PREDICTION OF EFFICIENCY IN ELITE VOLLEYBALL: MULTIPLE REGRESSION APPROACH

Ivana Klaričić[1], Zoran Grgantov[2], Igor Jelaska[2]

[1]*Faculty of Educational studies, University of Osijek, Osijek, Croatia*

[2]*Faculty of Kinesiology, University of Split, Split, Croatia*

Original scientific paper

Abstract

The aim of this research was to identify the relationship between performance efficiency coefficients of the five phases of volleyball game (serve, reception, spike, block and dig) with a score difference, resulting in a win or a defeat in a set. According to the aim, a sample of 40 randomly selected sets played in the European League for Men in years 2011 and 2012 was used. Multiple linear regression analysis was applied on randomly selected half of the sample (N_1=20) and cross-validated using the second half of the sample (N_2=20). Due to significant validation statistics, it can be concluded that 78% of the difference in the set score can be explained by a system of predictor variables. It was determined that the spike and the dig have a significant relationship with the score difference in a set ($p<0.05$). The results implicitly point out dominance of attack compared to defense in elite volleyball. Additionally, they point out the importance of a spike as the game phase by which teams win the largest number of points in a volleyball set and also the importance of a dig by which teams prevent opponents in winning the points and making assumptions for winning points in the counter-attack.

Key words*: European league, volleyball, performance coefficients, score difference, cross validation.*

Introduction

Like in other sports, volleyball consists of a large number of tehnical and tactical skills that are classified and hierarchically organized within larger units such as phases and complexes of the game. The six basic phases that alternate during a volleyball match are serve, reception, setting, spike, block and dig (Busca & Febrer, 2012).

Due to significant differences in the game considering a team's serving and team's receiving, volleyball experts usually classify phases in two complexes. Complex 1 includes reception, attack phase setting and attack phase spiking, and complex 2 includes serve, block, dig, counter-attack phase setting and counter-attack spiking (Selinger, 1986; Marelić, 1998;). The complex of attack is characterized by an ease condition of setting and spiking compared to the the complex of counter-attack (Marcelino, Cesar, Afonso & Mesquita, 2009).

Another possible classification of volleyball phases is that by which points are directly won (serve, spike and block) and that by which good performance means some kind of preparation for winning points (reception, dig, attack phase setting and counter-attack phase setting) (Marcelino, Mesquita & Afonso, 2008; Rodriguez-Ruiz et al., 2011; Oliveira, Valladares Iglesias, Vaz & Joao, 2016; Oliveira, Vaz, Pastore & Joao, 2018).

In volleyball, regression (predictive) studies are very important because they provide evidence for a possible causal relationship between predictor variables and actual performance. The relationship between quality of performance of particular technical and tactical skills or phases of the game and set or match efficiency can be determined during a volleyball match (Papadimitriou, Pashali, Sermaki, Mellas & Papas, 2004; Rocha, & Barbanti, 2006; Zetou, Tsiggilis, Moustakidis & Komninakidou, 2006; Zetou, Moustakidis, Tsiggilis & Komninakidou, 2007; Monteiro, Mesquita & Marcelino, 2009). The greater the correlation between individual variables and match efficiency is, the greater the probability of causal connection between them will be. This probability additionally increases if the correlation is repeated in other studies and other subgroups of the volleyball population (Bishop, 2008). That is why it is important to repeat predictive studies so that scientists could create appropriate experimental studies with the aim of proving causal connection between selected predictor variables and match efficiency. And also coaches could decide which technical and tactical skills and phases of the game to put emphasis on in the training process.

