The Relationship of Situational Efficiency Parameters of Volleyball Game Phases and Their Intrateam Variability with the Set Score

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Abstract: The purpose of this study is to determine the relationship between situational efficiency parameters of five phases of the volleyball game and their intrateam variability with the set score. A sample of 40 volleyball sets played in the European League for Men in 2011 and 2012 were randomly selected. Although, the sample wasn't recent, the purpose of this methodologically based study was to propose a new performance indicator. The multiple regression analysis determined a high and positive relationship between the situational efficiency of five phases of the volleyball game with the set score. It also determined that the intrateam variability between the phases of the volleyball game had a statistically significant but negative relationship with the set score. The variability of game phases explained 4.1% of the variance of the score. Conclusion was that a larger negative deviation in situational efficiency of one phase of the game cannot be compensated only by the corresponding increase in another phase of the game, as the linear regression model suggests.

1 INTRODUCTION

Performance analysis is a powerful research area, providing answers to understand the factors that are critical for participation in elite level sports (Hughes and Bartlett, 2002). The purpose of performance analysis is to determine which performance indicators are the most responsible for a match score.

Each team sport has its specific performance indicators that are assumed to impact the match score. These specificities arise from the structure of the sport itself. The volleyball game consists of six phases that are sequentially executed: serve, reception, setting, attack, block and dig (Busca and Febrer, 2012). Thus, the selection of performance indicators in volleyball is mostly focused on the efficiency of game phases. The efficiency of the game phase can be defined by the efficiency coefficients (Marcelino et al., 2008) or discrete variables of total successful or / and unsuccessful performances (Marcelino, et. al., 2008; Yu et al., 2018). Marcelino et al. (2008) determined that the relative measures of the spike were better performance indicators of success in high level volleyball then the discrete ones. According to the authors of this study, efficiency coefficients are more appropriate because they consider all executions, not only the terminal ones.

In pursuit for predictors with a higher relationship with the score, researchers consider various relations between the performance indicators but also various manners for defining the score. Some of those less obvious performance indicators were the efficiency coefficients derived from two or more performance indicators (Drikos et al., 2009). Drikos et al. (2009) also determined that performance indicators derived from the discrete indicators were better predictors then the discrete ones. Those were the serving efficiency ratio, defined as the ratio of lost serves to aces, and the attack efficiency ratio, defined as the number of kill attacks divided by the sum of attack errors and kill-blocks. They also defined the team performance as the ratio of sets won to the total number of sets. In other study, Drikos et al. (2020) were determining differences in 12 performance indicators between volleyball sets classified by two indipendent factors (gender and type of result). They tested the effect of those independent factors as well as the interactions of factors (gender x type of result). It is very important that the total set of performance indicators isn't too complex. It has to be simple enough in order to be logically explained for the practical purpose.

The performance indicator introduced by the author in this study is the intrateam variability of the situational efficiency parameters of volleyball game

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phases. Variability is a measure of the the amount of dispersion in a dataset. In this study, higher variability implies greater differences between team's below average and above average efficiency coefficients of the game phases in a set. The relationship of the intrateam variability with the score will give the answer if a extremely low performance in one game phase could be compensated by proportionally high performance in another one.

Given the high sequentiality of game phases in volleyball, the assumption was that the extremely low performance in one game phase would consequently lower the score, that the high performance in another game phase could not compensate for. The assumption is that the homogeneity of performance efficiency of game phases would have the additional positive impact on the score when teams have the same cumulative situational efficiency.

The purpose of this study is to determine the realtionship between situational efficiency parameters of five phases of the volleyball game and their intrateam variability with the set score.

2 METHODS

2.1 Set of Entities

The samle of entities were 40 volleyball sets from matches played in the European Volleyball League for Men in 2011 and 2012. In order to avoid dependence of the sample, only the data from one set of a match and only one team were collected. Both the set and the team were randomly selected.

