.

TABLE 1
CRITERIA FOR RANKING PLAYERS ACCORDING TO QUALITY

Team quality	Player's quality within the team (evaluated by coaches)		
	Group 1	Group 2	Group 3
Group 1	5	4	3
Group 2	4	3	2
Group 3	3	2	1

TABLE 2
BASIC DESCRIPTIVE PARAMETERS OF MORPHOLOGICAL VARIABLES AND VARIABLES ASSESSING VOLLEYBALL TECHNIQUES (X±SD) IN FEMALE VOLLEYBALL PLAYERS OF DIFFERENT AGE GROUPS

Variable	1 (n=32)	2 (n=147)	3 (n=50)	4 (n=17)
Standing reach	221.59±7.95	223.55±9.00	227.12±9.71	231.00±10.87[b]
Body height	169.33±6.09	170.86±6.45	174.36±6.57	175.99±7.37[c]
Foot length	24.73±1.11	24.88±1.22	25.24±1.20	25.76±1.43[b]
Body mass	55.92±8.62	59.51±7.28	63.98±8.46	66.84±7.37[c]
Upper arm circumference	25.14±2.39	25.80±2.23	26.72±2.20	26.88±1.78[b]
Abdominal circumference	72.35±4.60	74.29±5.89	77.85±5.81	80.26±5.44[c]
Femoral circumference	53.96±4.07	55.23±3.89	57.60±4.15	58.21±2.59[c]
Elbow diameter	6.31±0.36	6.37±0.32	6.49±0.34	6.44±0.27
Wrist diameter	5.23±0.27	5.32±0.27	5.40±0.27	5.33±0.28
Ankle diameter	6.58±0.40	6.60±0.35	6.66±0.33	6.79±0.59
Subscapular skinfold	9.48±3.19	10.08±2.75	10.98±3.01	11.04±2.23
Triceps skinfold	14.79±3.89	14.85±3.93	16.24±4.08	14.76±2.52
Suprailiocristal skinfold	11.74±4.62	11.09±4.09	11.75±4.13	10.70±3.43
Service	2.84±1.07	2.94±0.99	3.45±0.96	3.87±0.87[c]
Serve reception	2.80±0.84	3.19±0.90	3.25±0.83	3.86±0.78[b]
Setting	3.12±1.02	3.15±0.87	3.53±0.78	3.52±1.01[b]
Spike	2.77±1.01	2.90±0.94	3.38±0.84	3.78±0.82[b]
Block	2.88±0.78	2.99±0.84	3.27±0.76	3.24±1.26[b]
Court defense	2.41±0.99	2.62±1.01	2.94±0.77	3.87±0.87[a]

Age groups: 1 – 12–13 years, 2 – 14–15 years, 3 – 16–17 years, 4 – 18–19 years
[a]$p<0.05$, [b]$p<0.01$, [c]$p<0.001$