In previous research, it was determined that during a voleyball game, the largest number of points is won by an attack phase spiking and counter-attack phase spiking then block, serve and opponents' errors (Eom & Schutz, 1992; Marelic, Žufar & Omrčen, 1998; Palao, Santos & Urena, 2004; Marcelino et al, 2008; Drikos, Kountouris, Laios, A. & Laios, Y., 2009). For this reason, in predictive research, spike is a technical and tactical skill that is

most related to success in a volleyball set or match (Nishijima, 2001; Hayrinen, Hoivala & Blomqvist, 2004; Palao et. al, 2004; Yiannis, Panagiotis, Ioannis & Alkinoi, 2004; Marcelino & Mesquita, 2006). Although the relationship between block efficiency and winning the match is lower than spike and serve, according to Palao et al. (2004) block is a skill that differentiates top-quality teams in men's volleyball. Also, in elite volleyball, teams need to take greater risks when serving in order to neutralize strong opponent's spikes and increase the probability of success by block (Marelić, Rešetar, Zadražnik & Đurković, 2005).

Skills by which teams can't directly win points in volleyball are also important for success in competition. Many studies have determined that spike as a skill by which the largest number of points are won in the game, is highly related with reception efficiency (Papadimitriou et al., 2004; Joao, Mesquita, Sampaio & Moutinho, 2006; Patsiaouras, Charitonidis, Moustakidis & Kokaridas, 2009; Bergeles, Barzouka & Nikolaidou, 2009). Similar to the relationship between reception and attack phase spiking efficiency, the relationship between counter-attack phase spiking and dig efficiency was also determined (Monteiro et al., 2009). For that reason, during research, it is important to identify the connection between particular phases of the game and success in competition, to add to the set of predictors, not only the skills by which points are directly won, but also those whose successfull performance make preconditions to win points in further course of rally. Performance of individual technical and tactical skills is most often rated on a three to five point scale. Although in some studies each point of the scale is treated as a separate variable (Marelić, 1994; Marcelino, Mesquita, Sampaio & Moraes, 2010; Bergeles & Nikolaidou, 2011; Claver et al., 2013), different performance coefficients are better predictors of success in competition (Marcelino et al., 2008; Drikos et al., 2009; Zadražnik et al., 2009). Different methods of calculating performance efficacy coefficients have been used, but in most researches (Marelić, Rešetar & Janković, 2004; Grgantov, Katić & Marelić, 2005; Zadražnik et al., 2009) the Coleman (1975) method was used. In this method, performance efficiency coefficients are calculated by adding up all the performances in specific categories (quality levels), multiplying them by the rating (number) related to the respective category and dividing them by the total number of performances in all categories. Although victory or defeat in a set or a match is the most commonly used criterion of competitive efficiency (Pena, Rodrigez-Guerra, Busca & Serra, 2013; Silva, Lacerda & Joao, 2013; Silva, Lacerda & Joao, 2014; Paulo, Davids & Araujo, 2018), authors think that score difference is a more appropriate way of defining efficiency in competition due to a more sensitive estimation scale that allows application of linear regression analysis.

Therefore, the basic aim of this research is to predict set efficiency based on the quality of performance of individual phases the volleyball game. Set efficiency is defined by the score difference by which the team won or lost the set.

Methods

The aim of this research was to identify the relationship between performance efficiency coefficients of the five phases of the volleyball game (serve, reception, spike, block and dig) with score difference resulting a win or a defeat in a set.

Entities

The sample of entities was represented by 40 volleyball sets played in years 2011 and 2012 and in The European League for Men. A set was randomly selected from a match. Sets were randomly distributed into two samples of 20 sets.

Variables

The sample of variables was composed of six variables, five variables are performance efficiency coefficient of technical and tactical volleyball skills or phases, serve, reception, spike, block and dig. Performance efficiency coefficients were estimated on the Likert scale from 1 to 4, 1 representing minimal and 4 representing maximal value. The sixth variable is a set score. Set score is defined as a score difference (positive or negative) between team's number of points and the number of opponent's points.

Data collection

Data collection was made from existing videos of volleyball games played in earlier prepared forms. It has been done by one of the authors of this research with multiannual playing experience, who has an A coaching license and multiannual coaching experience in men's volleyball. The reliability analysis was carried out with the help of an expert with multiannual playing, coaching and notational analysis work experience.

The camera was placed vertically to a side of the court. In this research, the setting was not estimated because it would demand extra cameras and the videos of the games already existed.