2.2 Set of Variables

The predictor variables were the efficiency coefficients of the five phases of the volleyball game: serve, reception, spike, block, dig, and their intrateam variability. The setting was excluded from this study because of its specific situational efficiency analysis. The efficiency coefficient of each game phase was defined as the arithmetic mean of scores of all performed technical skills within a particular phase in one set. Each performed skill was evaluated with a score (1 – 4) according to precisely defined criterion. The score 1 was an error, 2 was an advantage for the opponent, 3 was an advantage for the team being evaluated, and 4 was an ideal performance (reception, dig) or a point won (serve, spike, block). The intrateam variability of the game phases was the calculated standard deviation of the five efficiency coefficients of each team. The first step was to standardize the efficiency coefficients of each game phase. The second step was to calculate the standard deviation of standardized efficiency coefficients for each individual team. The criterion variable was the set score defined as a relative point difference, the point difference in a set devided by the total number of points. If the team won the set, the relative point difference was positive and on the contrary, if the team lost the set, the relative point difference was negative. The authors believe that the same point difference does not represent an equal outcome of the set in the case when the result is 15 : 13, 25 : 23 or 31 : 29. For this reason, the result in the set was defined as a relative point difference.

2.3 Data Collection

The data were obtained from the existing videos of played volleyball matches into prepared forms. It was done by the first author, who has multiannual playing experience, an A coaching license and a multiannual coaching experience in men’s volleyball. The reliability analysis was conducted with the help of an expert with multiannual playing, coaching and notational analysis work experience.

2.4 Statistical Analysis

A reliability analysis was conducted on a sample of 3 randomly selected sets. Spearman’s rank correlation and Cohen's kappa were calculated to determine the degree of agreement between the two different measurements (the first author and the expert) and two different measurements of the same measurer (the first author) at intervals of 4 – 6 weeks (test-retest method).

The descriptive statistics were: arithmetic mean (Mean), standard deviation (σ), minimum (Min) and maximum (Max). Normality of distribution was determined by Shapiro-Wilk test.

Two separate multiple regression analysis were conducted to determine the relationship between the efficiency coefficients of the five phases of the volleyball game and their intrateam variability and the set score. The first one was conducted without the variability as a predictor and the second one included the variability in order to determine its contribution on the regression model.

The collected data were analysed with the computer program Statistica for Windows 13.3 (TIBCO Software Inc.).

Table 1: Descriptive statistics results.

	Mean ± σ	Min	Max
Relative point difference	-0.01 ± 0.13	-0.32	0.25
Efficiency coefficient-serve	2.14 ± 0.20	1.75	2.50
Efficiency coefficient-reception	2.98 ± 0.26	2.55	3.50
Efficiency coefficient-spike	3.04 ± 0.24	2.44	3.65
Efficiency coefficient-block	2.29 ± 0.39	1.00	3.00
Efficiency coefficient-dig	1.95 ± 0.28	1.22	2.61
Variability-game phases	0.90 ± 0.34	0.39	1.77

Legend: Mean – arithmetic mean, **σ** – standard deviation**, Min** – minimal result, **Max** – maksimal result.

Table 2: The results of two multiple regressions (variability of the game phases included in the second analysis).

			β	b	t	R^2 part. (%)	p
R	0.89	Intercept		-2.29	-11.31		0.00
R^2	80.0%	Efficiency coefficient-serve	0.36	0.25	4.37	17.0	0.00
R^2_{adj}	76.5%	Efficiency coefficient-reception	0.27	0.14	3.31	11.8	0.00
F	26.3	Efficiency coefficient-spike	0.48	0.26	5.74	32.6	0.00
p	0.00	Efficiency coefficient-block	0.22	0.08	2.65	5.4	0.01
		Efficiency coefficient-dig	0.39	0.19	4.69	12.8	0.00
R	0.91	Intercept		-2.19	-11.20		0.00
R^2	82.3%	Efficiency coefficient-serve	0.38	0.26	4.92	18.2	0.00
R^2_{adj}	79.1%	Efficiency coefficient-reception	0.26	0.14	3.43	11.5	0.00
F	25.6	Efficiency coefficient-spike	0.47	0.26	5.88	31.6	0.00
p	0.00	Efficiency coefficient-block	0.20	0.07	2.47	4.8	0.02
		Efficiency coefficient-dig	0.37	0.18	4.68	12.2	0.00
		Variability-game phases	**-0.17**	**-0.07**	**-2.29**	**4.1**	**0.03**