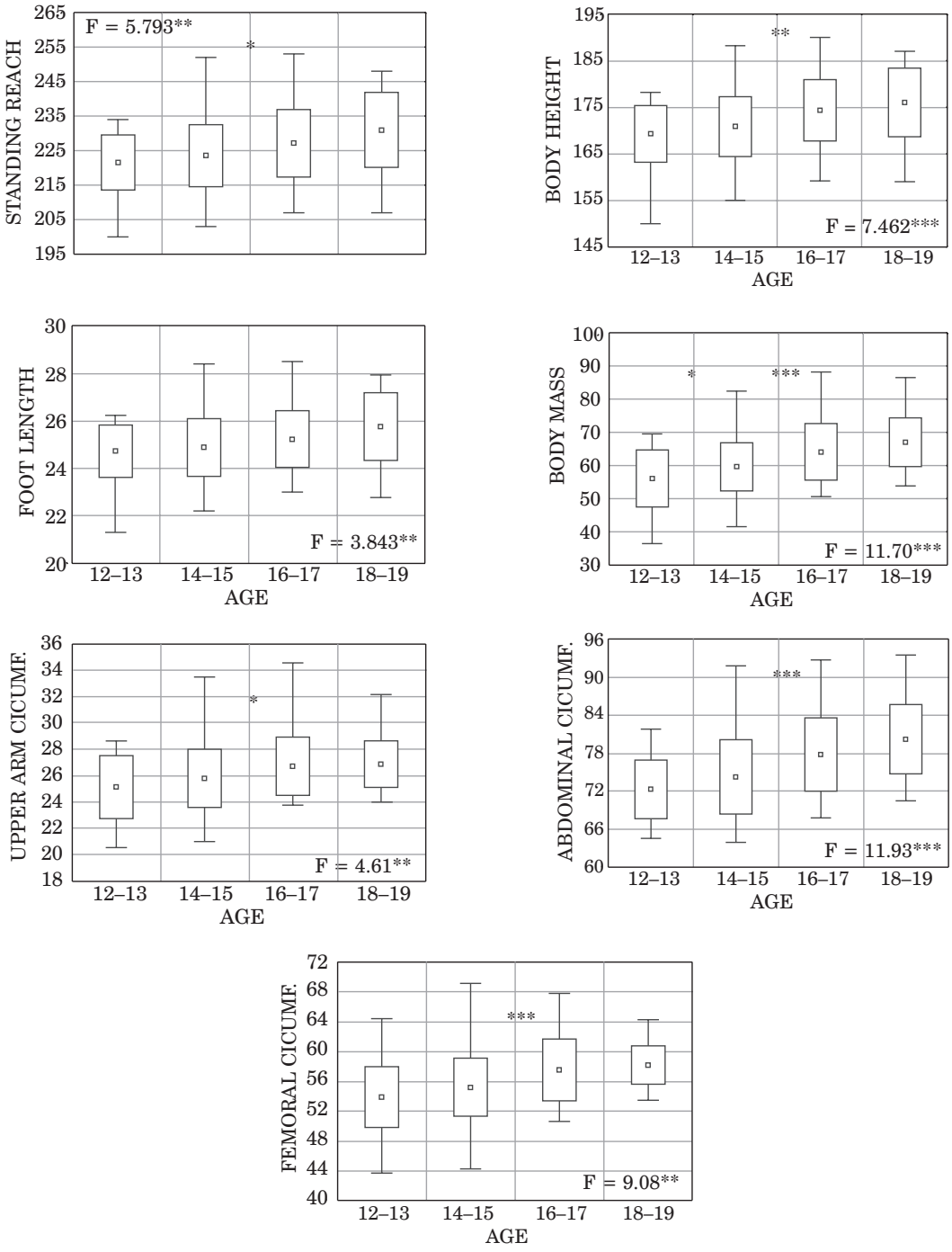

*Fig. 1. Analysis of variance of anthropometric variables. *p<0.05, **p<0.01, ***p<0.001. Circumf. – circumference, skinf. – skinfold.*
(continued on next page).

Data analysis

The basic descriptive parameters of morphological variables, technique variables and performance variables were calculated first (arithmetic mean and standard deviation) for each group of study subjects.

Univariate analysis of variance was used to test the significance of differences in the variables for assessment of anthropometric characteristics and variables for quality assessment of volleyball techniques among different age groups. Analysis of variance was also performed within particular age groups in order to additionally clarify the process of modification in all study variables.

Regression correlation analysis was also employed to determine correlation between the quality of technique and performance, i.e. playing quality.

