Original Article

Beach volleyball performance benchmarks in men's high level

GEORGE GIATSIS

School of Physical Education and Sports Science. Aristotle University of Thessaloniki. Thessaloniki, Greece

ABSTRACT

The aim of this study was to explore the set and technical indicators between winning and losing men's teams in the 2022 beach volleyball World Championship, depending on the set of the matches to 21- (S21) and 15-points (S15). A total of 250 sets and 9,096 points were analysed from the men's 2022 World Championship. Discriminant function analysis determined which skill(s) contributed significantly to winning a set in S21 and S15. This study showed that the teams that won S21 and S15 had better performance in all scoring skills (serve, attack, block, opponent errors), attack kill percent and attack and serve efficiencies compared to their opponents. The attack opponent errors points and attack kill percent, were the main predictors of a team's success of set and technical indicators respectively. In conclusion, the results of the men's teams at the highest level of beach volleyball, show that attack kill percent is not the only technical indicator that increases the probability of winning a set, since attack opponent errors per set points contribute equally significantly. Furthermore, teams should reduce the number of attack errors despite the high level of blocking to increase the probability of winning a set.

Keywords: Performance analysis of sport; Sports performance; Match analysis; Elite level; Discriminant analysis; Coaching; FIVB.

Cite this article as:
Giatsis, G. (2023). Beach volleyball performance benchmarks in men's high level. *Journal of Human Sport and Exercise, 18*(2), 446-461. https://doi.org/10.14198/jhse.2023.182.15

Corresponding author. *School of Physical Education and Sports Science, Aristotle University of Thessaloniki, Thessaloniki, Greece. Address: Viopoulou 6, s/n: 55132, Thessaloniki, Greece.* https://orcid.org/0000-0003-0029-6684
E-mail: ggiatsis@phed.auth.gr
Submitted for publication November 12, 2022.
Accepted for publication November 29, 2022.
Published April 01, 2023 *(in press* December 14, 2022).
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202.

doi:10.14198/jhse.2023.182.15

INTRODUCTION

The Beach Volleyball World Championship is the most important international men's competition along with Olympic Games, held every two years since 1997 (Couvillon, 2004). A total of 48 men's teams participates in the World Championship from all continents (Volleyball World, 2022).

In team sports, the quantification of competition skills is important because the performance of athletes and teams could evaluate and reveal the parameters that determine the outcome of the game (Carling et al., 2009; García-de-Alcaraz et al., 2016). For this reason, with the use of technology, all match data are recorded in software programs through specialized analysts (Data Project, 2017) and these statistics can be used in training by coaches and athletes. On the other hand, due to the large amount of data collected, interpretation is more complicated, and data use may be kept private or distributed among the competing teams. However, basic statistics can be easily applied into court training sessions (Mackenzie and Cushion, 2013). Various studies that have been done in other sports as volleyball using match report, data revealed that even with simplified statistics it is possible to find the performance indicators that determine the winners from the losers in the matches (Giatsis et al., 2022; Giatsis, 2022). However, more detailed match reports using software could present a clearer picture of the game, while the analysis of individual sets would also give a clearer picture of the performance of teams and players.

In recent years in beach volleyball (Link and Wenninger, 2019) and volleyball (Fernadez-Echeverria et al., 2017; Oliveira et al., 2016), match report has been used in major tournaments and includes team and individual statistics, quantifying the frequency of different skills and how points are scored. The beach volleyball match report includes the points a team can earn from serve, reception, attack, block, and from opponents' serve, attack, or other errors. With this data, frequencies, percentages, efficiencies, coefficients, and performance indicators could be used by coaches and athletes evaluating their performance and using it in matches and training (Griego-Cairo et al., 2016). Furthermore, these statistics can also be presented in the television broadcasts informing the viewers of the beach volleyball matches to have a more detailed picture of the game.

Beach volleyball is played by two against two players and a team needs two sets to win the match. The first two sets of the match are played to 21 points while if the score is equal one-one in the first two sets the third set is played to 15 points (FIVB, 2022). The sequence of actions is the serve, serve reception, set, attack block and dig (Giatsis and Zahariadis, 2008). However, a lot of players are attacking after the reception (over on two attack) without setting the ball (Giatsis and Tzetzis, 2003; Giatsis et al., 2015). Also, beach volleyball is divided in side-out and counterattack phases which are functionally different but related. The side-out phase (Complex I) includes serve, serve reception, set, and attack and counterattack (Complex II) includes block, dig, set and attack (Perez-Turpin et al., 2019). This distinction makes it easier for coaches and players to assess how their teams performed at the two different game complexes.

Studies of each technical action in beach volleyball provided essential knowledge to attain the best performance (Alvarado-Ruano and López-Martínez, 2022; Giatsis and Zahariadis, 2008; Giatsis et al., 2015; López-Martínez et al., 2018; Medeiros et al., 2014; Michalopoulou et al., 2005). Giatsis and Zahariadis (2008) found in FIVB matches with 2-0 score that winners had better performance in almost every game action analysed, and the opponents' attack errors, were the most important factor that contributed to win a match. However, in 2-1 matches winners had better performance only in the total of win points, while it was not being possible to establish an explanatory pattern of the winner's performance in relation to losers. In a recent research, Kumar at al. (2021) reported that opponent's errors were linked to winning in elite beach volleyball

matches. In another research, Palao and Ortega (2015) reported that winners had a better side-out efficacy with more points and fewer errors in attack. In terms of attack success in elite beach volleyball, various researchers reported that the kill attack rate for the teams was about 60% (Papadopoulou et al., 2020; Roglan and Grydeland, 2006). Furthermore, losing teams presented a higher attack errors rate than winners. However, the three first teams in Olympic Games held in Athens 2004 had more than 60% kill attack rate which was higher than the 55% found in other competitions from Koch and Tilp (2009).

Various studies reported the importance of serve (Jiménez-Olmedo et al., 2012; Kumar et al., 2021; Medeiros et al., 2014; Palao and Ortega, 2015; Tilp et al., 2006). The winners' teams serve more efficient than losers, obtaining more points and had lesser serve errors. Furthermore, in Olympic games level, a 2.9% of the serve were aces, while an 8.3% were serve errors (Papadopoulou et al., 2020).

Blocking action is very important in men's FIVB matches (Jimenez-Olmedo and Penichet-Tomas, 2017; Peña et al., 2013) and attacks were performed in the presence of the block at 84-90% in matches (Laios, 2008; Mesquita and Teixeira, 2004) and even more at 91% in side-out phase (Giatsis et al., 2015). Furthermore, winning teams performed more blocking points than losers' teams in beach volleyball matches (Grgantov et al., 2005; Medeiros et al., 2014; Medeiros et al., 2017).

According to the literature review, data for beach volleyball at the highest level of men's competition do not appear to be broken down into single sets. Since the benchmarks may be lower when the final score of the matches is 2-1 due to the winning team lost a set, we believe that this distinction is required to appropriately assess the performance of the winning teams in every set. Additionally, we also assume that the performance indicators will be differentiated between sets in 21- and 15-points.