Legend: R – coefficient of multiple correlation, **R^2** – coefficient of determination, **R^2_{adj}** – adjusted coefficient of determination, **F –** Fisher's test value, **β** – standardized regression coefficients, **b** – unstandardized regression coefficients, **R^2_{part}** – partial coefficient of determination**, t** – t–test value, **p** – significance level.

3 RESULTS

Reliability analysis results determined a high correlation between the two measurements of the same measurer conducted at two-time points (R = 0.91; κ = 0.92) and the two different measurers (R = 0.92; κ = 0.88).

Two separate multiple regression analysis were conducted. The first one in order to determine the extent of the relationship of the efficiency coefficients of five volleyball game phases and the relative point difference in the set. The second one was conducted in order to determine the contribution of the variability of the game phases witin a team in the regression model.

The multiple regression analysis showed that all predictors had a significant relationship with the set score. The efficiency coefficients of the five phases of the volleyball game and the variability of the phases explained a total of 82.3% of the variance of the relative point difference in the set. All regression coefficients of game phases were positive, the increasement of their efficiency coefficients had a positive impact on the set score. The regression coefficient of variability was negative, which ment that the greater the variability of game phases within the team, the greater negative impact on the set score. Variability explains 4.1% of the results.

4 DISCUSSION

The purpose of this research was to determine the extent of the relationship between the efficiency coefficients of the volleyball game phases and also their intrateam variability with the set score.

Descriptive indicators showed that the attack is the phase of the game that has the highest situational efficiency coefficient, 3.04 out of 4, the maximal possible efficiency coefficient. The second one was the reception with almost equal values, then block and serve, the dig had the lowest situational efficiency coefficient, 1.95. Previous research has also shown that attack have been the most effective phase of the volleyball game (Eom and Schutz, 1992; Marelić et al., 1998; Marcelino, et al, 2008; Stutzig et al., 2015). The block had the highest standard deviation (0.39), which ment that it was the phase of the game in which the sample of teams is the least homogeneous. In contrast, serve had the lowest standard deviation (0.20). However, a high situational efficiency coefficients of a game phase does not represent its impact on the set score.

The correlation coefficient of the arithmetic mean of the five efficiency coefficient of game phases and their standard deviation (intrateam variability) was r = -0.09. This ment that both the teams with high and the teams with low situational efficiency could have equally high or low variability. However, it is not possible to determine the impact of efficiency coefficients and treir variability on the set score based on descriptive results. That was why a multiple regression analysis was conducted to determine the aforementioned relationship.

The results of multiple regression analysis showed that the situational efficiency coefficient of the five phases of the volleyball game have a high relationship with the set score. All regression coefficients of game phases were positive, increasment in their efficiency coefficients had a positive impact on the set score. The attack was the phase of the game that explained the most variance of the results (31.6%), followed by serve (18.2%), dig (12.2%) and reception (11.5%) and finally block with only 4.8%. As mentioned, a high efficiency coefficient does not imply as high impact on the set score. For example, dig, which had the lowest average efficiency coefficient of all game phases (1.95), had a greater relationship (the amount of common variance) with the set score (12.2%) than both the reception (11.5%) and the block (4.8%).