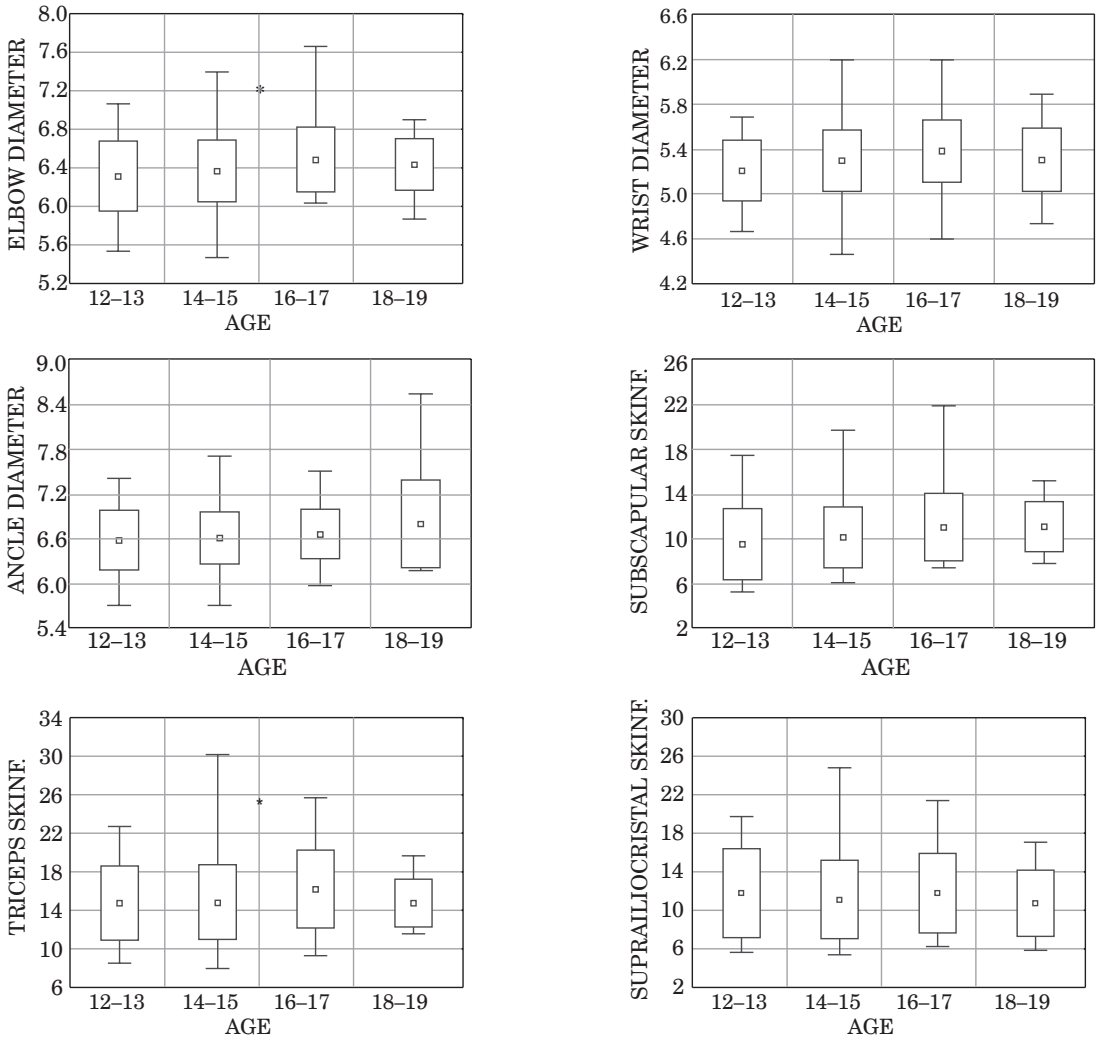

*Fig. 1. (continued from previous page): Analysis of variance of anthropometric variables.*p<0.05, **p<0.01, ***p<0.001. Circumf. – circumference, skinf. – skinfold.*

Results and Discussion

Analysis of variance of anthropometric variables (Table 2 and Figure 1) indicated the female volleyball players of various age groups to differ significantly in the variables evaluating longitudinal skeleton dimensionality and voluminosity. Changes were more pronounced at the turn from age 14–15 to age 16–17. Body height was by 3.5 cm greater in 16–17 than in 14–15 age group, and by 1.7 cm in 18–19 than in 16–17 age group. This could be explained by the process of selection, which was especially emphasized at the turn from 14–15 to 16–17 age group (corresponding to high school enrollment). Obviously, in this period the players with more pronounced longitudinal skeleton dimensionality were selected as competition team members. Thus, the role of longitudinal skeleton dimensionality in competition success increased in older age groups.

Longitudinal skeleton dimensionality enables ball contacts at a greater height above the net, which is of utmost importance in spiking and blocking. However, due to the complexity of these elements, considerable amount of time is needed to master the technique and to apply it in situation conditions (at competitions).

For these reasons, longitudinal skeleton dimensionality does not entail any significant competition advantage in the players aged 12–13. The more so, in very tall players it may even have an unfavorable effect on situation performance because of accelerated growth and development. It is of paramount importance that the coaches be aware of it and to offer adequate opportunities to the very tall players to play, even at the cost of less successful competition results. It is also important to pay due attention to these players on training sessions. The ideal option is individual training, which should be by far more practiced, especially in the work with young age groups. May these factors be neglected, which frequently happens due to the great wish for the best possible results, the extremely tall players fail to realize their utmost

playing abilities, and may occasionally cease playing volleyball too early.