Therefore, the aim of this study is to explore the performance indicators using the data from the men's match reports in the beach volleyball 2022 World Championship depending on single set to 21- and 15-points. The purpose of this study was twofold: a) to examine the contribution of skill parameters to the set result, b) to determine the best predictor variable(s) in winning a set among scoring skills.

MATERIALS AND METHODS

Participants

A total of 48 teams from 30 countries participated in the main draw of the beach volleyball World Championship (2022) held in Rome, Italy. In the World Championships Beach Volleyball tournament (2022), qualified statisticians using DataVolley (Data project, 2017) appointed by the event organizers uploads the official match report to the tournament website. This report contains match and sets information such as player details, score, and players' performance in beach volleyball skills. The data collection was performed using the Volleyball Information System (FIVB VIS, 2015) created from official statistics and published on the website of the International Volleyball Federation (FIVB).

A total of 107 official match reports were obtained for the data sample from the World Championships in 2022. One match was not included in the data due to an injury to a player. In sum, 250 sets and 9,096 points were performed in the tournament. A total of 214 sets were played in 21 points (Set-21) and 36 sets played in 15 points (Set-15). Figure 1 shows the distribution of sets according to the points difference in both types of sets. The primary recorded and evaluated parameters were: 9,096 serves, 425 serve points (aces), 1,102 serve errors, 10,461 attacks, 5,658 attack points, 777 blocks, 993 attack errors, and 141 other points

(blocking and setting errors). All matches were played using the rally scoring system (RS), where every rally results in a point (FIVB, 2022).

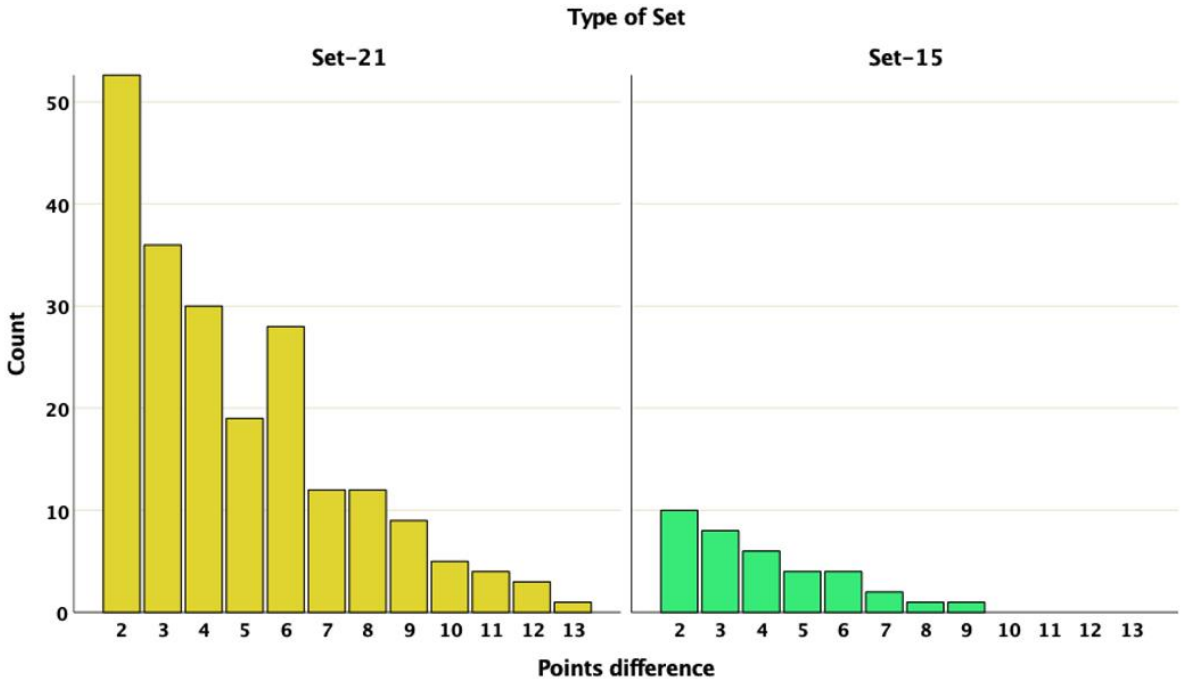

Figure 1. Distribution of sets according to the points difference in Set-21 (N = 214) and Set-15 (N = 36).

Measures and procedures

The total attempts of attack and serve were analysed. Also, the total and break (points gained when a team is serving) points were analysed. All the ways in which a team can earn a point were analysed: attack, serve, and block scoring skills. The points that a team earned due to the opponent's errors (OpErr) were also analysed (serve, attack, blocking, and setting errors). The criteria for blocking errors were referred to the illegal touch of the net, and for overhand setting to the incorrect handling of the ball.

In this study, set and technical performance indicators were analysed (Hughes and Bartlett, 2002). Set indicators were the points earned by each scoring skill (attack, serve, block) and opponents' errors (attack, serve and other errors), and technical indicators were the attack kill percent, attack efficiency, serve aces per set points, block per set points, and opponents' errors (serve and block) per set points. The attack kill percent value was calculated as the sum of successful attempts divided by the total sum of the attacks. The serve aces, block and opponents' errors as the fraction of the points earned by the team divided by the total sum of both teams' set points. The attack efficiency was calculated as the sum of successful attempts minus the lost points (attack errors and blocked attempts) divided by the total sum of the attacks. The serve efficiency was calculated as the sum of serve aces minus the serve errors divided by the total sum of the serve attempts.

The teams' performance in every set was classified according to the type of set (21 and 15 points) and set result (win-loss). The author (G.G.), which is a beach volleyball expert, recorded the data from 25% of the total matches (N = 27 matches) from the official FIVB channel (http://www.volleyballworldtv.com) in a special Microsoft Excel worksheet (Tabachnick and Fidell, 2007) and the reliability of data recording presented perfect intra-ratter Cohen Kappa values (κ = 1.000, p < .001) for serve, attack, block, and opponents' errors).

Also, an inter-rater reliability analysis using Cohen's Kappa statistic was carried out to find the degree of consistency of data recording between the author (G.G.) observations and the DataVolley statisticians. The Cohen's Kappa coefficient indicated perfect agreement for serve, attack, block, and opponent's errors (κ = 1.000, p < .001).

Analysis

Descriptive statistics were applied to determine means and standard deviations for sets won and lost, and for the two types of sets for each independent variable. An ANOVA was used for set and technical indicators to compare the differences of the selected variables between winning and losing men's teams in all types of sets. Effect sizes (ES) based upon partial eta squared (η_p^2) were calculated to report on the magnitude of the effect of the performance effectiveness for each beach volleyball skill, with the following interpretation criteria adopted by Cohen (1988): 001 - .05 = small, .06 - .13 = medium, and ≥ .14 = large effect.

