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Effect of New Rules on the Correlation between Situation Parameters and Performance in Beach Volleyball

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A B S T R A C T

The aim of the study was to assess the effect of basic technical-tactical elements, i.e. specific motor abilities, on performance in beach volleyball, with special reference to differences between the old and new official rules. Analysis of variance for 6 variables of technical-tactical elements between the winning and defeated teams included a sample of 129 sets played according to the old official rules (1995 and 1996) and 74 sets played according to the new official rules (2003). This was followed by regression analysis between these technical-tactical elements as predictors and a variable, i.e. score difference at which the team won or lost the game, as a criterion. Results of the analysis of variance between the winning and defeated teams showed highest differences in the performance of attack-hit, followed by counterattack-hit and blocking in both game types. However, difference in the performance of serve reception, serve, and field defense between the winning and defeated teams decreased significantly with the use of new rules as compared with the old ones. Results of regression analysis indicated the sets played according to the new rules relative to old ones to increase the predominant impact of technical-tactical elements in the above-net actions, especially attack-hit and block, on the final result in beach volleyball.

Key words: *beach volleyball, new rules, situation parameters, performance*

Introduction

Beach volleyball appeared as a demonstration sport at Olympic Games in Barcelona in 1992, and has been included in the Olympic Games official program since Atlanta 1996. The basic technical-tactical elements of beach volleyball are serve, serve receiving, setting, spike, block, and field defense.

The International Volleyball Federation has officially confirmed the new rules to be used at Olympic Games in Athens in 2004[1,2]. The new rules were tested in 2002. The major changes in the rules are as follows:

- Changes in the scoring system: previously, one set took 15 points (only the serving team could get a point), whereas now, according to the new rules, each action score a point (rally point system). The match is won by the team that wins two sets. A set (except the deciding 3rd set) is won by the team that first scores 21 points with a minimum lead of two points. In the case of a 1-1 tie, the deciding set is played to 15 points with a minimum lead of 2 points. The possible third set is played at 15 points; and
- Reduction in court dimensions from 18 x 9 m to 16 x 8 m.

According to Homberg and Papageorgiou (1995)[3], the mean rally duration is about 8 seconds, and interruptions between the rallies 20 seconds. During a one rally, a player performs an average of 0.6 jumps and 1.6 starts, at a distance of 5.4 m. The average running distance is 3.3 m *per* action. During one-hour play, a player performs about 85 jumps (20 while serving, 39 while attacking and 26 during blocking actions) and 234 starts (129 forward, 51 to the right, to the left or backward, and 54 in changing direction). The beach volleyball contest winner team play a minimum of 7 and maximum of 10 games in the main contest. The average number of rallies *per* game is 84 in Germany, 74 in the USA (men), and 60 for women. Kroger and Schreiber (1996)[4] analyzed the frequency and coefficient of performance of

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various attack-hit types. Errors on spiking were scored 0, attack-hits with the ball staying in play were scored 1, and spikes resulting in point or side-out were scored 2. The values thus obtained were summed up and divided by the total number of attacks. The coefficient of attack performance ranged from 0 (when all attacks resulted in errors) through 2 (when all spikes resulted in point or side-out). The coefficient of performance was 1.47 and 1.36 for spiking from position 4 and 2, respectively. According to attack types, strong and soft (off speed) attack were found to have a comparable level of efficiency (1.47 *vs.* 1.44). Spikes along the line (parallel) were more efficient than diagonal attack-hits (1.60 *vs.* 1.45).

The aim of the present study was to assess the impact of basic technical-tactical parameters on performance in beach volleyball. The effect was evaluated in separate for the games played according to previous rules and those played according to the new official rules set by the International Volleyball Federation. Aim was also to assess the effect of rule modifications on the structure and role of particular technical-tactical elements on the performance in beach volleyball.

Methods

Entity sample

Entity sample included 129 sets played according to the old rules and 74 sets played according to the new rules. Data were collected at contests counted toward the Croatian championship in 1995 and 1996 (old rules) and 2003 (new rules).