The dig and the reception are not the game phases by which a team is not able to win a point. The team is able to win a point by the serve, spike and block (and the opponent error). A high amount of the common variance of the dig with the score ($R^2_{part.}$ = 12.2%) in this study was unexpected. According to Palao et al. (2006), despite the crucial role of the attack, it is assumed that defensive actions are fundamental to maintain success in the competition. Similar to the dig, the reception had an unexpectedly high relationship with the set score ($R^2_{part.}$ = 11.5%). But, according to Laios and Moustakidis (2011) the reception has a high impact on the score. The efficient reception enables all tactical variants of the team's attack which makes the attack unpredictable for the opponent. In contrary to the reception and the dig, the block as a terminal game phase, had an unexpectedly low relationship with the set score ($R^2_{part.}$ = 4.8%). But, in top level volleyball, the block stops only 15¬20 % of the opponent's spikes (Palao et al., 2004). The reason is that the team's tactics emphasize quick spikes that make the time deficit to the opponent's block. That may be the reason the block doesn't win many points in the set (in this sample 10,4%). On contrary, The fewest points are won by the serve (in this sample 4,4%) but the serve has a high relationship with the score ($R^2_{part.}$ = 18.2%). The game phases in volleyball are executed in a manner that makes volleyball a highly sequential sport, efficiency of every game phase is partially determined by the previous one.

The intrateam variability of game phases has a statistically significant relationship with the score, but the regression coefficient was negative, which shows that variability had a negative impact on the set score. The variance of the score explained by the team's variability was low, 4.1%, but when we consider that the block explained 4.8%, then the magnitude of the impact of the variability on the set score can't be ignored. The consequence of 4.1% common variance of the variability and the score in practical application is the number of points in the set. The team with the lowest variability (0.39) loses approximately 1.4 points and the team with the highest variability (1.77) loses 6.2 points in a set with a total of 50 points (26 : 24). According to the regression model, the team with the lowest variability wins 4.8 points more then the team with the highest variability even the both teams have the same all situational efficiency coefficients of the game phases. Theoretically, if more point were played (31:29) the difference would increase to 5.8 points. It is obvious which team wins the theoretical match.

For examle, if a team A has higher variability and lower efficiency coefficient only in block then the team B, it isn't enough to substitute proportional backlog in, for example, attack in order to catch up with the team B, as the linear regression model without variability suggests. Additional increase has to be accomplished in order substitute the higher variability. As already mentioned, the reason to this could be the high sequentiality of the volleyball game. Although invisible to the observer, in a large number of sequentialy performed skills during the set, variability of the game phasese manages to achieve that 4% negative impact on the set score.

The purpose of the performance analysis is to determine predictors that impact the score in as many possible ways. Many less obvious predictors had also been determined to have an impact on the score. Various interactions between predictors have been determined as such less obvious predictors with a significant impact on the score (Drikos, et al., 2020). In some research various efficiency coefficients were derived from predictor variables in order to determine the relationship with the score (Drikos, et al., 2009). The intrateam variability between situational efficiency of game phases showed that the homogeneity of performance indicators is important for overall situational efficiency. Given the fact that in top level sport even the smallest differences can decide between victory and defeat, the importance of variability of game phases becomes even more important. The virtue of this predictor is its explication simplicity for the scientific and practical application.

European League for Men is a top level volleyball competition so the limitation of this study is that it's results could not refer to other levels of competition in volleyball. It is difficult to assume would the intateam variability of the game phases have this type of impact on the set score if the volleyball sets were played in a lower level of competition. So the implication of this study is that the further research should be conducted with volleyball sets collected from the lower level of competition.

5 CONCLUSION

The multiple regression results determined a high and positive relationship between the five phases of the volleyball game and the relative point difference in the set. The relationship between the game phases variability and the relative point difference was also determined but it was negative. The intrateam variability between efficiency coefficients of the game phases has been determined to be another possible predictor of team's performance. The practical applicability of the results of this research is a recommendation for teams to place additional emphasis in the training process primarily on increasing the efficiency of game phases with the lowest efficiency coefficients, and only then on increasing the efficiency coefficients of game phases that have the greatest positive impact on the set score.

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