ORIGINAL ARTICLE

Attack efficiency in first league men's volleyball for playing positions, according to the value level of the teams

George Danut Mocanu[ACDE], Neculai Harabagiu[ABDE], Carmen Pârvu[ADE]

Faculty of Physical Education and Sport, "Dunarea de Jos" University of Galati, Romania

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Abstract

Background and Study Aim: The attack is a crucial technical element in scoring points in volleyball. This research aims to identify differences in attack efficiency and errors based on the value level of teams in the competitive system, considering different playing positions.

Material and Methods: The analysis included 86 attacking players from the rosters of 12 teams in the men's domestic first league. The distribution by positions was as follows: 37 outside hitters, 19 opposites, and 30 middle blockers. Statisticians from each team recorded the data using Data Volley software during three championship matches. For each player, the following parameters were interpreted: Attack Efficiency (E%), Error% (=), Blocked Attack% (/), Poor% (-), Blocked but Recovered% (!), Positive% (+), and Winning% (#). Attack efficiency was analyzed for each playing position across top teams (positions 1-4 in the final ranking), mid-level teams (positions 5-8), and lower-level teams (positions 9-12).

Results: Across all three playing positions, top teams demonstrate higher percentages in attack efficiency, winning executions, and positive outcomes compared to average and lower-level teams. Top and average teams also have lower percentages of errors in attack executions. For the outside hitter position, no statistically significant superiority is observed between top and middle teams for any attack variable, indicating a balance in player performance. In the opposite hitter position, top and middle-level players show higher attack efficiency and direct point scores (Winning). They also have lower poor execution rates, despite the lack of statistical confirmation for superiority in many attack variables. Among all positions, top middle blockers exhibit a clear superiority over low-level teams across all attack variables.

Conclusions: The findings of the study highlight the critical role of team value level in influencing attack efficiency and execution quality across different playing positions in volleyball. The results underscore the importance of strategic differentiation in training and game planning. This is especially crucial for teams aiming to optimize their performance. Coaches and trainers should focus on tailored approaches that address the specific strengths and weaknesses of each playing position. They should also consider the overall team value level in their strategies. This approach could lead to improved competitive outcomes and a more effective utilization of player potential across all levels of competition.

Keywords: performance analysis, positional roles, team value level, error rates

Introduction

Volleyball is one of the most popular sports, where attack efficiency is crucial for winning matches. However, despite the importance of attacking actions, the differences in attack efficiency and error rates among teams of varying levels require the search for more effective solutions. This concern is particularly relevant when considering specific playing positions. Addressing this gap calls for a deeper analysis and understanding of how team level and playing position influence attack performance in competitive settings.

In this context, research on various approaches to improving attacking actions and enhancing team efficiency has become increasingly relevant. Volleyball and other ball sports influence the coordination processes and anthropometric dimensions of the participants [1, 2, 3]. Used in physical education and leisure, these activities promote a healthy lifestyle [4]. Volleyball is an extremely dynamic sport, requiring players to quickly analyze and process information and game situations. This ability facilitates adaptation and finding solutions to disrupt the opposing team [5]. The fundamental role of attack, particularly the spike as a phase for accumulating points, compared to defense, is well-documented in elite men's volleyball within the European League [6]. Fast attacks are predominantly observed in higher age categories/senior teams, showing higher effectiveness. An increased use of attack in the first and second tempo has been identified across all age groups [7]. Elite men's volleyball often involves system situations, providing optimal conditions for constructing attacks [8]. Winning points in a typical

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set during volleyball tournaments is influenced by the effectiveness of the attack following reception, as well as the success rate of the breakpoint complex [9]. For volleyball teams participating in the Olympic Games, receptions that facilitated well-organized attacks significantly improved the teams' chances of winning points [10].

These findings underscore the critical importance of attack strategies in volleyball, particularly at the elite level, where effective execution can decisively influence match outcomes. As such, understanding and optimizing attack efficiency remains a key focus for teams aiming to achieve competitive success.

The factors that influence outcomes in men's volleyball matches in Puerto Rico and ensure competitive success are varied. Complex I and II efficiency, blocking points, point service, and points in attack are some predictors of the results [11]. Technical indicators that ensure the victory of men's volleyball teams in the Olympic Games and World Championships are analyzed by [12]. For matches completed in 3-4 sets, the most important predictor is attack, but for those completed in 5 sets, points accumulated from serve and block play a major role. The use of Social Network Analysis provides detailed and more refined information about the influence of actions and game variables associated with attacks in volleyball [13]. Statistical analysis of volleyball matches is becoming increasingly important for coaches, as they capitalize on the data provided to improve training programs [14]. The application of logistic regression models in the Turkish Men's Volleyball League facilitates the explanation of results in official matches. The efficiency of different players/positions (middle blocker, setter, outside hitter, opposite/universal) predicts winning or losing matches by more than 80% [15].

These studies highlight the diverse factors that contribute to match outcomes, emphasizing the critical role of specific technical indicators and player efficiency. Understanding these variables allows teams to refine their strategies and enhance their competitive edge.

During volleyball matches, the playing positions of the players and their value/sport level may influence the number of jumps executed and their intensity. Individualized training is recommended according to the specialization of the players by position [16]. Other studies also analyze the individualization of jump training in volleyball players, considering the playing position, correlated with the number and height of jumps. The highest jump heights (96.5%) are recorded for jumps executed during attacks, with lower values for blocks (88.8%) and serves (81.5%) [17]. Other sources analyzing elite Brazilian men's volleyball highlight the necessity of using backrow attackers (positions 1 and 6), which increases scoring chances due to the uncertainty created for the opposing team [18]. In Brazilian volleyball at the elite level, predictive factors for the attack performed by the opposite player from positions 1 and 2 are analyzed by [19]. Offensive strategies often require the implementation of a system with four attacking players [20].

These findings underscore the importance of position-specific training and the strategic use of backrow attackers to enhance offensive performance. By tailoring training to player positions and employing varied offensive systems, teams can significantly improve their effectiveness during matches.

Side out attack (attack after reception) efficiency is crucial for winning points and sets in volleyball. In situations where the side out attack is unsuccessful or missed, the setter's decision-making becomes critical. Executing a faster attack tempo is an effective solution in these cases [21]. Players' movements on the court are determined by the tasks associated with their playing position. The setter covers the longest distances during sets, while the middle blockers cover the shortest, with a significant difference between these two positions [22]. Research on world-class men's volleyball players has shown a significant relationship between the middle blocker and setter positions, influencing the attack area [23]. Attack efficiency is heavily dependent on quick decision-making by the setter and the middle blocker's choice for the pass when available [24]. For men's volleyball teams at the Olympic level, attack efficiency is conditioned by the setter's prior performance. This enables successful points from 1st or 2nd tempo attacks [25]. Another study corroborates this, demonstrating that better setter performance leads to higher attack player performance, particularly for those participating in the Olympic Games [26].

These findings emphasize the critical role of the setter in optimizing attack efficiency, especially in high-stakes matches. A well-coordinated effort between the setter and attack players can significantly enhance a team's chances of winning points and sets.

The different playing position tasks in men's volleyball impose variations in the somatotype of each specialization/position on the court, as highlighted in Croatian national league volleyball players [27]. Height and vertical jump values are key performance determinants in men's volleyball, with significant differences identified between outside hitters, middle blockers, and opposites [28]. A comparison of the somatic traits of Indian college volleyball players indicates significant differences between the profiles of middle blockers and outside hitters. Middle blockers are taller and have a higher ectomorph component, while outside hitters are heavier and more mesomorphic. These aspects contribute to the understanding of the peculiarities

of the playing positions and the preparation of players for the attack phase [29]. A comparative analysis of anthropometric parameters for male volleyball players in the Ethiopian League shows differences between playing positions. Middle blockers, followed by outside hitters and opposites, have the highest values of height and weight among those involved in attacks [30]. An investigation of anthropometric parameters in the top two value leagues in Italian men's volleyball highlights the need to improve shoulder flexibility and mobility. Among the players involved in attacks, opposites and middle hitters are the heaviest and tallest, with higher values in upper limb length widths and contracted arm circumference [31]. Height and body weight are positively and significantly associated with attack efficiency in men's volleyball. For national teams participating in a European tournament (Croatia, Italy, France, and Estonia), middle blockers are the tallest and execute the most blocks, while outside hitters and opposites have average height but stand out with the highest attack load. Setters execute the fewest attacks [32]. For the setter position, attack execution is recommended to be preceded by a high-quality pass. Although less common in men's volleyball, setter attacks can be a way to diversify a team's attack options [33].