Statistical analysis

All data was presented as mean ± standard deviation together with 95% confidence interval. Normality of distribution was tested using the Kolmogorov-Smirnov test. Reliability of measurements was calculated using the Spearman's rank of correlation (a sub-sample of 6 entities). Used sample of sets (N=40) was randomly divided into 2 sub-samples: regression sample (N_1=20) and cross-validation sample (N_2=20). Multiple regression was calculated on the regression sample and then cross-validated by using the Blandt Altman plot (average between the expected and obtained scores on x-axe and differences between the obtained and expected scores on y-axe) and ANOVA for dependent samples. In ANOVA, partial-eta squared (partial η^2) was used as an effect size

assesment. Type one error was set at α=5%. All calculations were performed using a data analysis system Statistica 13 (Dell Inc., Tulsa, OK, USA).

Results

Kolmogorov-Smirnov test confirmed normality of all variables ($p>0.20$). Spearman rank of correlation determined a high and significant correlation ($R=0.951$; $p<0.001$) between 2 estimations of one of the authors in two time points and between two different estimators (the same author and the expert) ($R=0.923$).

Descriptive parameters of five efficiency coefficients of five technical and tactical skills in volleyball (serve, reception, spike, block and dig) and score difference in a set are presented in table 1.

Table 1: Descriptive statistics results

	Mean±σ	95% CI
Score difference	-0.43±5.44	-2.17-1.32
Efficiency coefficient - serve	2.13±0.19	2.07-2.20
Efficiency coefficient - reception	2.98±0.26	2.90-3.06
Efficiency coefficient - spike	3.04±0.24	2.96-3.12
Efficiency coefficient - block	2.29±0.39	2.17-2.42
Efficiency coefficient - dig	1.95±0.27	1.86-2.04

Table 1 shows basic descriptive parameters (arithmetic mean and standard deviation, and 95% confidence interval). Spike and reception have the highest efficiency coefficient values, while some lower values were determined in block, serve and dig.

Table 2: Multiple regression results for analysis sample

	b	Se(b)	β	Se(β)	t	p
Intercept (constant)	-90.65	14.38			-6.30	0.000
Efficiency coefficient - serve	7.02	4.70	0.21	0.14	1.49	0.157
Efficiency coefficient - reception	6.66	3.61	0.28	0.15	1.85	0.086
Efficiency coefficient - spike	10.30	3.07	0.49	0.15	3.36	0.005
Efficiency coefficient - block	2.98	1.83	0.23	0.14	1.63	0.126
Efficiency coefficient - dig	8.74	2.84	0.47	0.15	3.07	0.008
	$R=0.88$; $R^2=0.78$; $F=9.66$; $p<0.001$					