Furthermore, the contribution of the set and technical indicators to winning in each type of set was identified using two stepwise discriminant analyses (DA). The discriminant analyses were planned to determine three items in each type of final score set: a) which variables were the best predictors of the teams winning, b) the discriminant function that best distinguishes winning from losing in a volleyball match, and c) the accuracy of the equation that best discriminated success in a volleyball set. The magnitudes of structure coefficient (SC) loadings larger than .30 were meaningful, indicating that the respective independent variables contributed substantially to the separation of the dependent variable's different levels (Pedhazur, 1997). Absolute loadings were defined as follows: > .32 poor, > .45 fair, > .55 good, > .63 very good, and > .71 excellent (Comrey and Lee, 1992). Jack-knifed was used to reduce bias in the classification (Cohen, 1988). The eigenvalues > 1 indicate a good model, such as canonical correlation high values imply a high level of association between the groups in the dependent variable and the discriminant function. In order to represent graphically the importance of selected key performance indicators, a Scatterplot was created and the accuracy of the discriminant function with regards to the main variables was depicted. Statistical tests were performed with SPSS (version 27) at a significance level of α = .05.

The level of tolerance and inflation factor has previously been applied to indicate the absence of multicollinearity (VIF). There were no collinearity issues as the model's tolerance values were larger than 50% and the values were far from zero. The model's inflation factor values were less than five, which indicates that there was no collinearity since the permissible value for VIF is five or less.

RESULTS

Descriptive statistics of the attack and serve attempts, break, and total points of the set for the factor set result, results of the ANOVA (F- value), significance value (p-value), and effect size are presented in Table 1.

Set indicators

Descriptive statistics of the set indicators for the factor set result, results of the ANOVA (F- value), significance value (p-value), and effect size are presented in Table 2. Attack, serve, block and attack opponent errors set indicators were significantly different (p < .001) in Set-21 and Set-15 as winners won more points than losers. However, serve opponent errors and other points were not significantly different (p > .05). Figure 2 shows a visual summary of the set indicators (including outliers).

Table 1. Means (M) and standard deviations (SD) of attack and serve attempts, break, and total points for the factor set result. Results of ANOVA (F-value), significance value (*p*-value) and effect size.

		Winners		Losers				
	N	M	SD	M	SD	Sig.	F	ES (η_p^2)
Attack attempts								
Set-21	214	21.1	4.9	22.4	4.4	**<.05**	9.116	0.021
Set-15	36	15.2	3.8	17.0	3.0	**<.05**	4.867	0.065
Serve attempts								
Set-21	214	20.8	1.5	17.3	3.2	**<.001**	208.581	0.329
Set-15	36	14.6	0.6	11.6	2.3	**<.001**	58.086	0.453
Total points								
Set-21	214	21.4	1.3	16.7	3.3	**<.001**	382.495	0.473
Set-15	36	15.1	0.5	11.1	2.1	**<.001**	122.827	0.637
Break points								
Set-21	214	5.3	1.9	2.5	1.6	**<.001**	274.198	0.392
Set-15	36	3.7	1.7	1.6	1.0	**<.001**	42.476	0.378

Note. Effect size: .001 - .05 = small effect, .06 - .13 = medium effect, ≥ .14 = large effect.

Table 2. Means (M) and standard deviations (SD) of set indicators for the factor set result. Results of ANOVA (F-value), significance value (*p*-value) and effect size.

		Winners		Losers				
	N	M	SD	M	SD	Sig.	F	ES (η_p^2)
Attack points								
Set-21	214	12.8	2.9	10.6	3.1	**<.001**	59.241	0.122
Set-15	36	9.7	2.4	8.3	2.0	**<.05**	7.509	0.097
Block points								
Set-21	214	2.1	1.4	1.2	1.1	**<.001**	59.414	0.122
Set-15	36	1.4	1.4	0.8	0.7	**<.05**	6.904	0.090
Attack Opponent Errors points								
Set-21	214	2.7	1.5	1.6	1.2	**<.001**	69.305	0.140
Set-15	36	1.9	1.5	0.6	0.9	**<.001**	17.993	0.204
Serve points								
Set-21	214	1.2	1.1	0.7	0.9	**<.001**	25.509	0.056
Set-15	36	0.6	0.7	0.2	0.5	**<.05**	8.246	0.105
Serve Opponent Errors points								
Set-21	214	2.3	1.6	2.4	1.5	.586	0.298	0.001
Set-15	36	1.3	1.0	1.1	0.9	.534	0.390	0.006
Other points								
Set-21	214	0.3	0.5	0.3	0.5	.648	0.209	0.000
Set-15	36	0.3	0.4	0.1	0.4	.279	1.191	0.017
Total Opponent Errors points								
Set-21	214	5.3	2.2	4.3	1.9	**<.001**	29.385	0.065
Set-15	36	3.4	1.9	1.9	1.5	**<.001**	12.890	0.156

Note. Effect size: .001 - .05 = small effect, .06 - .13 = medium effect, ≥ .14 = large effect.