These findings underscore the critical role that somatotype and anthropometric characteristics play in determining the performance of players in different volleyball positions. Tailoring training and strategy to these physical attributes can significantly enhance attack efficiency and overall team performance.

Investigations in volleyball players of different age groups in national teams (Brazil, Argentina, Australia, Canada) identify differences in position profiles. Middle blockers are taller and heavier than outside hitters and setters. Additionally, attack and block jumps occur more frequently for middle blockers. Vertical jump and spike jump values are highest for middle blockers and outside hitters [34]. Testing elite volleyball players in Iran revealed significant differences in muscle strength performance tests for attack players. Middle blockers performed worse, but no significant differences were found between outside hitters, opposites, and middle blockers in agility tests [35]. The comparison between the profiles of Brazilian volleyball players (U19) indicates that middle blockers and opposites (attack players) have superior anthropometric dimensions. These positions also show higher values in vertical jumps (spike jump and block jump) compared to defensive players (libero and setters) [36]. The profile of middle blockers highlights their superior height, weight, block jump height, and spike/attack height. They also exhibit a higher frequency of jumping during matches, which is crucial in tempo 1 attacks [37]. The relationship between vertical jump height and unsuccessful attack executions in Turkish high-level players was analyzed by [38]. The data indicate that negative attacks (errors, blocked attacks, and poor attacks) are not significantly correlated with jump values for middle blockers. However, for opposites, only weak positive correlations were found between jump height and points lost due to attack errors [38].

These findings emphasize the distinct physical and performance profiles required for different volleyball positions, particularly for middle blockers and opposites. Understanding these differences is crucial for optimizing training programs and enhancing match performance.

Most of the analyzed studies make a strong case for the critical role that specific physical and performance profiles play in determining success in men's volleyball. Middle blockers and opposites consistently show superior height, weight, and vertical jump abilities, which are essential for effective attack and block executions. The findings underscore the importance of individualized training tailored to the unique demands of each playing position. Additionally, the studies highlight the strategic value of setter performance and the frequency of jumps, particularly in high-level competitive settings. However, there remains a challenge in fully understanding and optimizing the interaction between these physical attributes and tactical decisions during matches. In this context, the aim of the research is to identify the differences in efficiency and errors for attack, depending on the value level of the teams in the competitive system, separated by playing positions. For this purpose, the following hypotheses were formulated:

- H1: Significant differences in the parameters of attack efficiency are expected between top, middle, and low-level teams for outside hitters.
- H2: Significant differences in the parameters of attack efficiency are expected between top, middle, and low-level teams for opposite hitters.
- H3: Significant differences in the parameters of attack efficiency are expected between top, middle, and low-level teams for middle blockers.

Materials and Methods

Participants

The analyzed group includes all players in attacking positions from the Romanian men's volleyball first league national championship (2017-2018 season). A total of 86 attacking players from the 12 participating teams were analyzed: 37 outside hitters, 19 opposites, and 30 middle blockers. The age of the participants ranges from 18 to 35 years.

Research Design

The data were recorded by each team's statisticians using Data Volley software during three matches of the return championship. The data

were provided to the Human Performance Research Centre of the Faculty of Physical Education and Sports of Galati in 2024. For each player, the following parameters were analyzed: Attack Efficiency (E%), Error% (=), Blocked attack% (/), Poor% (-), Blocked but recovered% (!), Positive% (+), and Winning% (#). The codes and their interpretations related to the quality and efficiency of the attack are provided in the Data Volley book [39]. Attack efficiency was analyzed for each playing position across the top teams (positions 1-4 in the final ranking), mid-level teams (positions 5-8), and lower-level teams (positions 9-12). The requirements of scientific research involving human subjects were followed, ensuring the confidentiality of personal data [40, 41]. The publication of the results received approval from the faculty's Ethics Committee (no. 242/10.07.2024).

Statistical Analysis

SPSS Software (Statistical Package for the Social Sciences, IBM, Version 24, Chicago, IL, USA) was used to transfer the individual data and calculate the differences in the dependent variables across the three value levels of the championship. The total number of attacks and the mean values for the entire group, as well as separately by the three playing positions, are summarized in Table 1. The normality of the data distribution was assessed using the Shapiro-Wilk test. The Kruskal-Wallis test was employed to identify the significance of differences between the three value levels for each playing position. The significance of differences within each value pair (top vs. middle, middle vs. low, and top vs. low) was determined using the Mann-Whitney U test. The confidence interval was set at 95% [42, 43, 44, 45].

Results

The comparison of values between positions indicates the superiority of middle blockers for E% and Winning%. This group also has the lowest scores for Error%, Blocked attack%, and Poor%. The significance of differences between the three groups was not further calculated, as the efficiency of middle blockers is evident and can be explained by their favorable attack execution positions. In terms of mean values for the number of attacks per playing position, opposites rank first, followed by outside hitters, with middle blockers last.

The average values of the variables analyzed for the outside hitter position at the three ranking levels are shown in Figure 1. Players in the top group have the best percentages for E%, Positive%, and Winning% (which directly contributes to scoring points), while the low group has the worst values. The Blocked but Recovered% variable has the highest score in the middle group. The low group shows higher percentages in categories associated with mistakes, such as Error%, Blocked Attack%, and Poor%.

The significance of the differences between the medians of the three groups at the outside hitter specialization level is shown in Table 2. The χ^2

Table 1. Mean values of the independent variables for the 3 specialisations by positions at the level of the whole lot.

Group	Whole group N=86 (3515 attacks)		Outside hitter N=37 (1611 attacks)		Opposite N=19 (1234 attacks)		Middle blocker N=30 (670 attacks)	
Variables	**Mean**	**Std. deviation**	**Mean**	**Std. deviation**	**Mean**	**Std. deviation**	**Mean**	**Std. deviation**
Attack Efficiency (E%)	24.488	13.584	20.027	13.348	23.105	8.245	30.866	13.584
Total attack executions	40.872	27.558	43.540	23.703	64.947	33.781	22.333	8.707
(=) Error executions	4.127	3.446	4.351	3.417	6.789	4.035	2.166	1.23
Error%	10.069	3.978	10.000	4.189	10.578	4.694	9.833	3.270
Blocked attack executions	3.837	3.490	4.054	3.265	6.789	4.144	1.700	1.149
Blocked attack%	8.930	4.423	9.135	5.207	10.315	3.198	7.800	3.836
Poor executions	6.480	5.427	7.540	5.156	10.050	6.390	2.900	2.218
Poor%	14.941	6.225	16.567	6.217	15.473	6.449	12.600	5.537
Blocked but recovered executions	3.220	2.019	3.783	2.070	3.947	2.146	2.066	1.284
Blocked but recovered%	9.162	4.637	9.837	4.734	6.842	3.287	9.800	4.894
Positive executions	5.430	4.263	5.891	3.717	8.526	5.796	2.900	1.446
Positive%	13.360	4.246	13.918	5.330	12.789	3.750	13.033	4.246
Winning executions	17.860	12.652	17.864	10.919	28.894	16.512	10.866	4.644
Winning%	43.674	9.070	40.000	9.070	43.947	5.338	48.033	9.474