Variable sample

Independent (predictor) variables included a group of six technical-tactical elements of beach volleyball, each of them implying three levels of performance. The six technical-tactical elements are serve, serve reception, attack-hit, block, defense and counterattack-hit. The three performance levels are as follows:

- Good performance, resulting in direct point earning in case of attack and counterattack-hit, serve or block. On serve reception and field defense, it implies precise pass at not more than 2–3 steps from the setting spot. It is scored 3.
- Inappropriate performance, implying the ball has remained in play in case of attack and counterattack-hit, serve or block. On serve reception and field defense, it implies imprecise ball direction (at more than 2–3 steps from setting spot). It is scored 2; and
- Error in performance, resulting in rally loss; it is scored 1.

The scores for each technical-tactical element are summed up and divided by the number of particular element performance. In this way, each technical-tactical element can be graded from 1 to 3.

The difference in points by which a team won (e.g., +4) or lost (e.g., –6) a game served as a dependent (criterion) variable.

Data analysis

The basic descriptive parameters of the variables (arithmetic mean and standard deviation) were calculated first, in separate for the winning and defeated teams according to the old and new rules. F-test was used to determine the significance of differences between the variables observed. The significance of the effect of the group of predictor variables on the criterion (score difference by which a team won or lost) was assessed by regression analysis in separate for the games played according to the old and new rules.

Results

As illustrated in Figure 1, the scores obtained by the old and new rules were quite comparable in all variables except for serve reception. The scores for serve reception were somewhat higher in the games played according to the new rules, which was expected because of the reduced court dimensions (16 x 8 m *vs.* former 18 x 9 m). The absence of changes in some other variables (block, defense, counterattack-hit) must have been due to the improved serve reception. One of the reasons to modify the rules was an attempt to reduce the predominance of attack over defense. The rally duration would thus prolong, making the game more attractive for the audience. It appeared quite logical to presume that reduced court dimensions should facilitate blocking and court defense, while providing due conditions for successful attack-hit through upgraded serve reception. However, in the game sample observed attack still prevailed over defense (higher scores for the variables of serve reception and attack than for serve, block and field defense).

According to the old rules (Table 1), F-test produced significant differences between the winning and de-

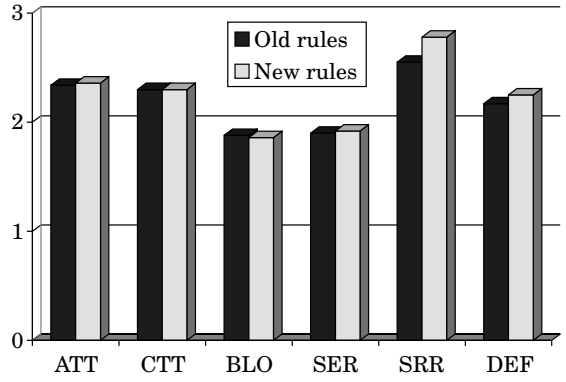

Fig. 1. Arithmetic mean of evaluation scores for 6 basic technical-tactical elements in beach volleyball according to old and new rules. ATT – attack-hit, CTT – counterattack-hit, BLO – block, SER – serve, SRR – serve reception, DEF – court defense.

TABLE 1
ANALYSIS OF VARIANCE OF TECHNICAL-TACTICAL EFFICIENCY VARIABLES BETWEEN WINNING AND DEFEATED TEAMS

Variable	Old rules		New rules	
	Winners X±SD	Defeated X±SD	Winners X±SD	Defeated X±SD
Attack-hit	2.45±0.17	2.22±0.20[c]	2.44±0.19	2.26±0.18[c]
Counterattack-hit	2.37±0.23	2.23±0.29[b]	2.41±0.32	2.15±0.31[a]
Block	1.99±0.39	1.74±0.52[b]	1.99±0.43	1.69±0.49[a]
Serve reception	2.61±0.17	2.49±0.19	2.80±0.14	2.77±0.14
Service	1.93±0.10	1.86±0.11[a]	1.94±0.74	1.89±0.92
Defense	2.12±0.23	2.11±0.30[a]	2.30±0.29	2.19±0.35

[a]$p<0.05$, [b]$p<0.01$, [c]$p<0.001$

feated teams in all variables except for serve reception. These differences were even more pronounced in the elements performed above the net, and especially after serve reception. According to the new rules, significant differences between the winning and defeated teams were only obtained in the variables of attack, counterattack and block, whereas differences in the serve reception, serve and field defense did not reach statistical significance.