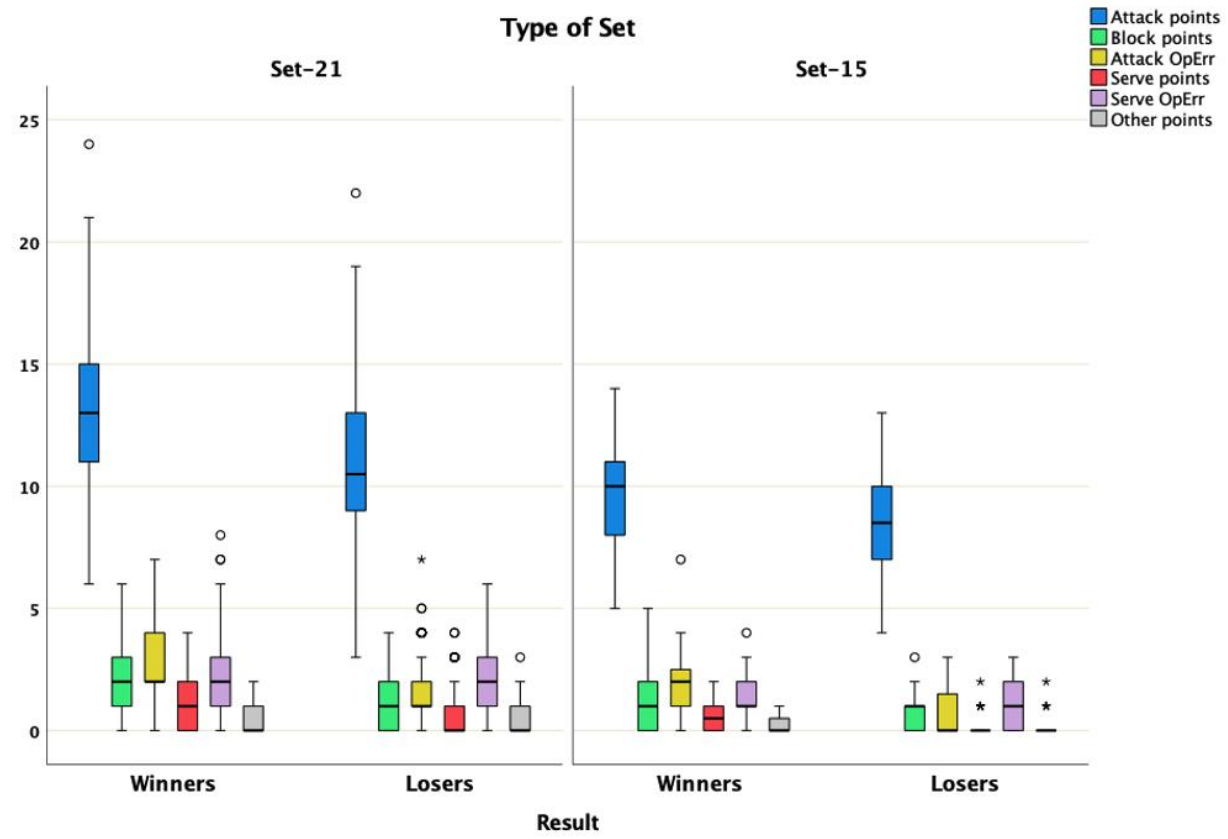

Figure 2. Boxplot of set indicators of all types for the factor set result.

Table 3 presents the eigenvalues, canonical correlations, chi-square values, respective significances, and correct classifications of the discriminant functions. The discriminant functions were statistically significant (p < .001) for Set-21 and Set-15. Specifically, the canonical correlation values were .686 and .779 and the corresponding classifications between winning or losing a set were 84.6% for Set-21 and to 90.3% for Set-15.

Table 3. Eigenvalue, test of the significance and classification table of set indicators for the discriminant function.

Type of score	**Set-21**	**Set-15**
Eigenvalue	0.888	1.539
Canonical Correlation	0.686	0.779
Wilks' Lambda	0.530	0.394
Chi-square	269.367	63.355
Df	4	4
$p\leq$	**<.001**	**<.001**
Correct Classification	84.6	90.3

The discriminant function coefficients and the relative contribution of each set indicator in maximizing the multivariate difference for the type of result (winning or losing) were investigated (Table 4). The attack, block, serve and attack OpErr indicators possessed a meaningful SC for the Set-21, while only the attack OpErr indicator possessed a meaningful SC for the Set-15. Therefore, the only common indicator across all set

types was attack OpErr points, which also differ according to the type of set. The dominant SC value of the attack OpErr points indicator for the Set-21 and Set-15 (.428 and .409 respectively) indicated that 18% and 17% (squared SC values) of the variance respectively is accounted for by each discriminant function.

Table 4. Test of significance (*p*-values, in bold) of set indicators for the equality of group means and structure coefficients (in bold > |.3|) for the type of result in all types of sets.

Set Indicators	**Set-21**		**Set-15**	
Attack points	**<.001**	**0.396**	**<.05**	0.264
Serve points	**<.001**	0.260	**<.05**	0.277
Block points	**<.001**	**0.396**	**<.05**	0.253
Attack OpErr points	**<.001**	**0.428**	**<.001**	**0.409**

Scatter plots present (Figure 3) the accuracy of the discriminant function of the importance of attack, block, and attack OpErr points indicators. Attack points are shown on the Y-axis, block points on the X-axis, and attack OpErr points on the Z-axis. The predicted group labels for the factor score result are also presented.

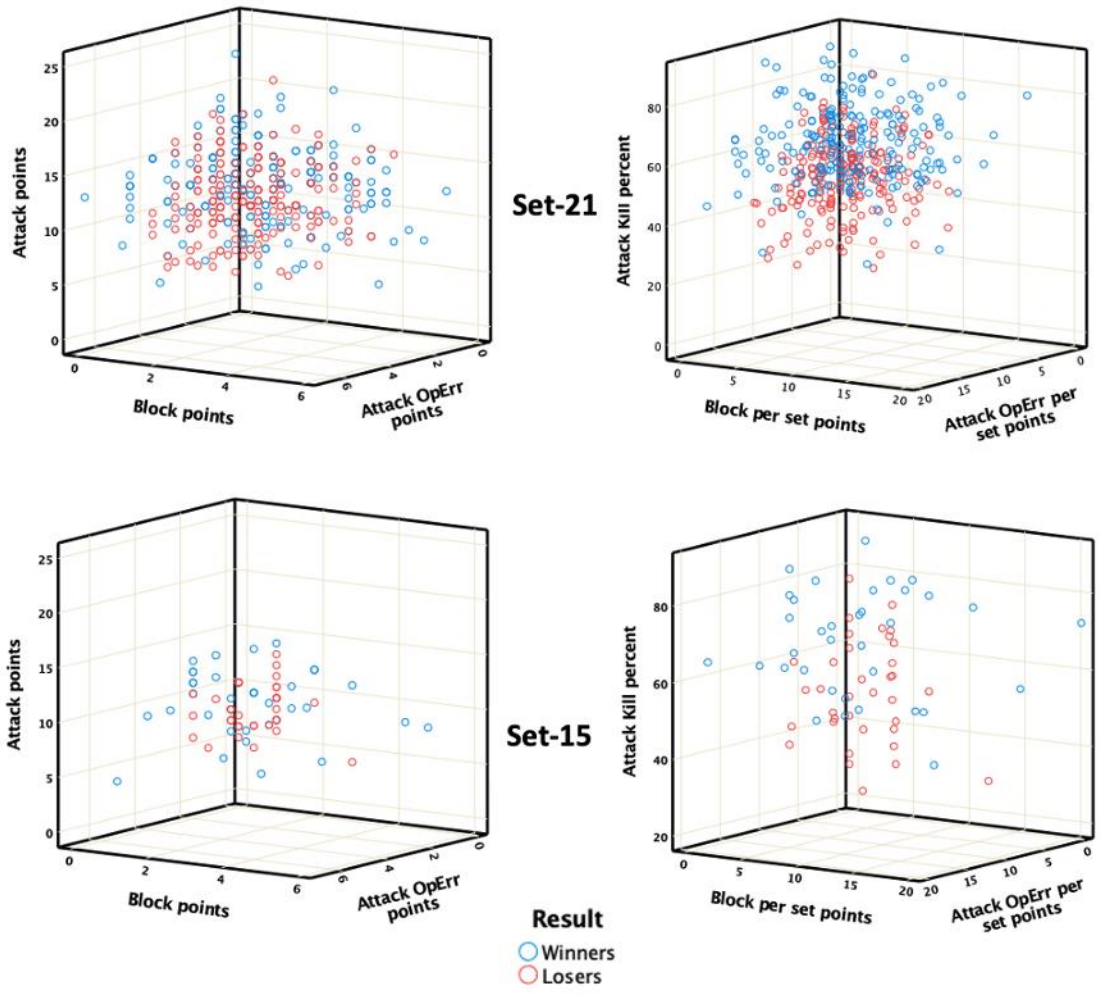

Figure 3. Scatter plot with values of the set point indicators (left column) and technical indicators (right column) and labels of the predicting group (blue for winners and red for losers) for all types of set.