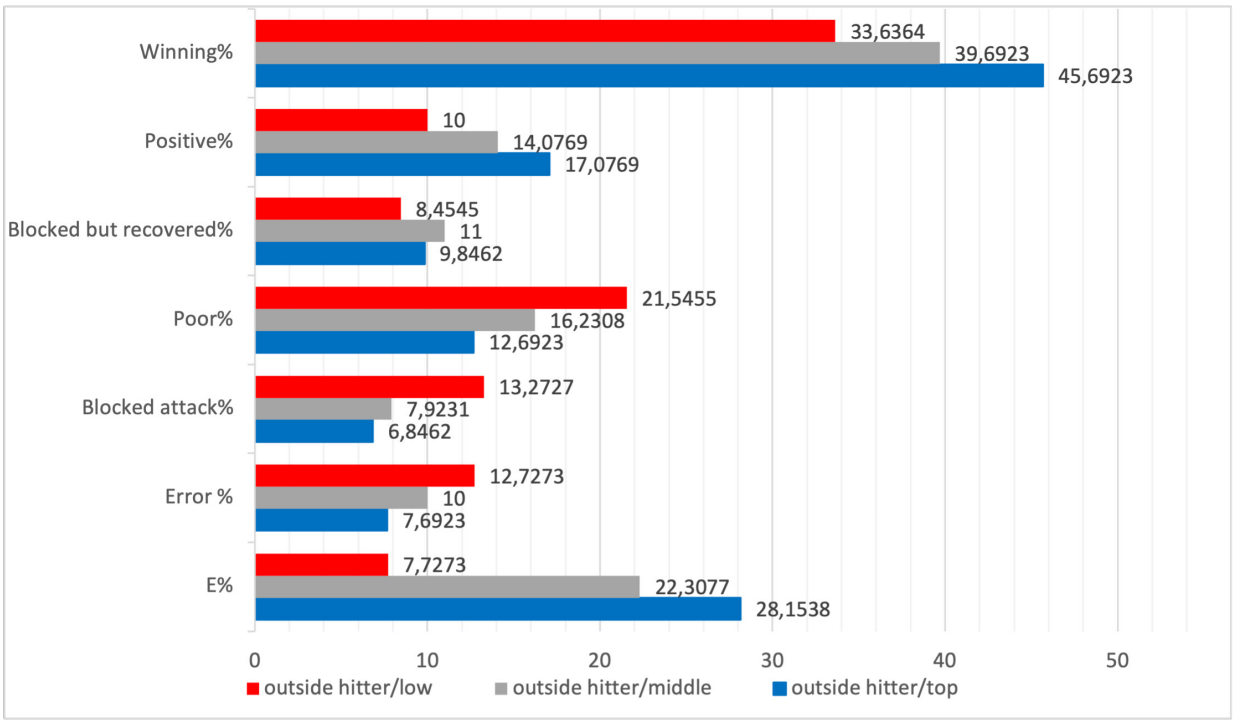

Figure 1. Average attack efficiency values and percentages for the 6 execution variants at the outside hitter specialisation levels (top, middle, and low levels)

Table 2. Kruskal Wallis test values for the outside hitter specialisation for the 3 levels of ranking (top, middle and low)

Variables	Chi-Square/χ2	df	Sig.
E%	15.890	2	.000
Error%	8.767	2	.012
Blocked attack%	10.310	2	.006
Poor%	12.200	2	.002
Blocked but recovered%	0.726	2	.696
Positive%	12.043	2	.002
Winning%	11.906	2	.003

values indicate significant thresholds for E% and all attack variants except for Blocked but Recovered% (P > 0.05).

The differences between the top and middle groups for outside hitters do not show any significant difference (P > 0.05), as indicated in Table 3. Therefore, there is a value balance in terms of attacking for this specialization between these two categories, which is a unique aspect among all the compared pairs.

In the comparison between the middle and low groups for outside hitters, significant differences in favor of the middle group are found for E%, Positive%, and Winning%. The low group has significantly higher scores for Blocked Attack% and Poor% (P < 0.05). No significant differences are identified for Error% and Blocked but Recovered%, as shown in Table 4.

The differences in mean rank between the top and low levels for outside hitters are summarized in Table 5. Top players have significantly better scores for E%, Positive%, and Winning%. Low-level players have higher values for Error% and unsuccessful attack variants. The only insignificant difference is for Blocked but Recovered% (P > 0.05).

Figure 2 shows the average scores for the opposite play position at the three value levels of the ranking. Once again, the top teams have higher E% values and higher percentages for favorable attack executions, while the low-level teams have the lowest values. Errors and mistakes in attack execution have higher values for the low-level teams, followed by the middle-level teams. The only independent variables where there are close scores across the three value levels are Blocked Attack% and Blocked but Recovered%.

Table 6 presents the significance of the differences between the medians of the three value

Table 3. Mann Whitney U test results for the comparison of the outside hitter top vs outside hitter middle result pair

Variables	Outside hitter/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	top	13	15.77	205.00	55.000	-1.515	.130
	middle	13	11.23	146.00			
Error%	top	13	11.54	150.00	59.000	-1.314	.189
	middle	13	15.46	201.00			
Blocked attack%	top	13	12.35	160.50	69.500	-.778	.436
	middle	13	14.65	190.50			
Poor%	top	13	11.15	145.00	54.000	-1.572	.116
	middle	13	15.85	206.00			
Blocked but recovered%	top	13	12.77	166.00	75.000	-.490	.624
	middle	13	14.23	185.00			
Positive%	top	13	15.12	196.50	63.500	-1.081	.280
	middle	13	11.88	154.50			
Winning%	top	13	16.19	210.50	49.500	-1.799	.072
	middle	13	10.81	140.50			

Table 4. Mann Whitney U test results for the comparison of the outside hitter middle vs outside hitter low outcome pair

Variables	Outside hitter/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	middle	13	16.54	215.00	19.000	-3.044	.002
	low	11	7.73	85.00			
Error%	middle	13	9.96	129.50	38.500	-1.924	.054
	low	11	15.50	170.50			
Blocked attack%	middle	13	9.46	123.00	32.000	-2.299	.022
	low	11	16.09	177.00			
Poor%	middle	13	9.88	128.50	37.500	-1.977	.048
	low	11	15.59	171.50			
Blocked but recovered%	middle	13	13.73	178.50	55.500	-.933	.351
	low	11	11.05	121.50			
Positive%	middle	13	15.65	203.50	30.500	-2.386	.017
	low	11	8.77	96.50			
Winning%	middle	13	15.27	198.50	35.500	-2.088	.037
	low	11	9.23	101.50			

groups for the opposite specialization. The χ^2 results are significant only for E%, Winning%, Positive%, and Poor%.

The significance of the differences between the top and middle levels for the opposite position is shown in Table 7. The Z values are significant for E%, Winning%, and Positive% in favor of the top group, and for Poor% in favor of the middle group.

The significance of the differences between the middle and low levels for the opposite position is summarized in Table 8. The Z values are significant only for E% and Winning% in favor of the middle group, and for Poor% in favor of the low group. No significant differences were identified for the other comparisons.

The significance of the differences between the top and low levels for the opposite position is shown in Table 9. The Z values are significant for E%, Winning%, and Positive% in favor of the top group, and for Poor% in favor of the low group. However, the higher scores for Error% and Blocked Attack% in the low group are not significant ($P > 0.05$).