These results suggested a conclusion that differences in the performance of technical-tactical elements between the winning and defeated teams diminished in the sample of games played according to the new rules, which was at least in part due to the rule modifications. Similar observations have also been reported by the authors who investigated the impact of rules changes in the indoor volleyball[5–7]. So, changes in the indoor volleyball rules reduced the score difference between the winning and defeated teams, and increased the rate of games with the final score of 3:1 and 3:2.

During the 7-year period elapsed between the two studies the number of high-rank beach volleyball teams playing in the Croatian championship has increased, which has presumably contributed to quality alignment seen at the contests, and thus to the attractiveness of beach volleyball for the audience.

F-test yielded highest differences in performing attack-hit, followed by counterattack-hit and block, i.e. in the above-net play. In beach volleyball, points are mostly scored by good performance of these elements. Good performance of serve reception and field defense is just a precondition for the points to be scored by appropriate play above the net during subsequent outplay.

Points can also be scored directly by appropriate service performance; however, it is by far less common than by spiking and blocking. In addition, attack and counterattack-hit as well as blocking are performed in the air, which makes these actions even more difficult.

Based on the results obtained, the coaches and players are advised to pay due attention to the technical-tactical elements performed above the net (attack and counterattack-hit, and block).

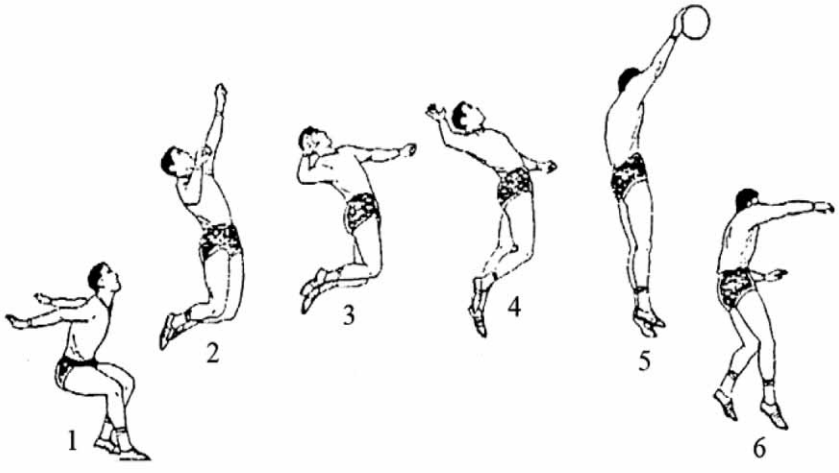

Fig. 2. Spike: 1 – preparing for the take-off, 2, 3 and 4 – arm swing, 5 – contact with a ball, 6 – follow-through.

TABLE 2
REGRESSION ANALYSIS OF PREDICTOR VARIABLES AND CRITERION

Variable	Old rules β	New rules β
Attack-hit	0.46[c]	0.53[c]
Counterattack-hit	0.19[b]	0.27[c]
Block	0.20[c]	0.31[c]
Serve reception	0.23[c]	–0.02
Serve	0.19[b]	0.20[b]
Court defense	0.22[c]	0.24[c]
ρ	0.81[c]	0.85[c]
δ	0.66[c]	0.72[c]

β – regression coefficients, ρ – multiple correlation, δ – coefficient of determination
[a]p<0.05, [b]p<0.01, [c]p<0.001

The results obtained (Table 2) pointed to a significant association between the group of predictor variables and the criterion (score difference at which the team won or lost the game) according to both old and new rules. In both cases, predictor variables accounted for more than 60% of total criterion variance.

In the sample of games played according to the new rules, the regression coefficients β clearly indicated that all the variables, except serve reception, significantly influence the criterion.

In both cases, the attack-hit variable accounted for the greatest partial contribution to the criterion explanation. It was expected, because this variable, along with counterattack-hit, service and block, is directly responsible for winning points in case of successful performance or losing points in case of error. However, during the game, points are much more commonly scored by the attack-hit than by the other variables mentioned above.

The results of regression analysis clearly showed the success in beach volleyball to be to a considerably greater extent determined by the group of the applied variables for the evaluation of technical-tactical efficiency when played according to the new rules as compared with the previous ones. The results illustrate modifications in the structure of the beach volleyball performance within this group of variables.