Technical indicators

Descriptive statistics of the technical indicators for the factor set result are presented in Table 5. The ANOVA results (F-value), significance value (*p*-value), and effect size are also displayed. All the technical indicators except serve OpErr per set points were significant different ($p < .001$) in Set-21, as winners had higher values percentage than losers. In Set-15, attack kill percent, attack OpErr per set points ($p < .001$), block and serve per set points, serve efficiency ($p < .05$) were significant different, as winners had higher values percentages than losers. However, serve OpErr per set points was not significant different in Set-15 ($p > .05$). The technical indicators are visually summarized in Figure 4 (including outliers).

Table 5. Means (M) and standard deviations (SD) of technical indicator percentages for the factor set result. Results of ANOVA (F-value), significance value (*p*-value) and effect size.

		Winners		**Losers**				
	N	M	SD	M	SD	Sig.	F	ES (η_p^2)
Attack Kill percent								
Set-21	214	62.0	11.3	47.5	11.2	**<.001**	178.824	0.296
Set-15	36	64.8	13.2	49.5	13.0	**<.001**	24.516	0.259
Attack Efficiency								
Set-21	214	49.5	15.7	25.9	17.0	**<.001**	222.542	0.343
Set-15	36	55.7	16.8	30.4	18.7	**<.001**	36.400	0.342
Block per set points								
Set-21	214	5.6	3.9	3.0	2.7	**<.001**	65.081	0.133
Set-15	36	5.5	5.3	3.0	2.7	**<.05**	6.802	0.089
Attack Opponent Errors per set points								
Set-21	214	7.1	4.3	4.0	3.2	**<.001**	73.993	0.148
Set-15	36	7.3	5.9	2.3	3.4	**<.001**	18.999	0.213
Serve Aces per set points								
Set-21	214	3.1	3.1	1.8	2.2	**<.001**	28.728	0.063
Set-15	36	2.5	3.0	0.8	1.8	**<.05**	8.795	0.112
Serve Opponent Errors per set points								
Set-21	214	6.1	4.0	6.4	3.9	.526	0.402	0.001
Set-15	36	4.8	3.7	4.3	3.5	.510	0.438	0.006
Serve Efficiency								
Set-21	214	-6.0	8.1	-9.9	9.9	**<.001**	19.980	0.045
Set-15	36	-3.2	7.2	-9.5	9.5	**<.05**	9.822	0.123

Note. Values are percentages. Effect size: .001-.05 = small effect, .06-.13 = medium effect, ≥.14 = large effect.

Table 6 shows the discriminant functions' eigenvalues, canonical correlations, chi-square values, relative significances, and correct classifications. The discriminant functions were all statistically significant ($p < .001$). Canonical correlation decreased from .703 to .769 and the corresponding classifications between winning or losing set were 88.1% for a Set-21 to 89.4% for Set-15.

Table 7 presents the relative contribution of each set indicator in maximizing the multivariate difference for the type of result (winning or losing), and the discriminant functions coefficients. Attack kill percent, and attack OpErr per set points indicator percentages possessed a meaningful SC for all types of set. However, block per set points indicator possessed a meaningful SC only in Set-21. Therefore, attack kill percent, and attack OpErr per set points were the only common indicators across all set types and differs according to the type of final score. The dominant SC value was the attack kill percent indicator for the Set-21 and Set-15 (.606

and .492 respectively), indicating that 37% and 24% (squared SC values) of the variance respectively is accounted for by each discriminant function.

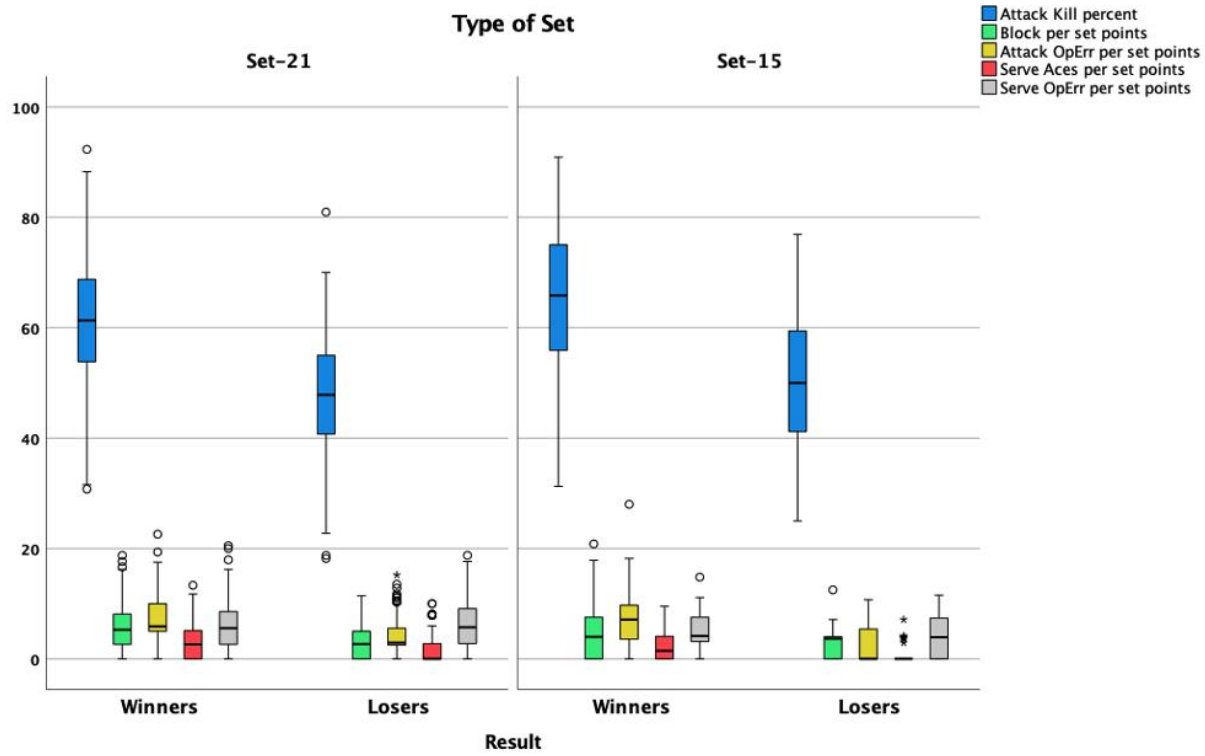

Figure 4. Boxplot of technical indicators for all types of the set for the factor set result.

Table 6. Eigenvalue, test of significance and classification table of technical indicators for the discriminant function.

Type of score	**Set-21**	**Set-15**
Eigenvalue	1.143	1.445
Canonical Correlation	0.730	0.769
Wilks' Lambda	0.467	0.409
Chi-square	323.255	60.787
Df	4	4
p≤	**<.001**	**<.001**
Correct Classification	88.1	88.9

Table 7. Test of significance (*p*-values, in bold <.05) of technical indicators for the equality of group means and structure coefficients (in bold > |.3|) for the type of result in all types of sets.