Figure 3 shows the average scores for the middle blocker position across the three value levels. As with the other positions, E%, Winning%, and Positive% have higher values at the top level, followed by the

Table 5. Mann Whitney U test results for comparing the outside hitter top vs outside hitter low outcome pair

Variables	Outside hitter/ Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	top	13	17.23	224.00	10.000	-3.569	.000
	low	11	6.91	76.00			
Error%	top	13	8.81	114.50	23.500	-2.804	.005
	low	11	16.86	185.50			
Blocked attack%	top	13	8.38	109.00	18.000	-3.120	.002
	low	11	17.36	191.00			
Poor%	top	13	7.92	103.00	12.000	-3.466	.001
	low	11	17.91	197.00			
Blocked but recovered%	top	13	12.65	164.50	69.500	-.118	.906
	low	11	12.32	135.50			
Positive%	top	13	16.96	220.50	13.500	-3.376	.001
	low	11	7.23	79.50			
Winning%	top	13	16.77	218.00	16.000	-3.220	.001
	low	11	7.45	82.00			

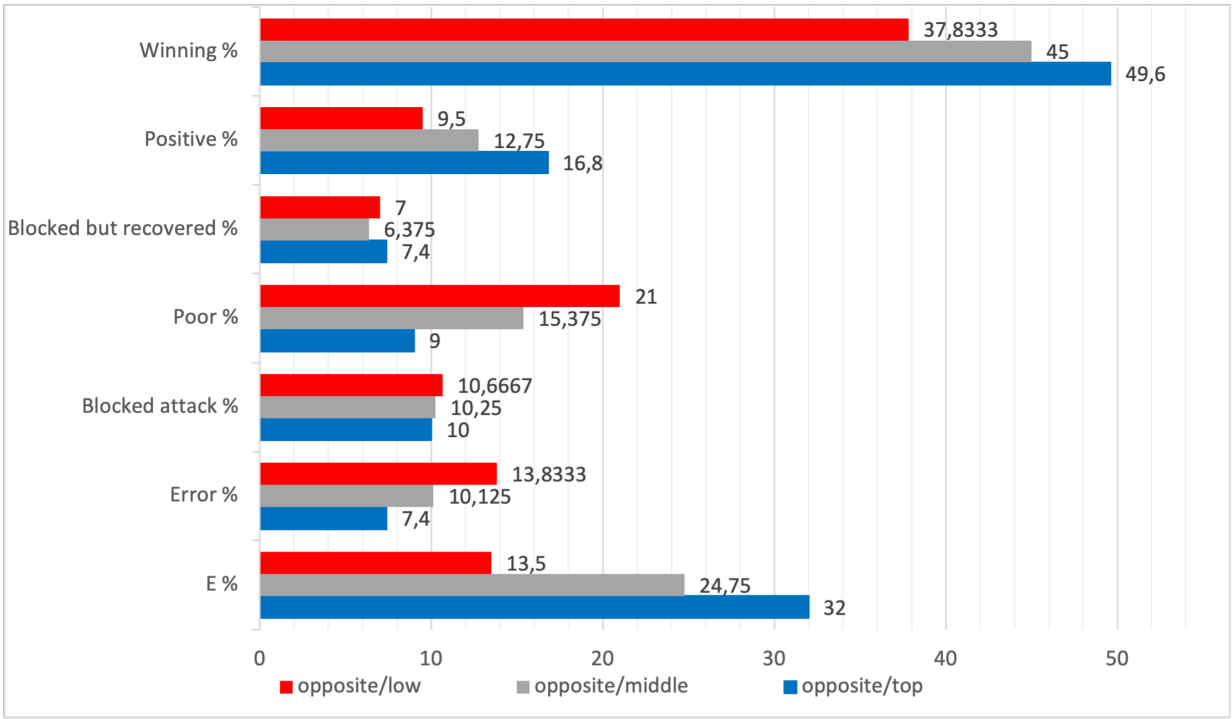

Figure 2. Average attack efficiency values and percentages for the 6 execution variants at opposite specialisation (top, middle, and low levels)

middle level. Mistakes and poor attack execution have higher percentages in the low-value group. In contrast to the other two positions, the middle blocker position shows a higher percentage for the Blocked but Recovered% variant in the low group, while the top and middle groups have lower and nearly equal values.

Table 10 shows the significance of the differences between the medians of the three value groups for the middle blocker position. The χ^2 results are significant for all the independent variables analyzed, a result not found for the other two playing positions.

The differences between the top and middle groups for middle blockers are statistically significant in favor of the top group only for E% and Winning%. The middle group has only one significantly higher value, namely Error% ($P < 0.05$), as shown in Table 11.

The comparison between the values of the middle and low groups for the middle blocker position indicates the significant superiority of the

Table 6. Kruskal Wallis test values at the opposite specialisation for the 3 ranking levels (top, middle, and low)

Variables	Chi-Square/χ2	df	Sig.
E %	15.334	2	.000
Error %	4.478	2	.107
Blocked attack %	.191	2	.909
Poor %	11.236	2	.004
Blocked but recovered %	.614	2	.736
Positive %	11.843	2	.003
Winning %	13.896	2	.001

Table 7. Mann Whitney U test results for opposite top vs opposite middle outcome pair comparison

Variables	Opposite/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	top	5	10.70	53.50	1.500	-2.742	.006
	middle	8	4.69	37.50			
Error%	top	5	5.10	25.50	10.500	-1.418	.156
	middle	8	8.19	65.50			
Blocked attack%	top	5	6.70	33.50	18.500	-.222	.825
	middle	8	7.19	57.50			
Poor%	top	5	3.70	18.50	3.500	-2.422	.015
	middle	8	9.06	72.50			
Blocked but recovered%	top	5	8.00	40.00	15.000	-.736	.462
	middle	8	6.38	51.00			
Positive%	top	5	11.00	55.00	.000	-2.956	.003
	middle	8	4.50	36.00			
Winning%	top	5	10.30	51.50	3.500	-2.432	.015
	middle	8	4.94	39.50			

Table 8. Mann Whitney U test results for the opposite middle vs opposite low outcome pair comparison

Variables	Opposite/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	middle	8	10.50	84.00	.000	-3.112	.002
	low	6	3.50	21.00			
Error%	middle	8	6.31	50.50	14.500	-1.236	.216
	low	6	9.08	54.50			
Blocked attack%	middle	8	7.19	57.50	21.500	-.325	.745
	low	6	7.92	47.50			
Poor%	middle	8	5.56	44.50	8.500	-2.014	.044
	low	6	10.08	60.50			
Blocked but recovered%	middle	8	7.13	57.00	21.000	-.389	.697
	low	6	8.00	48.00			
Positive%	middle	8	8.94	71.50	12.500	-1.501	.133
	low	6	5.58	33.50			
Winning%	middle	8	10.31	82.50	1.500	-2.921	.003
	low	6	3.75	22.50			

Table 9. Mann Whitney U test results for the opposite top vs opposite low outcome pair comparison

Variables	Opposite/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	top	5	9.00	45.00	.000	21.000	.006
	low	6	3.50	21.00			
Error%	top	5	4.00	20.00	5.000	20.000	.065
	low	6	7.67	46.00			
Blocked attack%	top	5	5.60	28.00	13.000	28.000	.712
	low	6	6.33	38.00			
Poor%	top	5	3.00	15.00	.000	15.000	.007
	low	6	8.50	51.00			
Blocked but recovered%	top	5	6.50	32.50	12.500	33.500	.646
	low	6	5.58	33.50			
Positive%	top	5	9.00	45.00	.000	21.000	.006
	low	6	3.50	21.00			
Winning%	top	5	9.00	45.00	.000	21.000	.006
	low	6	3.50	21.00			