When the longitudinal bone growth has reached the peak, the longitudinal skeleton dimensionality is being integrated into the players' situation-motor complex.

Then the technical-tactical elements performed above the net (spike and block) become prominent.

However, it should be borne in mind that, in this sample, most successful players aged 18–19 generally play at the setter and libero positions. At these positions, the pronounced longitudinal skeleton dimensionality is not as important as in other positions. These positions require considerable playing experience.

A player at the libero position should have a very high precision in serve reception. This requires high quality technique as well as emotional stability.

A setter is expected to set precise balls to the spikers, with due consideration of the characteristics of both her team-mates and opposite team members. Several-year playing experience is needed for all this information to be properly integrated in the setting tactics.

Most successful players aged 16–17 are very tall girls (mostly members of junior team) that generally play middle attacker position. At this position, a pronounced longitudinal skeleton dimensionality is of great importance, and can at the same time be covered by players with shorter playing experience.

As there were no significant differences in the variables for assessment of subcutaneous adipose tissue among volleyball players of various age groups, the significant differences in the variables for assessment of body voluminosity could in part be explained by the impact of training process on the muscle tissue increase. These differences may have in part resulted from the process of selection according to particular motor abilities. To a certain extent, the muscular mass increase has a favorable impact on the players' explosive strength and agility.

The variables for assessment of body voluminosity also showed greatest differences at the turn from 14–15