Technical Indicators	**Set-21**		**Set-15**	
Attack Kill percent	**<.001**	**0.606**	**<.001**	**0.492**
Serve Aces per set points	**<.001**	0.243	**<.05**	0.295
Block per set points	**<.001**	**0.366**	**<.05**	0.259
Attack OpErr per set points	**<.001**	**0.390**	**<.001**	**0.433**

Scatter plots (Figure 3) present the importance of attack kill percent, block per set points, and attack OpErr per set point, in the accuracy of the discriminant function. Values of attack efficiency are shown on the Y-axis, block per set points on the X-axis, and attack OpErr per set points on the Z-axis. The predicted group labels for the factor result are also presented.

Scatter plot (Figure 5) present the attack and serve efficiency for the factor result. Values of attack efficiency are shown on the Y-axis and of serve efficiency on the X-axis.

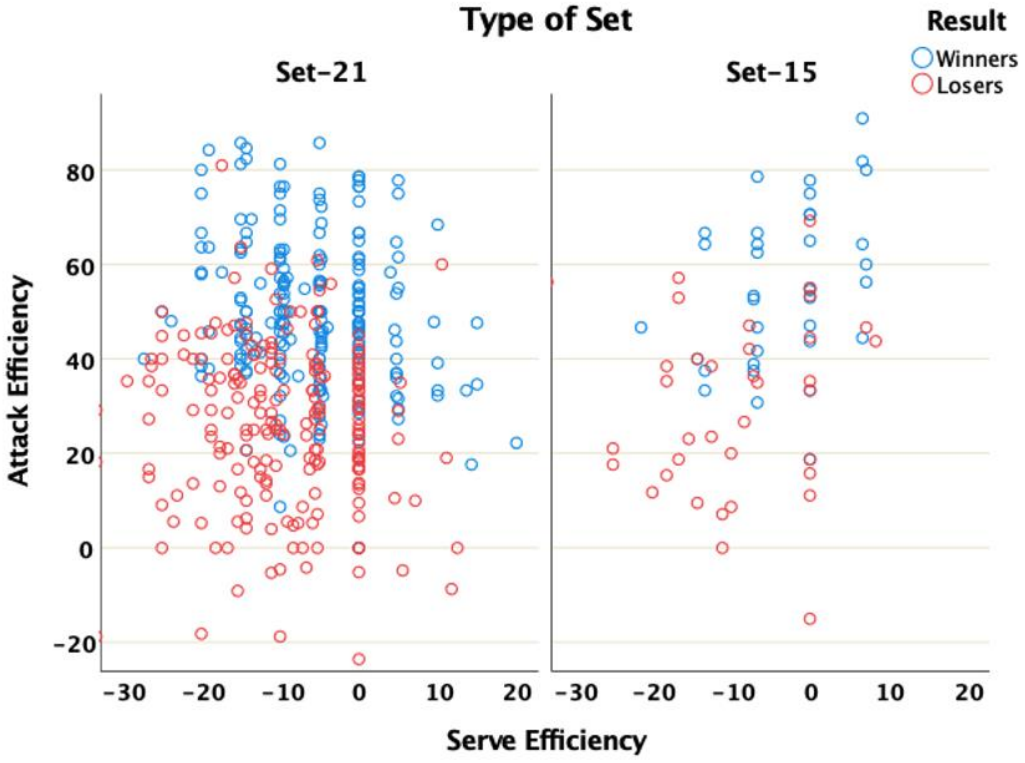

Figure 5. Scatter plot with values (percent) of the attack and serve efficiency and labels of the predicted group (blue for winners and red for losers) for all types of set.

DISCUSSION

The aim of this study was to explore which performance indicators contributed to winning a set with Set-21 and Set-15 points, using the match report data of men's beach volleyball 2022 World Championship. Set and technical indicator types of performance were analysed to identify which were the best predictors for winning a set and which classified the cases more accurately. The set points and technical indicators presented high correct classification in Set-21 (84.6% and 88.1%) and Set-15 (90.3% and 89.9%) sets respectively. The results in high level men's beach volleyball revealed that winning teams had higher set indicator values in 21- and 15- sets in all scoring skills except serve opponent errors and other points.

The importance of serve in men's beach volleyball has been reported in various studies (Kumar et al., 2021; Medeiros et al., 2014). The results of the present study agree with the previous findings, as serve points, and serve efficiency indicators were significant in Set-21 and Set-15. This may be happened due to the ability of winning teams to serve more effectively, as the average aces were 0.5 and 0.4 more points for winners in

Set-21 and Set-15 respectively. However, no difference found between winners' and losers' teams in serve opponents errors points in both types of sets despite the highest number of serve attempts from winners' teams. As a result, serve efficiency was higher for winners with significant difference. This indicates that players should practice serve even more (Zetou et al., 2005) to be able to increase the number of serve points while keeping the number of serve errors as low as possible.

The importance of block in beach volleyball has been highlighted in previous studies (Giatsis and Zahariadis, 2008; Jiménez-Olmedo and Penichet-Tomas, 2017; Medeiros et al., 2017; Mesquita and Teixeira, 2004; Peña et al., 2013) and matches the findings of the present study. As with serve, 0.9 and 0.6 more points in block or a +2.6% and +2.5% increase of block per set point percentage in winners compared with losers, increases the probability of winning a set in Set-21 and Set-15 respectively.

Despite the lower correct classification in Set-21 compared with Set-15, winners differ significantly ($p < .001$) with block points and block per set points percentage indicators possessed a meaningful SC for Set-21. A previous study (Giatsis and Zahariadis, 2008) on men's FIVB beach volleyball, found that block was an important factor of winning a match with 2-0 score and differentiated winners from losers' teams. In the present study, winners achieved 0.9 and 0.6 points more than losers in Set-21 and Set-15 respectively. It seems that the same applies to high-level men's beach volleyball, not only in overall matches but in every set. These results are in agreement with Medeiros et al. (2017) who found that 0.6 more points for winners in men's 2011 beach volleyball World Championship but only in 42 sets comparing with the 214 sets in the present study.

Attack points and attack kill percent were important predictors of winning a Set-21. Winners achieved 2.2 more points per set and 14.5% higher attack kill percent. Similar results presented by Medeiros et al. (2017) in attack points and Giatsis and Zahariadis (2008) in attack kill percent. The performance in attack (points from the attack and losing points from block and unforced errors) is crucial. The SC of the attack, block and attack opponent errors were important indicators, and 84.6% of the variance accounted for by the discriminant function in S21 indicated that make the difference between winners and losers in the highest level of men's volleyball. However, this probability increased in S15 were 90.3% of the variance indicated that only attack opponent errors possessed a meaningful SC. Furthermore, attack kill percent was the dominator indicator in both types of set indicating the importance of players' attacking ability in beach volleyball.