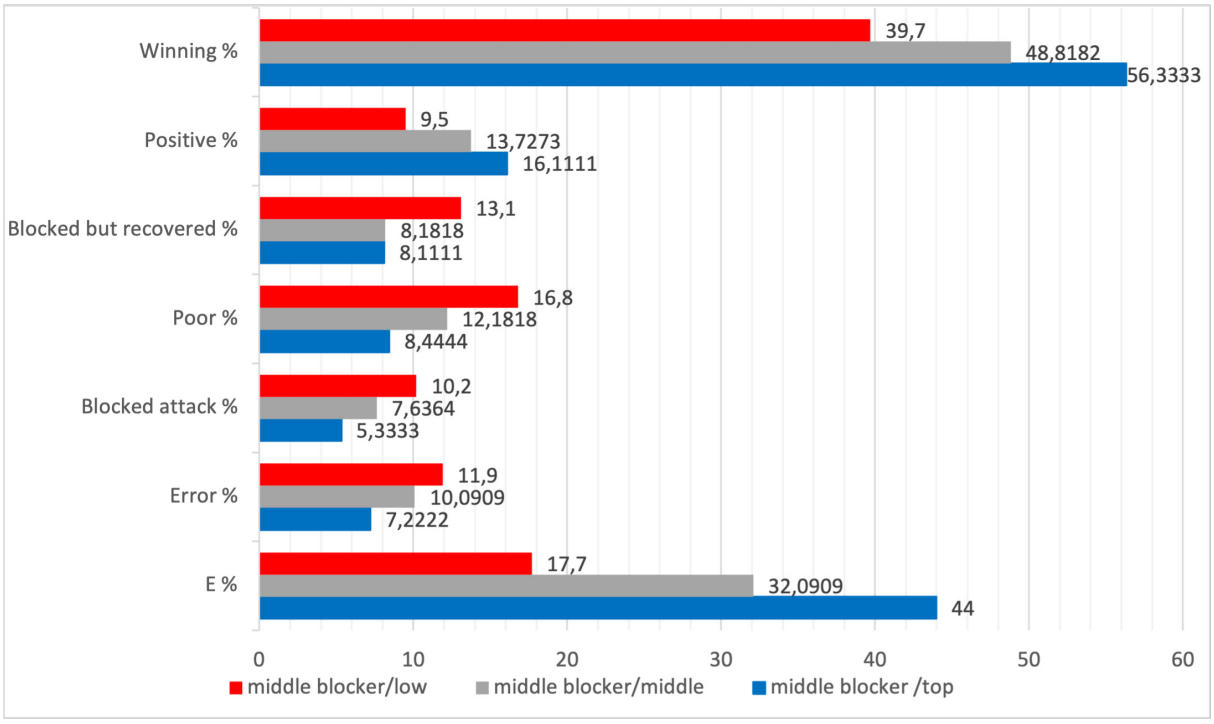

Figure 3. Average attack efficiency values and percentages for the 6 execution variants at the middle blocker levels (top, middle, and low levels)

Table 10. Kruskal Wallis test values for the middle blocker specialisation for the 3 ranking levels (top, middle and low).

Variables	Chi-Square/$\chi 2$	df	Sig.
E%	19.232	2	.000
Error%	10.450	2	.005
Blocked attack%	7.101	2	.029
Poor%	9.418	2	.009
Blocked but recovered%	6.431	2	.040
Positive%	13.537	2	.001
Winning%	16.349	2	.000

Table 11. Mann Whitney U test results for the comparison of the middle blocker top vs middle blocker middle outcome pair

Variables	Middle blocker/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	top	9	14.22	128.00	16.000	-2.551	.011
	middle	11	7.45	82.00			
Error%	top	9	7.61	68.50	23.500	-1.990	.047
	middle	11	12.86	141.50			
Blocked attack%	top	9	8.39	75.50	30.500	-1.480	.139
	middle	11	12.23	134.50			
Poor%	top	9	7.72	69.50	24.500	-1.911	.056
	middle	11	12.77	140.50			
Blocked but recovered%	top	9	9.83	88.50	43.500	-.461	.645
	middle	11	11.05	121.50			
Positive%	top	9	12.61	113.50	30.500	-1.454	.146
	middle	11	8.77	96.50			
Winning%	top	9	13.50	121.50	22.500	-2.058	.040
	middle	11	8.05	88.50			

Table 12. Mann Whitney U test results for the comparison of the middle blocker middle vs middle blocker low outcome pair

Variables	Middle blocker/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	middle	11	15.00	165.00	11.000	-3.107	.002
	low	10	6.60	66.00			
Error%	middle	11	9.36	103.00	37.000	-1.280	.201
	low	10	12.80	128.00			
Blocked attack%	middle	11	9.09	100.00	34.000	-1.491	.136
	low	10	13.10	131.00			
Poor%	middle	11	8.91	98.00	32.000	-1.629	.103
	low	10	13.30	133.00			
Blocked but recovered%	middle	11	8.00	88.00	22.000	-2.343	.019
	low	10	14.30	143.00			
Positive%	middle	11	14.77	162.50	13.500	-2.940	.003
	low	10	6.85	68.50			
Winning%	middle	11	14.77	162.50	13.500	-2.936	.003
	low	10	6.85	68.50			

middle group for E%, Winning%, and Positive%. The low group of athletes has significantly better values only for Blocked but Recovered%. No significant differences were found for errors, blocked attacks, and poor executions, where the low group stands out with higher values, as shown in Table 12.

The significance of the differences between the top and low levels for the middle blocker position is shown in Table 13. The Z values are significant for all independent variables analyzed ($P < 0.05$). This is the only comparison between the top and low levels where such a result is reported.

Discussion

The primary aim of this study was to identify the differences in attack efficiency and errors across different playing positions, based on the value level of teams in the Romanian men's volleyball first league. The results revealed that the average number of executions per playing position indicates a higher frequency for opposites, followed by outside hitters, and finally middle blockers. However, middle blockers have the best values for E% and Winning%. These players also have the lowest percentages for

Table 13. Mann Whitney U test results for the comparison of the middle blocker top vs middle blocker low outcome pair

Variables	Middle blocker/Level	N	Mean Rank	Sum of Ranks	Mann Whitney U	Z	Sig. (2 tailed)
E%	top	9	15.00	135.00	.000	-3.681	.000
	low	10	5.50	55.00			
Error%	top	9	5.67	51.00	6.000	-3.201	.001
	low	10	13.90	139.00			
Blocked attack%	top	9	6.61	59.50	14.500	-2.520	.012
	low	10	13.05	130.50			
Poor%	top	9	6.17	55.50	10.500	-2.832	.005
	low	10	13.45	134.50			
Blocked but recovered%	top	9	7.33	66.00	21.000	-1.968	.049
	low	10	12.40	124.00			
Positive%	top	9	14.22	128.00	7.000	-3.119	.002
	low	10	6.20	62.00			
Winning%	top	9	14.72	132.50	2.500	-3.481	.000
	low	10	5.75	57.50			

incorrect executions, including Error%, Blocked Attack%, and Poor%. Across all three attacking positions, top teams have higher percentages for attack efficiency and executions categorized as winning and positive, compared to middle and low-level teams. Top and middle teams also have lower percentage scores for attack executions with errors.

For the outside hitter position, the superiority of the top vs. middle teams is not statistically confirmed for any of the attack variables, indicating a balance between the value of these players. Significant differences were identified for most variables between the top and low teams (except for Blocked Attack%). Differences were also statistically confirmed between middle and low teams (except for Blocked Attack% and Blocked but Recovered%). Low-level teams have players with lower efficiency in this position.

For the opposite hitter position, the superiority of the top vs. middle teams is statistically confirmed only for E%, Positive%, and Winning%. Opposites from the top teams also have significantly lower values for Poor% executions, but for other types of inefficient executions, no significant differences were reported. However, significant differences were observed between the top and low teams for four variables: E%, Winning%, Positive%, and Poor%. For the middle vs. low comparison, fewer significant differences were identified; middle-level teams had better values only for E% and Winning%, and lower values for Poor%. This suggests a more balanced distribution of values among teams of different levels for this position. Nevertheless, top and middle-level teams have the advantage of higher attack efficiency and more directly scored points (Winning%) and lower values for poor executions.

For the middle blocker position, the superiority of top vs. middle teams is statistically confirmed only for E%, Winning%, and lower Error% values. This indicates that top teams have higher attack efficiency in this position due to more directly won points and lower error percentages. A similar situation is observed for the middle vs. low comparison. In the top vs. low comparison, significant differences were identified for all analyzed variables, indicating that among all the attacking positions, middle blockers from top-level teams hold a clear advantage over those from low-level teams.