It has already been noted that there was no difference between the winning and losing teams in the performance of serve reception when playing according to the new rules, thus, in this sample, the parameter of serve reception obviously having no impact on the final result in beach volleyball. The effect of field defense and service on the final result was the same in the games played according to the old and new rules. However, the effect on the final result of attack-hit, counterattack-hit, and of block in particular was considerably greater in the games played according to the new rules than in those played according to the old rules. Thus, in comparison with other elements, the impact of technical-tactical elements performed above the net on the final result was even more pronounced in beach volleyball games played according to the new rules.

Discussion

The results of the study revealed the beach volleyball winning and defeated teams to differ most significantly in above-net actions. The level of take-off is one of the key components of the play at the net. Giatsis et al. [8] found the level of vertical jump height on the sand to be significantly lower than that on the firm surface. Using kinematic analysis, they recorded a decrease of maximal speed and take-off force on the sand *vs.* wood. Biomechanical analysis performed on sand surface revealed an increased extension of the hip joint in the phase of preparation for take-off, resulting in greater axial centre descend.

Bishop (2003)[9] found strong and significant correlation between the jump height on the sand and on the hard surface. These finding suggest the one and the same mechanism to be involved in the height of the jump on both surface types.

Simultaneously with the right leg stepping forward on preparing for jumping on during the spike action (Figure 2, number 1) the arms start moving backward and upward. This movement is ended just before the right foot touching the ground. This leads the spiker's hips backward and shoulders forward (hip joint flexion). Besides the hip joint, flexion also occurs in the knee and ankle joints. Upon placing the right foot onto the ground, the arms start moving forward and downward, while the hips continue moving backward and shoulders forward and downward. Flexion in the hip, knee and ankle joints increases. In this way, the ground reaction force, i.e. jump height is enhanced. In beach volleyball, the descend of the axis centre on preparing for taking-off is more pronounced due to the uneven and soft sand surface. Therefore, it appears that in beach volleyball the hip and ankle joint extensors are more intensely involved in taking-off than in indoor volleyball. On the other hand, plantar flexors of the ankle joint are more intensely used in the latter. Besides reducing the jump height, the uneven sand surface interferes with body balance on taking-off, which makes the performance of spike and block as well as jump service even more difficult.

Bringing the hands in front of the body the hips move forward (hip joint extension), which is followed by knee joint extension and eventually ankle joint plantar flexion. The arms continue moving forward and upward to stop abruptly at the head level (Figure 2., number 2). In this way, the power impulse is transferred to the rest of the body, thereby additionally elevating the body gravity center. The left arm (in the right-handed) stays elevated in the air, above the left shoulder for balance, while the right arm is preparing for swing.

In next phase (Figure 2., number 3 and 4), the body is rotated to the right along the longitudinal axis. In this way the striking shoulder and hip move backward, while the abdominal and thoracic oblique muscles are being extended. Trunk extension along the horizontal axis occurs.

Body segments should be accelerated one by one in a coordinated manner for the ball to achieve the greatest possible velocity. Trunk flexion and leftward rotation are done first by engaging the rectus and oblique abdominal musculature, followed by inner rotation of the upper arm by thoracic musculature; the forearm is extended by triceps brachii, while hand flexors allow for snapping the ball by the palm and fingers. Contact with the ball should be directly over and slightly in front of the spiking arm shoulder (Figure 2, number 5).

Upon spiking, the arm continues moving forward and downward (Figure 2, number 6). The spiker lands and prepares for the new action.

The brief biomechanical description of the technical-tactical elements of spike leads to a conclusion that an integrated action of all relevant anthropologic structure sub-segments, i.e. morphologic, motor, cognitive and functional sub-segments, is necessary to successfully perform this specific motor skill. The mechanisms of the morphologic-motor functioning are crucial for spiking[10]. The relevant basic motor abilities, especially those of explosive strength, speed, coordination and flexibility, which are inter-related and thus conditioned by the superior mechanisms, are being integrated in the morphological structure[10,11]. For example, the mechanisms regulating the sequence of inclusion and exclusion of particular muscle groups and muscle units, the mechanisms regulating the force and speed in each phase of spiking performance, and the mechanisms regulating muscle tonus and movement amplitude are involved in the performance of spike. A general mechanism that controls, regulates and integrates the work of all these subordinate mechanisms is necessary for efficient spike performance. That is why the performance of spike is very complex, and success in beach volleyball is to a great extent determined by the quality of performing this technical-tactical element, as elaborated above.