In previous studies related with volleyball (Giatsis et al., 2022; Giatsis, 2022) suggested that organizers could modify the match report by including additional data, such as the attack efficiency. In the present match report, attack opponent errors, serve errors and other errors included in the data presented. According to these data, attack opponent errors points was the dominant indicator in both types of set and even more the only set indicator that possessed a meaningful SC for the Set-15. This could be explained by the fact that the skill of the blockers and their tall height (Tili and Giatsis, 2011) may lead the players to avoid the block leading to errors that determine the outcome of the set. This distinction in errors is very important as serve opponent errors points, and other points indicators were not significant different in the present study. Furthermore, using these various types of errors, attack and serve efficiency could calculated revealing additional performance indicators. These efficiencies were found higher for winners in both types of sets with winners performed 24.4% and 6.3% more than loser in attack and serve efficiencies respectively.

It has been reported (Kumar et al., 2021) that the number of points obtained in the break point phase (points gained when a team is serving) was the major contribute factor to the final outcomes of elite men's beach

volleyball matches. This is in agreement with the findings of this study, as winners scored 2.8 and 2.1 points in S21 and S15 respectively.

Given that the use of statistics software is mandatory for all major competitions because it provides the statistical information on the competition websites and can be viewed by users and media all over the world, the use of data volley (Data Project, 2017) in men's beach volleyball World Championship 2022 modified the match report by including additional data and revealed new performance indicators (attack and serve efficiencies) which evaluated how effective a team, or a player, is attacking or serving counting the ratio between total points minus errors (and block in attack) per the total number of attempts. However, more performance indicators could be added in match report as the attack efficiency after the reception (side-out phase) and after the defence (counterattack). The performance indicators of points after reception and counterattack to total serves would be useful because the specific indicators show the performance of the teams in the two game complexes. With these data included in the match report provided by the organizers of major beach volleyball competitions such as the Olympics and World Championships, coaches and players will be able to use the match or set statistics even better.

In the men's beach volleyball World Championship 2022, apart from the top playing level of the teams, a 58% of sets ended with a difference ≤ 4 points indicating the balance of the score between most sets (Figure 1). Furthermore, the highest frequency of points difference (26%) was the 2-points. For this reason, the reference values presented in this study for analysing the set and technical indicators of men's high-level beach volleyball sets are very important. In a Set-21, the winning team must score 12.8 points from attack, 2.1 points from blocking, and 1.2 points on serve. Furthermore, a team should have 62% attack kill percent, 49.5% attack efficiency and 5.6% block per set points. As for the Set-15, the winning team must score 9.7 points from attack, 1.4 points from blocking, and 0.6 points per serve. The attack kill percent should be increased to 64.8% and the attack efficiency to 55.7%. Researchers, media, coaches, and athletes can benefit from these reference values (Fernandez-Echverria et al., 2017; Laporta et al., 2019). Finally, the enhanced match report, it has proved to be a useful tool, since the present study's major findings could display performance benchmarks for each set and to produce additional ones.

CONCLUSION

In conclusion, the results of the men's teams at the highest level of beach volleyball, show that attack kill percent is not the only technical indicator that increases the probability of winning a match, since attack opponent errors per set points, contribute equally significantly. Furthermore, teams should reduce the number of attack errors despite the high level of blocking to increase the probability of winning a set. The attacking ability indicating the importance of winning a set, in men's beach volleyball, high level.

SUPPORTING AGENCIES

No funding agencies was reported by the author.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author.

REFERENCES

Alvarado-Ruano, R. & López-Martínez, A. B. (2022). Analysis of technical-tactical factors in beach volleyball: a systematic review. Cultura, Ciencia y Deporte, 17(52), 15-35. https://doi.org/10.12800/ccd.v17i52.1839

Carling, C., Reilly, T., & Williams, A.M. (2008). Performance Assessment for Field Sports (1st ed.). Routledge. https://doi.org/10.4324/9780203890691

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

Comrey, A.L., & Lee, H.B. (1992). A First Course in Factor Analysis (2nd ed.). Psychology Press. https://doi.org/10.4324/9781315827506

Couvillon, A. (2004). Sands of Time. The History of Beach Volleyball. VO:3. Hermosa Beach: Information Guides.

Data Project. (2017). Data volley (Release 3.8.6). Sarerno, Italy.

F.I.V.B. (2022). Official Beach Volleyball Rules 2021-2024. Lausanne, Switzerland. Retrieved from: https://www.fivb.com/-/media/2022/coorporate/volleyball/rules%202021-2024/fivb-beachvolleyball_rules2021_2024-en-v01d.pdf?la=en&hash=22B1948796DE4F9D5E0927DFF1E2E72B

F.I.V.B. VIS (Volleyball Information System). (2015). Guide Manual VIS. Retrieved from: https://cevadmin.cev.eu/Administration/BeachVolley/EditorImages/547/fivb_vis_user_manual.pdf

Fernández-Echeverria C., Mesquita I., González-Silva J., Claver F., & Moreno M. P. (2017). Match analysis within the coaching process: a critical tool to improve coach efficacy. International Journal of Performance Analysis in Sport, 17(1-2), 149–163. https://doi.org/10.1080/24748668.2017.1304073

García-de-Alcaraz, A. G., Valadés, D., & Palao, J. M. (2016). Evolution of game demands from young to elite players in men's volleyball. International Journal of Sports Physiology and Performance, 12(6), 788–795. https://doi.org/10.1123/ijspp.2016-0027

Giatsis, G. (2022). Performance indicators in women's volleyball Olympics and World Championships (2014–2021). International Journal of Sports Science & Coaching, 0(0). https://doi.org/10.1177/17479541221106378

Giatsis, G., & Tzetzis, G. (2003). Comparison of performance for winning and losing beach volleyball teams on different court dimensions. International Journal of Performance Analysis in Sport, 3(1), 65-74. https://doi.org/10.1080/24748668.2003.11868276

Giatsis, G., & Zahariadis, P. (2008). Statistical Analysis of Men's FIVB Beach Volleyball Team Performance. International Journal of Performance Analysis in Sport, 8(1), 31–43. https://doi.org/10.1080/24748668.2008.11868420

Giatsis, G., Drikos, S., & Lola, A. (2022). Analysis of match report indicators in men's volleyball olympics and world championships (2014–2021) depending on the type of final score. International Journal of Sports Science & Coaching. https://doi.org/10.1177/17479541221086779

Giatsis, G., Lopez Martinez, A. B., & García, G. M. G. (2015). The efficacy of the attack and block in game phases on male FIVB and CEV beach volleyball. Journal of Human Sport and Exercise, 10(2), 537-549. https://doi.org/10.14198/jhse.2015.102.01

Grgantov, Z., Katic, R., & Marelic, N. (2005). Effect of new rules on the correlation between situation parameters and performance in beach volleyball. Collegium Antropologicum, 29(2), 717–722.