Analyzing volleyball matches provides important information for coaches about the challenges faced by their teams. The results facilitate targeted interventions to improve specific game phases. Statistical analysis has indicated that a faster first-tempo attack is the most effective action during the offensive phase [46]. Defeats in volleyball matches are often predictable for teams lacking attack-related skills. For teams participating in the Men's Volleyball World Championship, the difference between winners and losers is often determined by factors such as serve points, excellent digs, attack errors, and service errors [47]. An analysis of the Men's Championship League revealed significant differences between winning and losing teams in terms of attacks. Winners are more efficient in executing spikes from different areas of the court, both in attacks and counterattacks [48]. A longitudinal study analyzing success factors for Greek men's championship teams over 12 seasons identifies the importance of winning on the first attack. This factor distinguishes top teams from

mid- and low-level teams [49]. Our study confirms the differences between teams' value levels for Winning% and Positive% executions, with top teams demonstrating superior performance.

Other studies have used the Bayesian hierarchical logistic model to estimate the contribution of volleyball playing positions and the players occupying those positions to team success or failure [50]. Using a similar investigative technique, another study highlights the importance of attack speed in men's collegiate volleyball [51]. Victory or defeat in volleyball matches is influenced by several factors, including lost serves, kill-blocks, aces, attack errors, and kill-attacks. However, the best predictors of performance are the Serving Efficiency Ratio (SER) and Attack Efficiency Ratio (AER), which show higher values for top-level men's teams in Greece [52]. Statistical analysis of the efficiency of different technical procedures in the Serbian men's volleyball league highlights the decisive importance of three components: attack, serve, and block efficiency. High values in these areas greatly increase the chances of victory and distinguish the top teams from the weaker ones [53]. Regarding attack efficiency, our investigation indicates higher percentages for the teams ranked higher. We identified significant differences in E% for all positions between the top vs. middle, middle vs. low, and top vs. low groups.

The swing movement is crucial for executing serves and attacks/spikes. Among adolescent volleyball players in China, middle blockers exhibit higher mean values of strength in the execution of swing movements at the arms and trunk compared to outside hitters. However, outside hitters demonstrate better coordination between the lower limbs, trunk, and arms during the swing [54]. A longitudinal analysis of Greek men's volleyball championship matches over 12 seasons highlights the predictors of winning. The most important factors include serve aces, attack after passing or defense, precise passing, and passing errors. For the top teams (positions 1-2 and 3-4), the attack win and attack error parameters show significant differences when compared to lower-ranked teams [55]. Our results indicate significant differences in Error% for the middle blocker position between the top vs. middle and top vs. low groups, but not between the middle vs. low groups. For the outside hitter position, we identified significant differences only in the top vs. low pair. For the opposite position, no significant differences were found for any of the value level pairs.

An investigation of attacks after the 20th point in an international tournament revealed significant differences by position. Most of the attacks in this situation were executed by the opposite, while the middle blocker had the lowest mean Error% and Blocked Attack% [56]. An analysis of the matches in the U23 Men's Volleyball World Championship indicates that attack-spike and block are the most frequently executed technical elements. In terms of players who score the most points, the outside hitter ranks first, followed by the opposite, and finally the middle blocker [57]. A study on Portuguese men's teams in the Portuguese Premier League found differences in the points accumulated by players according to their positions on the court. Outside hitters score slightly more break points than middle blockers and opposites. Increasing efficiency requires improving the counter-attack phase of the game [58]. The opposite player in volleyball is the most relied upon for hitting, with the highest chances of executing successful attacks. In men's volleyball, successful executions are largely dependent on the quality of the ball received from the setters [59]. In the matches we analyzed, the outside hitter had the most total attack executions (1611), followed by the opposite (1234), and the middle blocker (670). However, the average attack values place the opposite in first place (64.94), followed by the outside hitter (43.54), and the middle blocker (22.33).

At the high level of men's volleyball, the importance of variability among players of the same playing position is analyzed. For outside hitters, this understanding helps coaches better assign tasks by recognizing differences between players with the same positional status [60]. A comparative analysis of attack efficiency between outside hitters and opposites at the high level (World Championship) indicates differences between these two positions. Outside hitters have higher success percentages in attack (72.5%), while opposites achieve only 55.1% [61]. In terms of Winning%, our study measured lower values, with the highest being for middle blockers (48.03%), followed by opposites (43.94%), and outside hitters (40.00%).

Attack efficiency depends on the players' positions on the court, according to an analysis of teams participating in the European Championship. Middle blockers have higher efficiency in attacking compared to opposites (spikers) and outside hitters (receivers) [62]. An analysis of offensive phases in high-level Brazilian men's volleyball identified higher efficiency for middle attacks compared to wing and opposite attacks. The efficacy of middle attacks is influenced by powerful attacks, higher quality receptions, and appropriate timing [63]. At the Portuguese men's volleyball championship/ first division level, the predictors of victory include attack efficiency, aces, block points, and the efficacy of points in the defensive phase. For Attack Efficiency%, middle blockers have better values than opposites and outside hitters [64]. These findings are consistent with our results, where middle blockers had the highest E% (30.86%), followed by opposites (23.10%) and outside hitters (20.02%).

Improving muscle strength for repeated jumps

in volleyball players is crucial for reducing errors in attack execution. In a study of elite Turkish volleyball players analyzed over two seasons, it was found that the percentage of attack errors increases in middle blockers and outside hitters as the number of vertical jumps increases. However, this trend was not observed for the opposite position [65]. In terms of Error%, our study shows balanced results across the whole group. The highest values are for opposites (10.57%), followed by outside hitters (10.00%) and middle blockers (9.83%).

In summary, this study highlights the significant differences in attack efficiency and error rates across different playing positions and team value levels in the Romanian men's volleyball first league. Middle blockers consistently demonstrated superior performance metrics, particularly in top-level teams, where they exhibited the highest attack efficiency and the lowest error rates. While outside hitters and opposites also showed notable differences in efficiency between value levels, the middle blocker position proved to be the most consistent in differentiating team performance. These findings underscore the critical importance of tailored training strategies and positional roles in optimizing team success in competitive volleyball.

Limitations of the study and future research directions: The large volume of processed data did not allow for an overall comparative presentation of the results across the entire group by value levels (top, middle, and low). Additionally, a more detailed analysis of the attack phases (Complex 1/attack after reception and Complex 2/transition) would provide complementary information to this study.

Conclusions

The findings of this study offer valuable insights for coaches aiming to enhance the performance of their teams across different attacking positions in volleyball. By identifying the strengths and weaknesses specific to each position, coaches can tailor their training programs to address the areas where errors are most prevalent. This targeted approach to training has the potential to significantly improve overall team efficiency, ensuring that athletes are better prepared for the challenges of competitive play. The study underscores the importance of continual assessment and adjustment in coaching strategies to optimize the effectiveness of attack executions and ultimately contribute to team success.

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Conflict of Interest

The authors report no potential conflict of interest relevant to this study.