In Croatia, the true beginnings of beach volleyball date around 1990s. Every sports activity develops and improves rapidly early upon its introduction in a society. In 1995, the majority of study teams had a rather short-term playing experience necessary for quality results. As most players from 1995 still were active players in 2003, it could be presumed that during the study period, significant modifications irrespective of the official rule changes had also taken place in some other segments influencing the development of beach volleyball in Croatia (e.g., better conditioning of the players, improved performance technique and tactics, etc.).

Therefore, changes in the rules cannot be considered in separate from other factors mentioned above. The more so, changes in the rules are frequently dictated by improvements in particular game segments (e.g., in case of beach volleyball, the predominance of attack relative to defense resulted in change of court dimensions). However, changes in the rules can (and should) generate favorable modifications in the respective sports.

Additional studies are needed to establish the true relationships of the above mentioned factors in beach volleyball.

Conclusion

The sample of beach volleyball games played according to the new rules showed significantly lower differences between the winning and losing teams in the technical-tactical element of serve reception as compared with the games played according to the old rules 7 years before.

The greatest differences between the wining and defeated teams were recorded in the above-net actions (attack and counterattack-hit and blocking), while the attack-hit variable was found to have the greatest partial effect on the criterion of score difference between the winning and losing teams. It was expected, because these are the most complex volleyball elements that account for the highest score rate at a contest. At the same time, these elements are associated with the highest rate of errors, and every error brings points to the opponent team.

The results of the study indicated the new rules as compared with the old ones to increase the predominant impact of technical-tactical elements in the above-net actions (especially in attack-hit and block) on the final result in beach volleyball.

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REFERENCES

1. FIVB: Beach volleyball official rules. (FIVB, 1996). — 2. FIVB: Beach volleyball official rules. (FIVB, 2000). — 3. HOMBERG, S., A. PAPAGEORGIOU: Handbook for beach volleyball. (Meyer & Meyer Verlag, Aachen, 1995). — 4. KROGER, C., H. SCHREIBER, Leistungssport, 26 (1996) 51. — 5. URENA, A., The Coach, 4 (2000) 12. — 6. VAN AARTRIJK, S., The Coach, 1 (2000) 12. — 7. ZHANG, R., The Coach, 1 (2000) 9. — 8. GIATSIS, G., I. KOLLIAS, V. PANOUTSAKOPOULOS, G. PAPAIAKOVOVU, Sports Biomechanics, 3 (2004) 145. — 9. BISHOP, D., J. Sports Med. Phys. Fitness, 43 (2003) 418. — 10. KATIĆ, R., A. PEJČIĆ, N. VISKIĆ-ŠTALEC, Coll. Antropol., 28 (2004) 261. — 11. KATIĆ, R., Coll. Antropol., 27 (2003) 351.

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UTJECAJ PROMJENA PRAVILA NA POVEZANOST SITUACIJSKIH PARAMETARA I USPJEHA U ODBOJCI NA PIJESKU

S A Ž E T A K

Cilj ovog istraživanja je utvrditi utjecaj osnovnih tehničko-taktičkih elemenata, tj. specifičnih motoričkih znanja na uspjeh u odbojci na pijesku, posebno kad se natjecanje odvija po starim ili po novim pravilima. U tu svrhu na uzorku od 129 setova koji su odigrani po starim pravilima (1995. i 1996. god.) i 74 seta koja su odigrana po novim pravilima (2003. god.), primijenjena je analiza varijance u 6 varijabli tehničko-tehničkih elemenata između poraženih i pobjedničkih ekipa. Zatim je primijenjena regresijska analiza između tih tehničko-taktičkih elemenata kao prediktora i varijable – razlika u poenima sa kojom je ekipa pobijedila ili je poražena kao kriterija. Rezultati analize varijance između poraženih i pobjedničkih ekipa u oba natjecanja su pokazali da su najveće razlike u izvođenju smeča u napadu, zatim smeča u kontranapadu i blokiranju. Međutim, u natjecanju po novim pravilima u odnosu na natjecanje po starim pravilima značajno se smanjila razlika između poraženih i pobjedničkih ekipa u kvaliteti izvođenja prijema servisa, zatim u servisu i obrani polja. Rezultati regresijske analize su utvrdili da se u setovima odigranim po novim pravilima, a u odnosu na stara pravila, povećao dominantni utjecaj tehničko-taktičkih elemenata u igri iznad mreže i to posebno smeča u napadu i blokiranju, na konačni rezultat u odbojci na pijesku.