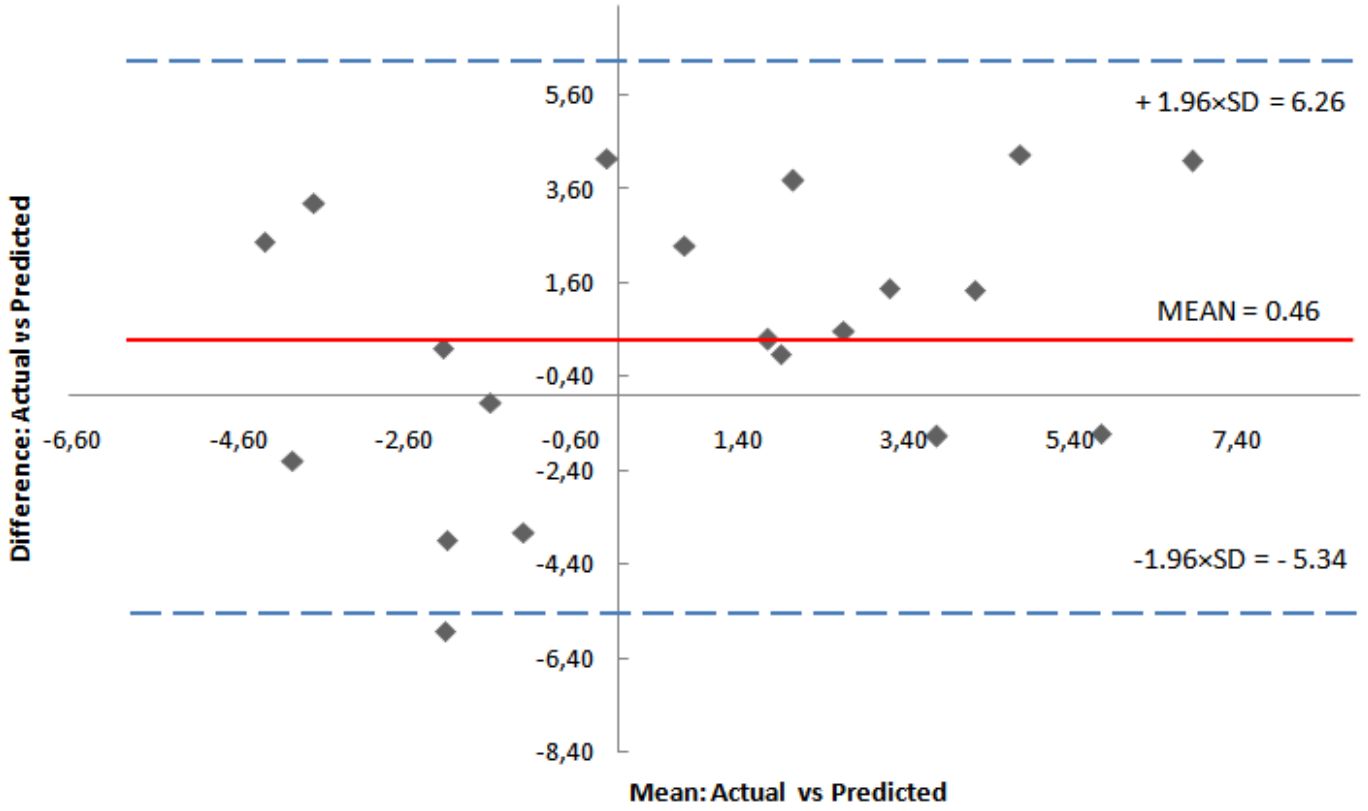
By using prediction equation obtained on regression sample:

Score difference = -90.65 + 7.02×" Efficiency coefficient - serve" + 6.66×" Efficiency coefficient - reception" + 10.30×" Efficiency coefficient - spike" + 2.98×" Efficiency coefficient - block" + 8.74×" Efficiency coefficient - dig"

regression analysis was cross-validated i.e. on a cross-validation sample predicted values of criterion variable were calculated and compared to achieved results of the criterion variable. Differences between observed (1,35±4,48) and predicted values (0.91±3.90) appeared not to be significant ($F_{1,19}=0.44$; $p=0.52$; $\eta^2=0.023$).

Additionally, the Blandt-Altman plot was calculated which provided successful cross-validation statistics.

Figure 1: Blandt-Altman plot for the calculated and achieved set scores for the cross-validation subsample