References

1. Badau A, Badau D. Identifying the Differences in Symmetry of the Anthropometric Parameters of the Upper Limbs in Relation to Manual Laterality between Athletes Who Practice Sports with and without a Ball. *Symmetry,* 2024;16:558. https://doi.org/10.3390/sym16050558
2. Iermakov S, Yermakova T, Prusik K. Modeling the gameplay actions of elite volleyball players and teams based on statistical match reports. *Pedagogy of Health*. 2023;2(2):50-64. https://doi.org/10.15561/health.2023.0202
3. Iermakov S, Yermakova T, Wnorowski K. Statistical match reports of the 2022 volleyball World Championship in the context of network analysis with Gephi. *Physical Culture, Recreation and Rehabilitation*. 2023;2(2):44-59. https://doi.org/10.15561/physcult.2023.0201
4. Bahadirovna KZ. The importance of physical education in a healthy lifestyle. *Ethiopian International Journal of Multidisciplinary Research*, 2023;10:164–7.
5. Salles W das N, Collet C, Porath M, Milistetd M, Nascimento JV do. Factors associated to performance efficacy of technical-tactical actions in volleyball. *Rev Bras Cineantropom Desempenho Hum*, 2017;19:74–83. https://doi.org/10.5007/1980-0037.2017v19n1p74
6. Klaričić I, Grgantov Z, Jelaska I. Prediction of efficiency in elite volleyball: multiple regression approach. *Acta Kinesiologica*, 2018;12:79–85.
7. García-de-Alcaraz A, Ortega E, Palao JM. Effect of age group on male volleyball players' technical-tactical performance profile for the spike. *International Journal of Performance Analysis in Sport*, 2015;15:668–86. https://doi.org/10.1080/24748668.2015.11868823
8. Rocha ACR, Laporta L, Andre Barbosa de Lira C, Modenesi H, Figueiredo LS, Costa GDCT. Complex I in male elite volleyball: an interactional analysis according to reception location. *International Journal of Performance Analysis in Sport,* 2022;22:77–89. https://doi.org/10.1080/24748668.2021.2003961
9. Drikos S, Barzouka K, Nikolaidou M-E, Sotiropoulos K. Game variables that predict success and performance level in elite men's volleyball. *International Journal of Performance Analysis in Sport*, 2021;21:767–79. https://doi.org/10.1080/24748668.2021.1945879
10. Araújo CRP, Tosini L, Freire AB, Costa GDCT, Meira JR CM. Reception-attack relation in men's and women's volleyball during the Rio 2016 Olympics. *Journal of Physical Education and Sport*,2020;20:2008–12. https://doi.org/10.7752/jpes.2020.s3271
11. Melendez-Nieves A, Celeste GS, Rodríguez-

Torres J. Relationship between the set outcome and volleyball skills in a professional volleyball champion male team in Puerto Rico. *Int J Phys Educ Sports Health*, 2020;7:33–6. https://doi.org/10.22271/kheljournal.2020.v7.i5a.1825
12. Giatsis G, Drikos S, Lola A. 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,* 2023;18:874–82. https://doi.org/10.1177/17479541221086779
13. Martins JB, Afonso J, Coutinho P, Fernandes R, Mesquita I. The Attack in Volleyball from the Perspective of Social Network Analysis: Refining Match Analysis through Interconnectivity and Composite of Variables. *Monten J Sports Sci Med,* 2021;10:45–54. https://doi.org/10.26773/mjssm.210307
14. Szabo DA, Neagu N, Voidazan S, Sopa IS, Gliga CA. Analyzing the attack players in volleyball through statistical methods. *Health, Sports & Rehabilitation Medicine*, 2019;20:154–8. https://doi.org/10.26659/pm3.2019.20.4.154
15. Akarçeşme C. Is it Possible to Estimate Match Result in Volleyball: A new Prediction Model. *Central European Journal of Sport Sciences and Medicine,* 2017;19:5–17. https://doi.org/10.18276/cej.2017.3-01
16. Lima RF, Palao JM, Clemente FM. Jump Performance During Official Matches in Elite Volleyball Players: A Pilot Study. *J Hum Kinet,* 2019;67:259–69. https://doi.org/10.2478/hukin-2018-0080
17. Pawlik D, Kawczyński A, Chmura J, Maćkała K, Kutrzyński M, Mroczek D. Jumping Flying Distance and Jump Performance of Elite Male Volleyball Players at FIVB Volleyball Men's World Championship. *Applied Sciences,* 2020;10:2045. https://doi.org/10.3390/app10062045
18. Conti GDCTC, Castro HDOC, Freire ABF, Evangelista BFE, Pedrosa GFP, Ugrinowitsch HU, et al. High level of Brazilian men´s volleyball: characterization and difference of predictive factors of back row attack. *Motricidade*, 2018; 58–65. https://doi.org/10.6063/motricidade.12221
19. Conti G, Freire A, Evangelista B, Pedrosa G, Ugrinowitsch H, Castro H. Brazilian high level men's volleyball: characterization of the attack performed by the opposite player. *Kinesiology,* 2018;50:211–7.
20. Silva M, Sattler T, Lacerda D, João PV. Match analysis according to the performance of team rotations in Volleyball. *International Journal of Performance Analysis in Sport,* 2016;16:1076–86. https://doi.org/10.1080/24748668.2016.11868949
21. Degrenne O, Langlois V, Paulo A, Éloi S, Mouchet A. The role of performance analysis within the coaching process: Dealing with failure in volleyball side out attack. *Movement & Sport Sciences - Science & Motricité,* 2023;119:47–60. https://doi.org/10.1051/sm/2022025
22. Mroczek D, Januszkiewicz A, KawczyNski AS, Borysiuk Z, Chmura J. Analysis of Male Volleyball Players' Motor Activities During a Top Level Match. *The Journal of Strength & Conditioning Research*, 2014;28:2297. https://doi.org/10.1519/JSC.0000000000000425
23. Peiró MS, Parra M, León J, Fradua L, Benítez JM, Ureña A. Relationship between middle hitter and setter's position and its influence on the attack zone in elite men's volleyball. *International Journal of Performance Analysis in Sport,* 2016;16:523–38. https://doi.org/10.1080/24748668.2016.11868906
24. Alexandros L, Athanasios M. The setting pass and performance indices in Volleyball. *International Journal of Performance Analysis in Sport,* 2011;11:34–9. https://doi.org/10.1080/24748668.2011.11868527
25. Nikos B, Elissavet NM. Setter's performance and attack tempo as determinants of attack efficacy in Olympic-level male volleyball teams. *International Journal of Performance Analysis in Sport*, 2011;11:535–44. https://doi.org/10.1080/24748668.2011.11868571
26. Nikos B, Karolina B, Elissavet NM. Performance of male and female setters and attackers on Olympic-level volleyball teams. *International Journal of Performance Analysis in Sport,* 2009;9:141–8. https://doi.org/10.1080/24748668.2009.11868470
27. Đurković T, Pašuld M, Kresoja D. Somatotypes of Top Croatian Male Volleyball Players. *Sport Mont*, 2023;21:71–7. https://doi.org/10.26773/smj.230711
28. Junior NKM. Vertical jump of the elite male volleyball players in relation the game position: a systematic review. *Revista Observatorio Del Deporte,* 2015;1:10–27.
29. Pradhan DK. Somatic traits and body composition characteristics of middle blockers and outside hitters of east zone inter university male volleyball players. *Wbcipe Journal*, 2018;1:1–10.
30. Muche TA, Elema TB, Walle DG, Mengistie AB. Comparison of Anthropometric Characteristics Among Volleyball Players Regarding with the Respect of Their Playing Positions in Ethiopian Men Premier League. *International Journal of Human Movement and Sports Sciences*, 2023;11(6): 1361–1367. https://doi.org/10.13189/saj.2023.110621
31. Toselli S, Campa F. Anthropometry and Functional Movement Patterns in Elite Male Volleyball Players of Different Competitive Levels. *The Journal of Strength & Conditioning Research*, 2018;32:2601. https://doi.org/10.1519/JSC.0000000000002368
32. Stamm R, Stamm M, Jairus A, Toop R, Tuula R, João PV. Do height and weight play an important role in block and attack efficiency in high-level men's volleyball? *Papers on Anthropology*, 2017;26:64–71. https://doi.org/10.12697/poa.2017.26.1.05
33. López E, Velasco Rodrigo M, Gea-García GM. The setter's attack in high-level volleyball. *Retos*, 2024;56: 95–106. https://doi.org/10.47197/retos.v56.103166
34. Sheppard JM, Gabbett TJ, Stanganelli L-CR. An Analysis of Playing Positions in Elite Men's Volleyball: Considerations for Competition Demands and Physiologic Characteristics. *The Journal of Strength & Conditioning Research*, 2009;23:1858. https://doi.org/10.1519/JSC.0b013e3181b45c6a