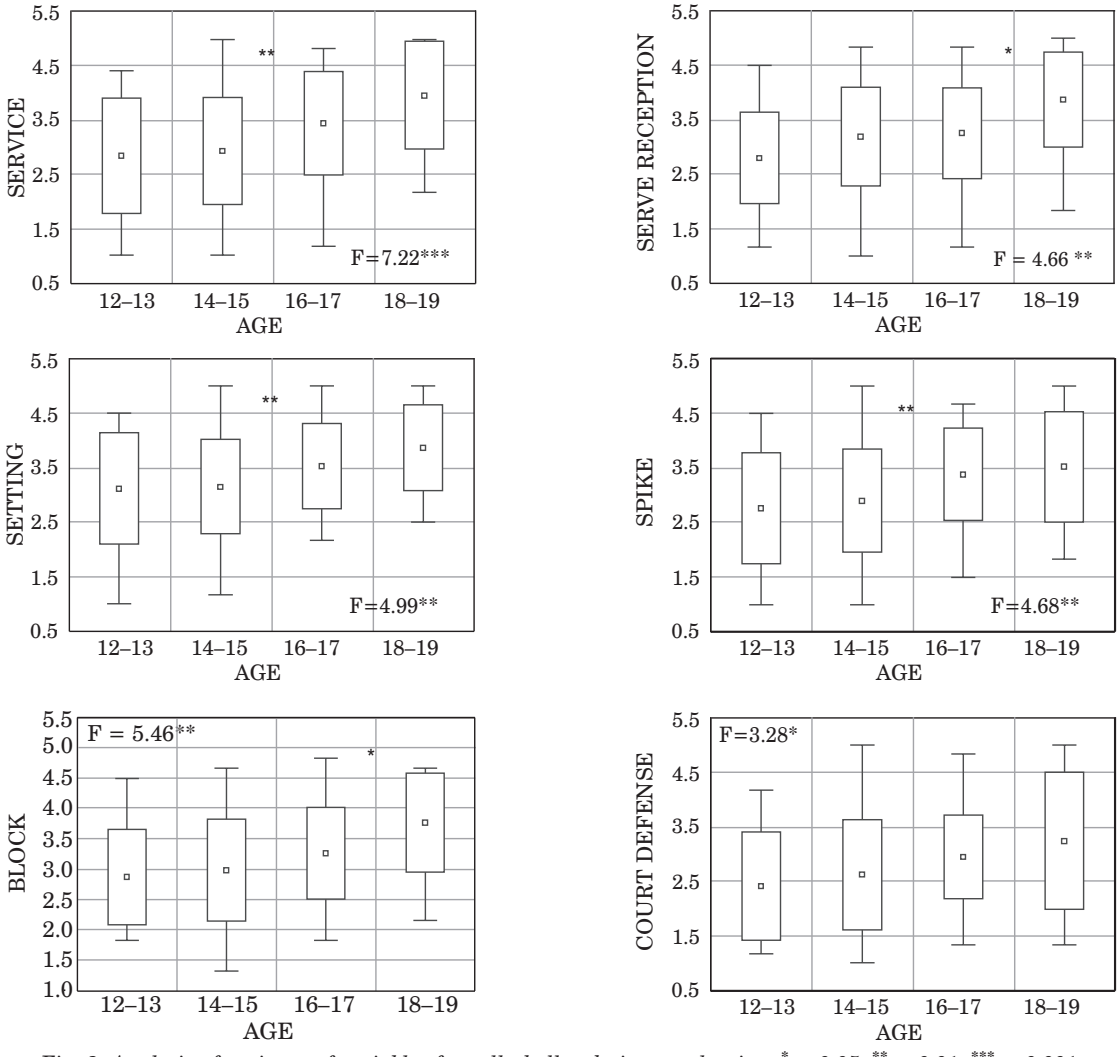

Fig. 2. Analysis of variance of variables for volleyball technique evaluation. $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$.

to 16–17 age group, as expected considering the intensified process of selection in this period as well as the work in small groups and with a higher number of training sessions *per* week in comparison to the preceding age group. Eventually, it results in greater training load, thus the adaptive processes of the body also being more pronounced (e.g., muscle tissue increase).

Some authors, e.g., Gualdi Russo and Zaccagni[4], suggest that excessive subcutaneous adipose tissue exerts an unfavorable effect on situation performance in volleyball players. As the amount of subcutaneous adipose tissue can be reduced by appropriate diet and exercise, it is quite a surprise that there were no significant differences in the variables for subcutaneous adipose tissue assessment among female volleyball players of various age groups. Therefore, all individuals involved in the training process (coaches, players, and their parents) should be advised to pay more attention to appropriate dietary habits and exercise directed to reduction of excessive subcutaneous adipose tissue.

The analysis of variance (Table 2 and Figure 2) revealed the female volleyball players of various age groups to differ significantly in all variables for assessment of the volleyball element technique quality. It was expected because a high quality technique is a major precondition to achieve supreme competition results.

Like in case of variables for assessment of anthropometric characteristics, changes in the aspect of technique were also most pronounced between the 14–15 and 16–17 age groups, most likely as the result of a combined impact of volleyball training directed toward technique improvement and the process of selection, which is especially emphasized at the turn between elementary and high school.

Volleyball elements are technically very demanding, especially those performed on jump (spike, block, jump service, and jump set). A great number of repeats over years of training are needed for the technique of volleyball elements to improve and become automatic. Therefore, the significant changes in the quality of service technique, setting, and spike at the turn from 14–15 to 16–17 age group, and in the quality of service reception technique and block at the turn from 16–17 to 18–19 age group were no surprise.

Summing up the results obtained in all tests for technique assessment and dividing the sum by the number of tests yielded a pooled mean value of the technique, which was 2.8, 3.0, 3.3 and 3.7 for the 12–13, 14–15, 16–17 and 18–19 age group, respectively.

Obviously, the elementary technique of all volleyball elements is important for competition success. This is quite logical because a high quality technique enables the players to make the best of their anthropometric properties and motor abilities.

The results listed above also indicate that mastering of the technique of volleyball elements is a longstanding process that should be paid due attention in all age groups.

Analysis of variance among particular age groups of female volleyball players revealed the process of selection and training to result in increased longitudinal skeleton dimensionality and voluminosity, and improved technique of all volleyball elements.

Analysis of variance was also performed within particular age groups in order to additionally clarify the process of modification in all study variables (Table 3). The players were divided into two groups according to the criterion of situation performance. Group 1 included players with average to under-average performance (score 1–3), and group 2 those with above-average performance (score 4–5).

In all age groups, the players with their performance scored 4–5 differed significantly from their less successful fellow players in all variables assessing longitudinal skeleton dimensionality (except for body height in the 18–19 age group) and in all variables assessing technical performance (except for serve reception, spike and court defense in the youngest age group).