Discussion

The aim of this study was to determine the relationship between the quality of performance of individual phases of the game with score difference obtained by winning or losing a volleyball set in elite men's volleyball. It was determined that spike and dig have a significant relationship with score difference in a set. Spike has the highest efficiency coefficient, and dig has the lowest, which confirms the dominance of the attack over the defense in modern volleyball (Palao, Santos & Urena, 2007; Zetou et al., 2007). The importance of spiking for success in a set or a match is consistent with the results of previous researches (Eom & Schutz, 1992; Marelić et al., 1998; Palao et al., 2004; Marcelino et al., 2008; Drikos et al., 2009). This is expected considering the fact that the largest number of points in volleyball are won by efficient spiking both in attack and counter-attack (Eom & Schutz, 1992; Marelic et al, 1998; Palao, Santos et al, 2004; Marcelino et al, 2008; Drikos et al, 2009). The fact that skills by which points are directly won are not the only ones important for success is confirmed by a significant contribution of dig to positive set outcome and also of reception whose impact is close to the bordeline of significance. Contribution of reception is expected due to its correlation with the quality of attack phase spiking by which the largest number of points are won in a set (Zhang, 2000; Rodriguez-Ruiz et al., 2011) Papadimitriou, et al. have determined that the quality of reception significantly differentiates the attack strategy in elite volleyball, and many other authors have determined that spike as the skill by which the largest number of point is won, is highly related with reception efficiency (Joao et al, 2006; Patsiaouras et al, 2009; Bergeles et al., 2009). Setting the ball for attack phase spiking is an important link between reception and attack phase spiking. Barzouka et al. (2006) have analyzed the excellent performance of olympic level setters and attackers during the attack phase and determined that their excellent performance is highly associated with the performance of their preceding actions. Specifically, the results showed that the frequency of setter's excellent performances is significantly higher when an excellent reception precedes compared to a good reception. Considering the fact that more points are won by attack phase spiking compared to counter-attack phase spiking (Zhang, 2000; Marelić, et al., 2004; Marcelino et al., 2008), it is slightly unexpected that next to the spike, the dig is the only skill that is significantly correlated to set's score difference. Previous researches determined that introduction of libero did not significantly improve dig efficiency (Zimmermann, 1999; Mesquita, Manso & Palao, 2007). Researchers studying elite teams determined that 1/3 of defensive actions is referring to errors resulting in a point lost, compared to only 25% excellent digs (Mesquita et al., 2007). The influence of the block on the score difference in the set was obtained in this research. Excellent performances are a necessary precondition for effective performance of counter-attack phase spike and often gets point advantage in a set in an elite level of the volleyball game (Monteiro et al., 2009).

Castro and Mesquita (2010) have determined that dig efficiency has a significant impact on spike tempo and efficiency.

In this research a statistically significant relationship between block and score difference in a set has not been determined. The probable reason is that in the top level volleyball block stops only 15-20 % of opponent's spikes (Palao et al., 2004). However, importance of block is to be considered in a way that a well performed block greatly eases the performance of the dig because players need to cover a much smaller space in the court, and also, block sometimes slows down the spiked ball. In addition, a notation analysis can't determine how many of the successful blocks affect the quality of opponents' spiking in the following rallies. Successful blocks often have an effect to demoralize opponents' attackers, thus deciding on less risky spikes that the players defending the court can more easily pass and also can result in an increased number of spike errors.

After dig, serve has the lowest efficiency coefficient. While low efficiency coefficient of the dig can be explained by very short time that players in court defense have to react to spikes that are often performed up to a speed greater than 100 km/h, the authors think that efficiency coefficient of the serve should be higher. During serving, players have complete control over their performance and at the top level of the game they are expected to execute strong and precise serves directed to opponent's receivers for which notational analysis has shown having the lowest receving efficiency during the game. It is important to serve the ball not directly to that player but to an empty part of the court because it is much harder to receive serves in a quality way after moving or during landing. Serve should not be just the skill used for putting the ball in the game but should be perceived as an attacking skill (Coleman, 2009) having an aim either to win points directly or significantly complicate the organization of the play in the attack phase to the opponent team. The high value of efficiency coefficient of receiving additionaly confirms that in men's volleyball there is still room for improvement in performance of the serve, with the aim of winning points directly or at least decreasing the receiving quality, making it difficult to set the ball and spike in the attack phase.

Conclusion

In this regression study, a significant relationship between performance efficiency of spike and dig with the score difference in volleyball set was determined. That indicates a possible causal connection of those phases of the game and the competition efficiency. In order to determine the causal connection, it is necessary to carry out experimental studies which will try to perceive whether the improvement of performance of these phases of the game in the training process influences situational efficiency of particular players. The cooperation between scientists and coaches is important, in which scientists need to create an experimental design of the research, and coaches to create the most effective experimental programs for improving phases of the game that have been significantly related with competition efficiency in regression studies. The causal connection can be adequately sensed only if repeated regression studies get consistent results. By analyzing results of former researches, it is justified to expect a causal connection between quality of the spike performance and the competition efficiency, whereas the relationship pointing to the dig and the reception should be additionally examined. Given that the phases of the volleyball game are mutually related and that the performance efficiency influances the performance of the following phases, coaches and scientists need to be very cautious in the interpretation of regression studies results. Therefore, considerable attention has to be dedicated also to improving the performance of phases by which the points couldn't be won (reception, dig, set), but are very important as a kind of a preparation for winning the points.