Griego-Cairo, O., Navelo-Cabello, R., Lanza-Bravo, A., & Griego-Cairo, E. (2016). Prueba para controlar el desarrollo técnico-táctico del saque en el voleibol de playa de iniciación. Arrancada, 16(29), 118-128.

Hughes, M., & Bartlett, R. M. (2002) The use of performance indicators in performance analysis, Journal of Sports Sciences, 20(10), 739-754. https://doi.org/10.1080/026404102320675602

Jiménez-Olmedo, J. M., & Penichet-Tomas, A. (2017). Blocker's activity at men's european beach volleyball university championship. Retos. Nuevas Tendencias En Educación Física, Deporte y Recreación, (32), 252-255. https://doi.org/10.47197/retos.v0i32.56076

Jimenez-Olmedo, J. M., Penichet-Tomas, A., Saiz-Colomina, S., Martinez-Carbonell, J., & Jove-Tossi, M. (2012). Serve analysis of professional players in beach volleyball. Journal of Human Sport and Exercise, 7(3), 706-713. https://doi.org/10.4100/jhse.2012.73.10

Koch, C., & Tilp, M. (2009). Beach volleyball techniques and tactics: a comparison of male and female playing characteristics. Kinesiology, 41(1), 52-59.

Kumar, G., Shukla, A., Chhoker, A., & Thapa, R. K. (2021). Identification of Factors Determining Winning in Men's and Women's Beach Volleyball: a Logistical Regression Approach. Teorìâ ta Metodika Fìzičnogo Vihovannâ, 21(1), 26-35. https://doi.org/10.17309/tmfv.2021.1.04

Laios, Y. (2008). Comparison of the basic characteristics of men's and women's beach volley from the Athens 2004 Olympics. International Journal of Performance Analysis in Sport, 8(3), 130-137. https://doi.org/10.1080/24748668.2008.11868454

Laporta, L., Afonso, A., Valongo, B., & Mesquita, I. (2019) Using social network analysis to assess play efficacy according to game patterns: a game-centred approach in high-level men's volleyball, International Journal of Performance Analysis in Sport, 19(5), 866-877. https://doi.org/10.1080/24748668.2019.1669007

Link, D., & Wenninger, S. (2019). Performance Streaks in Elite Beach Volleyball - Does Failure in One Sideout Affect Attacking in the Next?. Frontiers in Psychology, 10, 919. https://doi.org/10.3389/fpsyg.2019.00919

López-Martínez, A.B., Palao, J. M., Ortega, E., & García-de- Alcaraz, A. (2018). Forma de ejecución y eficacia de la defensa en jugadoras de élite de voley playa femenino. Actividad Física y Deporte: Ciencia y Profesión, 29, 75–87.

Mackenzie, R., & Cushion, C. (2013) Performance analysis in football: A critical review and implications for future research. Journal of Sports Sciences, 31(6), 639-676. https://doi.org/10.1080/02640414.2012.746720

Medeiros, A. I., & Palao, J., Marcelino, R., & Mesquita, I. (2014). Systematic review on sports performance in beach volleyball from match analysis. Brazilian Journal Kinanthropometry and Human Performance. 16(6), 698-708.

Medeiros, A. I., Marcelino, R., Mesquita, I. M., & Palao, J. M. (2017). Performance differences between winning and losing under-19, under-21 and senior teams in men's beach volleyball. International Journal of Performance Analysis in Sport, 17(1-2), 96-108. https://doi.org/10.1080/24748668.2017.1304029

Medeiros, A. I., Mesquita, I. M., Marcelino, R., & Palao, J. M. (2014). Effects of technique, age and player's role serve and attack efficacy in high level beach volleyball players. International Journal of Performance Analysis in Sport, 14(3), 680–691. https://doi.org/10.1080/24748668.2014.11868751

Mesquita, I., & Teixeira, J. (2004). Caracterização do processo ofensivo no voleibol de praia masculino de elite Mundial, de acordo com o tipo de ataque, a eficácia e o momento do jogo. Revista Brasileira de Ciencias do Esporte, 26(1),33-49.

Michalopoulou, M., Papadimitriou, K., Lignos, N., Taxildaris, K., & Antoniou, P. (2005). Computer analysis of the technical and tactical effectiveness in Greek Beach Volleyball. International Journal of Performance Analysis in Sport, 5(1), 41-50. https://doi.org/10.1080/24748668.2005.11868314

Oliveira, A., Valladares, N., Vaz, L., & João, 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.

Palao, J. M., & Ortega, E. (2015). Skill efficacy in men's beach volleyball. International Journal of Performance Analysis in Sport, 15(1), 125–134. https://doi.org/10.1080/24748668.2015.11868781

Papadopoulou, S. D., Giatsis, G., Billis, E., Giannako, A., & Bakirtzoglou, P. (2020). Comparative analysis of the techical-tactical skills of elite male beach volleyball teams. Sport Science, 13(1), 59-66.

Pedhazur, E.J. (1997) Multiple Regression in Behavioral Research: An Explanation and Prediction. Holt, Rinehart & Winston, New York.

Peña, J., Rodríguez-Guerra, J., Buscà, B., & Serra, N. (2013). Which skills and factors better predict winning and losing in high-level men's volleyball? Journal of Strength and Conditioning Research, 27(9), 2487-2493. https://doi.org/10.1519/JSC.0b013e31827f4dbe

Pérez-Turpin, J., Campos-Gutiérrez, L. M., Elvira-Aranda, C., Gomis-Gomis, M. J., Suárez-Llorca, C., & Andreu- Cabrera, E. (2019). Performance Indicators in Young Elite Beach Volleyball Players. Frontiers in Psychology, 10(2712). https://doi.org/10.3389/fpsyg.2019.02712

Ronglan, L. T., & Grydeland, J. (2006). The effects of changing the rules and reducing the court dimension on the relative strengths between game actions in top international beach volleyball. International Journal of Performance Analysis in Sport, 6(1), 1-12. https://doi.org/10.1080/24748668.2006.11868351

Tabachnick, B. G., & Fidell, L. S. (2007). Using Multivariate Statistics (5th ed.). pp. 980. New York: Allyn and Bacon.

Tili, M., & Giatsis, G. (2011). The height of the men's winners FIVB Beach Volleyball in relation to specialization and court dimensions. Journal of Human Sport & Exercise, 6(3), 504-510. https://doi.org/10.4100/jhse.2011.63.04

Tilp, M., Koch, C., Stifter, S., & Ruppert, S. G. (2006). Digital game analysis in beach volleyball. International Journal of Performance Analysis in Sport, 6(1), 140-148. https://doi.org/10.1080/24748668.2006.11868362

Volleyballworld. Beach Volleyball World Championship Rome (2022). Retrieved from: https://en.volleyballworld.com/beachvolleyball/competitions/beach-volleyball-world-championships-rome-2022/competition/history

Zetou, E., Tzetzis, G., & Giatsis, G. (2005). Validation and reliability of beach volleyball skill test instruments. Journal of Human Movement Studies, 49 (3), 215-230.