All age groups were characterized by the absence of any significant difference between the players with low-score and high-score performance in the variables assessing voluminosity and subcutaneous adipose tissue (with the variable of femoral circumference in 18–19 age group as the only exception).

Thus, the significant differences in the variable of body weight among study groups of female volleyball players (all age groups except for those aged 12–13) could probably be explained by positive correlation of body weight and body height.

The results of the study are consistent with those reported elsewhere, e.g., Toriola et al.[2], Viviani and Baldin[3], Gualdi-Russo and Zaccagni[4], Stamm et al.[6], demonstrating the favorable effect of longitudinal skeleton dimensionality on volleyball performance.

Regression correlation analysis yielded substantial information on the effect of technique quality on volleyball performance in various age groups. The set of variables of the six volleyball techniques evaluated is a good predictor of situation efficacy in each age group (Table 4). Multiple correlation of the set of predictors with the criterion was rather high in the 14–15, and in the 16–17 and 18–19 age groups alike, confirming that performance quality is predominantly determined by technique quality in female volleyball.

Particular techniques play a varying role in the expression of playing quality according to age groups. Thus, serve technique is the best predictor of playing quality in 12–13 age group, block and spike techniques in 14–15 age group, spike and block techniques in 16–17 age group, and field defense in 18–19 age group. Grgantov et al.[20] found similar effects in beach volleyball.

These results indicate the sequence and rate of learning particular volleyball techniques, which is closely related to the technique complexity. Having learned the serve technique to a certain extent (in addition to the previously acquired technique of ball setting), the play-

TABLE 3
MEAN VALUES OF MORPHOLOGICAL VARIABLES AND VARIABLES ASSESSING VOLLEYBALL TECHNIQUES IN FEMALE VOLLEYBALL PLAYERS OF DIFFERENT SITUATION EFFICACY

Variable	1 (n=32)		2 (n=147)		3 (n=50)		4 (n=17)	
	Group 1 (n=19)	Group 2 (n=13)	Group 1 (n=119)	Group 2 (n=28)	Group 1 (n=40)	Group 2 (n=10)	Group 1 (n=8)	Group 2 (n=9)
Standing reach	217.63	227.38[c]	222.05	229.93[c]	225.45	234.56[a]	224.38	236.89[a]
Body height	166.82	172.99[b]	169.65	176.02[c]	173.44	178.47[a]	172.36	179.22
Foot length	24.39	25.23[a]	24.76	25.37[b]	24.99	26.33[b]	24.83	26.59[b]
Body mass	54.35	58.22	58.72	62.84[b]	62.39	71.05[b]	62.77	70.45[a]
Upper arm circumference	24.97	25.38	25.80	25.78	26.59	27.28	26.28	27.40
Abdominal circumference	72.09	72.72	74.00	75.56	77.39	79.90	78.70	81.65
Femoral circumference	53.50	54.64	54.94	56.43	57.17	59.53	56.77	59.49[a]
Elbow diameter	6.19	6.49[a]	6.36	6.41	6.46	6.61	6.41	6.46
Wrist diameter	5.18	5.32	5.30	5.40	5.37	5.55	5.33	5.33
Ankle diameter	6.46	6.74	6.58	6.70	6.61	6.84	6.79	6.80
Subscapular skinfold	10.24	8.38	10.22	9.45	11.15	10.19	11.03	11.05
Triceps skinfold	15.86	13.24	15.09	13.83	16.36	15.72	13.80	15.61
Suprailiocrist. skinfold	12.50	10.63	11.19	10.66	12.22	9.66	10.87	10.55
Service	2.04	3.38[b]	2.69	3.68[c]	3.22	4.38[b]	3.17	4.67[c]
Serve reception	2.60	2.94	3.03	3.69[b]	3.14	3.83[a]	3.24	4.43[b]
Setting	2.40	3.60[b]	2.95	3.73[c]	3.40	4.19[b]	3.29	4.37[b]
Spike	2.28	3.09	2.61	3.77[c]	3.18	4.24[c]	2.83	4.13[b]
Block	2.36	3.22[a]	2.72	3.83[c]	3.07	4.02[c]	3.15	4.33[c]
Court defense	1.91	2.74	2.42	3.21[c]	2.80	3.52[a]	2.17	4.19[c]