References

1. Bergeles, N., Barzouka, K., & Nikolaidou, M.E. (2009). Performance of male and female setters and attackers on Olympic-level volleyball teams. *International Journal of Performance Analysis in Sport, 9*(1), 141-148.
2. Bergeles, N., & Nikolaidou, M.E. (2011). Setter's performance and attack tempo as determinants of attack efficacy in Olimpic-level male volleyball teams. *International Journal of Performance Analysis in Sports, 11*(3), 535-544.
3. Bishop, D. (2008). An applied research model for the sport sciences. *Sports Medicine*, *38*(3), 253-263.
4. Busca, B., & Febrer, J. (2012). Temporal fight between the middle blocker and the setter in high level volleyball. *International Journal of Medicine and Science of Physical Activity and Sport, 12*(46), 313-327.
5. Castro, J., & Mesquita, I. (2010). Analysis of the attack tempo determinants in volleyball's complex II - a study on elite male teams. International Journal of Performance Analysis in Sport 10(3), 197-206.
6. Claver (2013) Claver Rabaz, F., Jiménez Castuera, R., Gil Arias, A., Moreno Domínguez, A. & Moreno Arroyo, M. (2013). Relationship between performance in game actions and the match result. A study in volleyball training stages. Journal of Human Sport and Exercise - University of Alicante, 8(3Proc), 651-659.
7. Coleman, J. E. (1975). A statistical evaluation of selected volleyball techniques at the 1974 world's volleyball championships. Unpublished doctoral dissertation, Brigham Young University, Provo, Utah
8. Drikos, S., Kountouris, P., Laios, A., & Laios, Y. (2009). Correlates of Team Performance in Volleyball. *International Journal of Performance Analysis in Sport, 9*(2), 149-156.
9. Eom, H.J., & Schutz, R.W. (1992). Statistical analyses of volleyball team performance. *Research Quarterly for Exercise and Sport, 63*(1), 11-18.