35. Fattahi A, Shamsabadi AMM, Kalani A, Nemat S, Ghofrani MH. Differences between biomechanical variables of professional volleyball attackers due to game's position. *European Journal of Experimental Biology*, 2014;4:406–11.
36. Schons P, Birk Preissler AA, Berriel GP, Oses VHS, Kruel LFM. Training, anthropometric, and physical performance profiles of players in the U19 men's volleyball at different in-game role. *International Journal of Sports Science & Coaching,* 2023;18:1198–207. https://doi.org/10.1177/17479541221100058
37. Millán-Sánchez A, Morante Rábago JC, Ureña Espa A. The middle blocker in volleyball: A systematic review. *Journal of Human Sport and Exercise,* 2019;14:24–46. https://doi.org/10.14198/jhse.2019.141.03.
38. Tokat F, İŞgüzar MG. The Relationship Between Vertical Jump Height and Negative Attack Performance According to Different Positions of Elite Male Volleyball Players. *The Online Journal of Recreation and Sports*, 2023;12(4): 785–788. https://doi.org/10.22282/tojras.1343862
39. Data Project. *Software for the scouting and analysis of volleyball matches/Data Volley Media*. Via Dell'Elettricista 10, 40138 Bologna – Italy; 2024.
40. Sandu AS. *Professional ethics and deontology*. Iasi: Lumen; 2012. (In Romanian).
41. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. *JAMA*, 2013;310(20): 2191. https://doi.org/10.1001/jama.2013.281053
42. MacFarland TW, Yates JM. Kruskal–Wallis H-Test for Oneway Analysis of Variance (ANOVA) by Ranks. In: *Introduction to Nonparametric Statistics for the Biological Sciences Using R*, Cham: Springer International Publishing; 2016. P. 177–211. https://doi.org/10.1007/978-3-319-30634-6_6
43. MacFarland TW, Yates JM. Mann–Whitney U Test. In: *Introduction to Nonparametric Statistics for the Biological Sciences Using R*, Cham: Springer International Publishing; 2016. P. 103–132. https://doi.org/10.1007/978-3-319-30634-6_4
44. Murariu G, Munteanu D. *Practical works of identification, modeling and simulation of physical processes*. Galati: Galati: University Press; 2018. (In Romanian).
45. Opariuc DC. *Applied statistics in the social and human sciences. Analysis of associations and statistical differences*. Sibiu: Archip Art; 2011. (In Romanian).
46. Marques Junior NK. Match Analysis for Elaborate the Volleyball Training: A Review. *J Sport Game*, 2021;3:1–7. https://doi.org/10.22259/2642-8466.0301001
47. Silva M, Lacerda D, João PV. Match analysis of discrimination skills according to the setter attack zone position in high level volleyball. *International Journal of Performance Analysis in Sport*, 2013;13:452–60. https://doi.org/10.1080/24748668.2013.11868661
48. Grgantov Z, Jelaska I, Šuker D. Intra and Interzone Differences of Attack and Counterattack Efficiency in Elite Male Volleyball. *J Hum Kinet,* 2018;65:205–12. https://doi.org/10.2478/hukin-2018-0028
49. Drikos S, Papadopoulou SD, Barzouka K. Multivariate analysis of the success factors in high-level male volleyball: a longitudinal study. *TRENDS in Sport Sciences*, 2019;26(4): 177–185. https://doi.org/10.23829/TSS.2019.26.4-6
50. Fellingham GW. Evaluating the performance of elite level volleyball players. *Journal of Quantitative Analysis in Sports,* 2022;18:15–34. https://doi.org/10.1515/jqas-2021-0056
51. Fellingham GW, Hinkle LJ, Hunter I. Importance of attack speed in volleyball. *Journal of Quantitative Analysis in Sports*, 2013;9:87–96. https://doi.org/10.1515/jqas-2012-0049
52. Drikos S, Kountouris P, Laios A, Laios Y. Correlates of Team Performance in Volleyball. *International Journal of Performance Analysis in Sport,* 2009;9:149–56. https://doi.org/10.1080/24748668.2009.11868472
53. Majstorović N, Sikimić M, Osmankač N, Grbić V. Competitive activity analysis in play-off stage of "Wiener Stadtische" Serbian volleyball league for men in 2012/2013 season. *Fizička Kultura*, 2015;69:51–8. https://doi.org/10.5937/fizkul1501051M
54. Wang J, Qin Z, Wei Z. Power and velocity performance of swing movement in the adolescent male volleyball players – age and positional difference. *BMC Sports Sci Med Rehabil,* 2024;16:111. https://doi.org/10.1186/s13102-024-00898-2
55. Drikos S. A longitudinal study of the success factors in high-level male Volleyball. *Journal of Physical Activity Nutrition and Rehabilitation*, 2018:439–49.
56. Akarcesme C, Sahin M, Varol YK, Colakoglu FF. Examining the Attacks After the 20th Scores in Volleyball According to Nationality and Positions. *Journal of Education and Learning*, 2018;7(6): 184. https://doi.org/10.5539/jel.v7n6p184
57. Stankovic M, Ruiz Llamas G, Peric D, Quiroga Escudero ME. Point-scoring plays related to level of set win and in-game role during volleyball rules testing. *Journal of Human Sport and Exercise*, 2019;14:86–98. https://doi.org/10.14198/jhse.2019.141.07
58. Lima RF. Variations of technical actions among playing positions in male high level volleyball. *TRENDS in Sport Sciences*, 2021;28(2): 153–158. https://doi.org/10.23829/TSS.2021.28.2-9
59. Sotiropoulos K, Drikos S, Barzouka K. Variations in attack patterns between female and male opposite players in top-level volleyball. *International Journal of Sports Science & Coaching,* 2022;17:400–11. https://doi.org/10.1177/17479541211030633
60. Martins JB, Afonso J, Mendes A, Santos L, Mesquita I. Inter-player Variability Within the Same Positional Status in High-level Men's Volleyball. *Retos*, 2022;46: 129–137. https://doi.org/10.47197/retos.v46.93624
61. Millán-Sánchez A, Morante Rábago JC, Ureña Espa A. Differences in the success of the attack between outside and opposite hitters in high

level men's volleyball. *Journal of Human Sport and Exercise*, 2017;12:251–6. https://doi.org/10.14198/jhse.2017.122.01
62. Cieminski K. The efficiency of executing technical actions by female volleyball players depending on their positions on the court. *Baltic Journal of Health and Physical Activity,* 2022;9:44–52. https://doi.org/10.29359/BJHPA.09.3.04
63. Costa GDCT, Mesquita I, Coutinho P, Evangelista BF de B, Milistetd M, Freire AB, et al. Determinant factors of attack efficacy in high-level men's volleyball: what does distinguish the middle-attacker performance? *Kinesiology,* 2024;56:3–11. https://doi.org/10.26582/k.56.1.1
64. Lima R, Silva AF, Clemente FM. Temporal effects of final action on the performance of the Portuguese men's volleyball teams. *Biomedical Human Kinetics,* 2019;11:121–30. https://doi.org/10.2478/bhk-2019-0017
65. Tokat F, İşgüzar MG, Keskin K, Adıgüzel S. The Relationship Between Frequency of Jumps and Negative Attack Technique of Elite Male Volleyball Players During Demo Competitions. *YUJSS*, 2023;2:33–42.

Information about the authors:

George Danut Mocanu; https://orcid.org/0000-0002-3534-5055; george.mocanu@ugal.ro; Faculty of Physical Education and Sport, "Dunarea de Jos" University of Galati; Galati, Romania.

Neculai Harabagiu; (Corresponding author); https://orcid.org/0000-0001-7978-0553; neculai.harabagiu@ugal.ro; Faculty of Physical Education and Sport, "Dunarea de Jos" University of Galati; Galati, Romania.

Carmen Parvu; https://orcid.org/0000-0002-2910-9494; carmen.parvu@ugal.ro; Faculty of Physical Education and Sport, "Dunarea de Jos" University of Galati; Galati, Romania.

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