Age groups: 1 – 12–13 years, 2 – 14–15 years, 3 – 16–17 years, 4 – 18–19 years
Situation efficacy: group 1 – performance scored 1–3, group 2 – performance scored 4–5
[a]$p<0.05$, [b]$p<0.01$, [c]$p<0.001$

TABLE 4
REGRESSION ANALYSIS OF SITUATION PERFORMANCE IN THE AREA OF VOLLEYBALL TECHNIQUES FOR FEMALE VOLLEYBALL PLAYERS OF DIFFERENT AGE GROUPS

Variable	1 (n=32) β	2 (n=147) β	3 (n=50) β	4 (n=17) β
Service	0.49[b]	0.16[a]	0.15	0.51
Service reception	–0.19	–0.11	0.06	–0.21
Setting	0.26	0.04	0.03	–0.38
Spike	0.27	0.35[c]	0.45[c]	0.23
Block	0.18	0.43[c]	0.35[b]	0.11
Court defense	0.12	0.03	–0.02	0.67[a]
ρ	0.88[c]	0.79[c]	0.84[c]	0.87[b]

Age groups: 1 – 12–13 years, 2 – 14–15 years, 3 – 16–17 years, 4 – 18–19 years, β – regression coefficient, ρ – multiple correlation
[a]$p<0.05$, [b]$p<0.01$, [c]$p<0.001$

ers aged 14–15 acquire the block technique, followed by the acquisition of spike technique in the high-quality players aged 16–17. The 16- to 17-year-old players are selected to junior team aged 18–19 on the basis of the spike and block technical efficacy. Once selected to junior team (aged 18–19, also acting as the Croatian national junior team) according to the spike and block techniques, the players will show less differences in these technique elements and these will cease to exert a predominant impact on the playing quality, being replaced by the most demanding techniques in terms of motoricity, i.e. techniques of defense and jump service.

Conclusion

The present study investigated age and situation efficacy related differences in female volleyball players in the following parameters:

– manifest morphological variables and volleyball technique variables
– relations between technical and situation efficacy.

Analysis of variance of anthropometric variables indicated the female volleyball players of various age groups to differ significantly in the variables evaluating longitudinal skeleton dimensionality and voluminosity. Changes were more pronounced at the turn from age 14–15 to age 16–17. This could be explained by the process of selec-

tion, which was especially emphasized at the turn from 14–15 to 16–17 age group (corresponding to high school enrollment). Obviously, in this period the players with more pronounced longitudinal skeleton dimensionality were selected as competition team members. Thus, the role of longitudinal skeleton dimensionality in competition success increased in older age groups.

Like in case of variables for assessment of anthropometric characteristics, changes in the aspect of technique were also most pronounced between the 14–15 and 16–17 age groups, most likely as the result of a combined impact of volleyball training directed toward technique improvement and the process of selection, which is especially emphasized at the turn between elementary and high school.

Analysis of variance was also performed within particular age groups according to the criterion of situation efficacy. In all age groups, the players with their performance scored 4–5 differed significantly from players with average to under-average performance (score 1–3) in all variables assessing longitudinal skeleton dimensionality (except for body height in the 18–19 age group) and in all variables assessing technical performance (except for serve reception, spike and court defense in the youngest age group).

The set of variables of the six volleyball techniques evaluated is a good predictor of situation efficacy in each age group.

Study results indicate that achievement of top results in female volleyball requires the processes of selection and training to be performed in relation to solving both general and specific playing tasks, i.e. these processes should also be directed to a particular playing specialization.