10. Grgantov, Z., Katić, R., & Marelić, N. (2005). Effect of New Rules on the Correlation between Situation Parameters and Performance in Beach Volleyball. *Collegium* Antropologicum, 29(2), 717-722.
11. Hayrinen M., Hoivala T., & Blomqvist M. (2004). Differences between winning and losing teams in men's European top-level volleyball. In O'Donoghue P. & Hughes M. (Eds.), *Performance analysis of sport VI*. (pp.194-199). Cardiff, UK: UWIC.
12. Joao, P.V., Mesquita, I., Sampaio, J., & Moutinho, C. (2006). Comparative analysis between libero and priority receivers on the offensive organization, from the serve reception on the volleyball game. *Portuguese Journal of Sport Sciences, 6*(3), 318-328.
13. Marcelino, R., Cesar, B., Afonso, J., & Mesquita, I. (2009). Attack-tempo and attack-type as predictors of attack point made by opposite players in volleyball. *International Journal of Performance Analysis in Sport, 9*(3), 391-400.
14. Marcelino, R., & Mesquita, I. (2006). Characterizing the efficacy of skills in high performance competitive volleyball. In H. Dancs, M. Hughes & P. O'Donoghue (Eds.), *Notational Analysis of Sport - VII* (pp. 491-496). Cardiff: UWIC.
15. Marcelino, R., Mesquita, I., & Afonso, J. (2008). The weight of terminal actions in volleyball. Contributions of the spike, serve and block for the teams' rankings in the World League 2005. *International Journal of Performance Analysis In Sport, 88*(2), 1-7.
16. Marcelino, R., Mesquita, I., Sampaio, J., & Moraes, C. (2010). Estudo dos indicadores de rendimentoem voleibol em funcao do resultado do set. *Revista Brasileira de Educacao Fisica e Esporte. 24*(1), 69-78.
17. Marelić, N. (1994). Utjecaj situacionih parametara u odbojci na rezultat u odbojkaškom setu. Hrvatski športskomedicinski vjesnik, 9(2-3), 70-76
18. Marelić, N. (1998). *Kineziološka analiza karakteristika ekipne igre odbojkaša juniora.* Doktorska disertacija. Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu.
19. Marelić, N., Rešetar, T., & Janković, V. (2004). Discriminant analysis of the sets won and the sets lost by one team in A1 Italian volleyball league - A case study. *Kineziologija, 36*(1), 75-82.
20. Marelić, N., Rešetar, T., Zadražnik, M., & Đurković, T. (2005). Modelling of situation parameters in top level volleyball. In D. Milanović, & F. Prot (Eds.), *Proceedings Book of 4th International Scientific Conference, Opatija, 2005, „Science and Profession – Challenge for the Future*" (pp. 459-462). Zagreb: Faculty of Kinesiology, University of Zagreb.
21. Marelic, N., Žufar, G., & Omrcen, D. (1998). Influence of some situation-related parametres on the score in volleyball. Kinesiology, 30(2), 55-65.
22. Mesquita, I., Manso, F.D., & Palao, J.M. (2007). Defensive participation and efficacy of the libero in volleyball. Journal of Human Movement Studies, 52(2), 95-107.
23. Monteiro, R., Mesquita, I., & Marcelino, R. (2009). Relationship between the set outcome and the dig and attack efficacy in elite male volleyball game. *Intenational Journal of Performance Analysis in Sport, 9*(1), 294-305.
24. Nishijima, T. (2001). The relationship between the team skill and the fundamental skill in volleyball. *Physical Education and Sport Science 1*(1), 15-22.
25. Oliveira, A., Vaz, L., Pastore, J.C., & Joao, P. (2018). Discriminate Scoring Skills and Non-Scoring Skills According to Results in the Brazilian Men's Volleyball SuperLeague. Montenegrin Journal of Sports Science and Medicine, 7(1), 73-79.
26. Oliveira, A., Valladares Iglesias, N., Vaz, L., & Joao, P. (2016). Evaluation of Scoring Skills and Non Scoring Skills in the Brazilian SuperLeague Women's Volleyball. Montenegrin Journal of Sports Science and Medicine, 5(2), 25-31.
27. Palao, J.M., Santos, J.A., & Urena, A. (2004). Effect of team level on skill performance in volleyball. *International Journal of Performance Analysis in Sport, 4*(1), 50-60.
28. Palao, J.M., Santos, J., & Urena, A. (2007) Effect of the manner of spike execution on spike performance in Volleyball. International Journal of Performance Analysis in Sport 77(2), 126-138.
29. Papadimitriou, K., Pashali, E., Sermaki, I., Mellas, S., & Papas, M. (2004). The effect of the opponents serve on the offensive actions of greek setters in volleyball games. *International Journal of Performance Analysis in Sport, 4*(1), 23-33.
30. Paulo, A., Davids, K., & Araujo, D. (2018). Co-adaptation of ball reception to the serve constrains outcomes in elite competitive volleyball. *International Journal of Sports Science & Coaching*, 13(2), 253-261.
31. Patsiaouras, A., Charitonidis, K., Moustakidis, A., & Kokaridas, D. (2009). Comparison of technical skills efficiency of men's National Volleyball teams. *International Journal of Performance Analysis in Sport, 9*(1), 1-7.
32. Pena, J., Rodrigez-Guerra, J., Busca, B., & Serra, N. (2013). Which skills and factors better predict winning and losing in high-level men's volleyball? *Journal of Strenght and Conditioning Research, 27*(9), 2487-2493.
33. Rocha, C.M., & Barbanti, V.J. (2006). An analysis of the confrontations in the first sequence of game actions in Brazilian volleyball. Journal of Human Movement Studies, 50(4), 259-272.
34. Rodriguez-Ruiz, D., Quiroga, M.E., Miralles, J.A., Sarmiento, S., De Saa, Y., & García-Manso, J.M. (2011). Study of the technical and tactical variables determining set win or loss in top-level European men's volleyball. Journal of Quantitative Analysis in Sports, 7(1), article number 7.
35. Selinger, A., & Ackermann-Blount, J. (1986). *Arie Selinger's power volleyball.* New York: St. Martín Press.
36. Silva, M., Lacerda, D., & Joao, P.V. (2013). Match analysis of discrimination skills according to the setter attack zone position in high level volleyball. International Journal of Performance Analysis in Sport, 13(2), 452-460
37. Silva, M., Lacerda, D., & Joao, P.V. (2014). Game-Related Volleyball Skills that Influence Victory. Journal of Human Kinetics, 14(1), 173-179.
38. Šuker, D., Grgantov, Z. & Milić, M. (2015). Intrarater and interrater reliability of the spiking efficiency assessment in top men's volleyball. *Kinesiologia slovenica*, *21*(2), 22-30.
39. Yiannis, L., Panagiotis, K., Ioannis, A., & Alkinoi, K. (2004). A comparative study of the efficiency of Greek national men's volleyball team with internationally top-ranked teams. *International Journal of Volleyball Research, 7*(1), 4-9.
40. Zadražnik, M., Marelić, N., Rešetar, T. (2009). Differences in rotations between the winning and losing teams at the youth European volleyball championships for girls. Acta Universitatis Palackianae Olomucensis, Gymnastic, 39(4), 33-40.
41. Zetou, E., Tsiggilis, N., Moustakidis, A., & Komninakidou, A. (2006). Playing characteristics of men's Olympic volleyball teams in Complex II. International Journal of Performance Analysis In Sport, 6(1), 172-177.
42. Zetou, E., Moustakidis, A., Tsiggilis, N., & Komninakidou, A. (2007). Does efficiency of skill in Complex I predict win in men's Olympic volleyball games? Journal of Quantitative Analysis In Sports, 3(4), 1-9.

43. Zhang, R. (2000). How to profit by the new rules. The Coach, 1(1), 9-11.
44. Zimmermann, B. (1999). Changes and potential possibilities with the introduction of liberos in Men's World Class Volleyball. The Coach, 1(1), 4-12.

PREDVIĐANJE UČINKOVITOSTI U VRHUNSKOJ ODBOJCI: PRISTUP KORIŠTENJEM VIŠESTRUKE REGRESIJSKE ANALIZE

Sažetak

Cilj rada bio je identificirati povezanost koeficijenata uspješnosti izvedbe 5 faza igre (servis, prijem servisa, smeč, blok i obrana polja) s bodovnom razlikom kojom se ostvarila pobjeda ili poraz u setu. U skladu sa ciljem, korišten je uzorak od 40 slučajno odabranih setova odigranih u Europskoj ligi za muškarce 2011. i 2012. godine. Višestruka linearna regresijska analiza je primijenjena na slučajno odabranoj polovici uzorka (N_1=20) te je unakrsno validiran korištenjem drupe polovine uzorka (N_2=20). Obzirom da je validacija bila uspješna, može se zaključiti da 78% razlika u u osvojenim bodovima u setu može biti objašnjeno sustavom korištenih prediktorskih varijabli. Utvrđeno je da smečiranje i obrana polja imaju značajan utjecaj na bodovnu razliku u setu ($p<0.05$). Rezultati implicitno ukazuju na dominaciju napada u odnosu na obranu u modernoj odbojci te dodatno ukazuju na važnost smečiranja kao faze igre kojom se osvaja najviše poena u odbojkaškom setu, ali i obrane polja kojom se sprječava protivnike u osvajanju poena i ostvaruju pretpostavke za osvajanje poena u protunapadu.

Ključne riječi*: Europska liga, odbojkaši, koeficijenti uspješnosti, bodovna razlika,unakrsna validacija*

Corresponding information:

Received: 10 October 2017
Accepted: 21 April 2018
Correspondence to: Jelaska Igor associate prof, PhD
University: University of Split, Split, Croatia
Faculty: Faculty of Kinesiology
E-mail: jelaska@kifst.hr