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REFERENCES

1. WEIMIN, Y.: Characteristics in training women volleyball players. FIVB: Coaches Manual. (FIVB, 1990). — 2. TORIOLA, A. L., S. A. ADENIRAN, P. T. OGUNREMI, J. Sports Med. Phys. Fitness, 27 (1987) 235. — 3. VIVIANI, F., F. BALDIN, J. Sports Med. Phys. Fitness, 33 (1993) 400. — 4. GUALDI-RUSSO, E., L. ZACCAGNI, J. Sports Med. Phys. Fitness, 41 (2001) 256. — 5. GUALDI-RUSSO, E., G. GRUPPIONI, P. GUERESI, M. G. BELCASTRO, V. MARACHESINI, J. Sports Med. Phys. Fitness, 32 (1992) 303. — 6. STAMM, R., G. VELDRE, M. STAMM, K. THOMSON, H. KAARMA, J. LOKO, S. KOSKEL, J. Sports Med. Phys. Fitness, 43 (2003) 291. — 7. BOURGOIS, J., A. L. CLAESSENS, J. VRIJANS, R. PHILIPPAERTS, B. VAN RENTERGHEM, M. THOMIS, M. JANSSENS, R. LOSS, J. LEFEVRE, Brit. J. Sports Med., 34 (2000) 213. — 8. FLECK, S. J., Am. J. Sports Med., 11 (1983) 398. — 9. HAKKINEN, K., J. Sports Med. Phys. Fitness, 33 (1993) 223. — 10. JOHNSON, G. O., L. J. NEBELSICK-GULLETT, W. G. THORLAND, T. J. HOUSH, J. Sports Med. Phys. Fitness, 29 (1989) 314. — 11. MAREY, S., L. W. BOLEACH, J. L. MAYHEW, S. MCDOLE, J. Sports Med. Phys. Fitness, 31 (1991) 161. — 12. MORROW, J. R., W. W. HOSLER, J. K. NELSON, J. Sports Med. Phys. Fitness, 20 (1980) 435. — 13. PUHL, J., C. SAMUEL, S. FLECH, P. VAN HANDEL, Res. Q. Exerc. Sport, 53 (1982) 257. — 14. SMITH, D. J., D. ROBERTS, B. WATSON, J. Sports Sci., 10 (1992) 131. — 15. THISSEN-MILDER, M., J. L. MAYHEW, J. Sports Med. Phys. Fitness, 31 (1991) 380. — 16. VANDERFORD, M. L., M. C. MEYERS, W. A. SKELLY, C. C. STEWART, K. L. HAMILTON, J. Strength Cond. Res., 18 (2004) 334. — 17. VITASALO, J. T., Can. J. Appl. Sport Sci., 7 (1982) 182. — 18. KATIĆ, R., N. ZAGORAC, M. ŽIVIČNJAK, Ž. HRASKI, Coll. Antropol., 18 (1994) 141. — 19. KATIĆ, R., Coll. Antropol., 27 (2003) 351. — 20. GRGANTOV, Z., R. KATIĆ, N. MARELIĆ, Coll. Antropol., 29 (2005) 717.

R. Katić

Faculty of Natural Sciences, Mathematics and Kinesiology, University of Split, Teslina 12, 21000 Split, Croatia
e-mail: katic@pmfst.hr

MORFOLOŠKE KARAKTERISTIKE, TEHNIČKA I SITUACIJSKA UČINKOVITOST MLADIH ODBOJKAŠICA

SAŽETAK

Cilj istraživanja bio je utvrditi razlike u morfološkim varijablama i varijablama za procjenu kvalitete odbojkaških tehnika mladih odbojkašica u odnosu na dob i situacijsku uspješnost, te utvrditi utjecaj kvalitete tehnike na situacijsku učinkovitost. U tu je svrhu skup od 13 morfoloških mjera i skup od 6 elemenata tehnike primijenjen na uzorku od 246 odbojkašica: 32 mlađe kadetkinje u dobi od 12–13 godina, 147 mlađih kadetkinja u dobi od 14–15 godina, 50 kadetkinja u dobi od 16–17 godina i 17 juniorki u dobi od 18–19 godina. Također je izvršena procjena igračke kvalitete kao varijable kriterija. Analizom varijance između grupa je utvrđeno da se odbojkašice različitih dobnih kategorija značajno razlikuju u varijablama koje procjenjuju longitudinalnu dimenzionalnost skeleta i volumen i masu tijela, kao i u svim testovima za procjenu odbojkaških tehnika. Analiza varijance unutar pojedinih dobnih kategorija dodatno je razjasnila procese

promjena u promatranim varijablama. Regresijska korelacijska analiza je također pokazala da je skup varijabli od 6 procijenjenih tehnika dosta dobar predskazatelj situacijske učinkovitosti kod svih dobnih kategorija i to tako da je najbolji predskazatelj igračke kvalitete kod najmlađih kadetkinja tehnika servisa, kod mlađih kadetkinja tehnike bloka i smeča, kod kadetkinja tehnike smeča i bloka, a kod juniorki tehnika obrane polja.