




Key performance indicators discriminating winners and losers in Men's Volleyball Nations League

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ABSTRACT

The study identified performance indicators that differentiate winning from losing teams in the Men's Volleyball Nations League. Total of 208 matches from two consecutive Volleyball Nations League seasons (2023 and 2024) were analysed. Matches were categorized with the final set difference (3-0, 3-1, and 3-2). We analysed four performance indicators: attack points, block points, serve points, and opponent error points. The normality of data was verified using Kolmogorov-Smirnov test and an independent t-test was employed to compare the differences between winners and losers for all indicators. Variables that showed significant differences between two groups were selected for discriminant analysis. Discriminant analysis revealed all match types, block and serve points were the most important predictor. In 5-set type matches attack, block and serve were found the significant predictor of match outcome. In 3-set type matches, all performance indicators significantly influenced the match outcome. These results demonstrate that serve and block points are consistently critical in all match types. These findings offer insights for coaches on how performance indicators impact match outcomes in high level volleyball matches. Future researches should investigate different scoring phases and other indicators to enhance the application of volleyball performance analysis.

Keywords: Performance analysis, Volleyball National League, Discriminant analysis, Performance indicators, Match analysis.

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INTRODUCTION

In modern volleyball, the integration of match statistical analysis has fundamentally transformed coaching methodologies and performance evaluation across all competitive levels. Coaches and performance analysts increasingly rely on comprehensive statistical data to identify key performance indicators (KPIs) and uncover the underlying dynamics of game success. This data-driven approach replaces traditional observational methods with objective and quantifiable measures that support evidence-based decision-making (Palao & Hernández-Hernández, 2014). Advances in analytical tools and video analysis technologies have further enhanced coaches' ability to track, predict, and recall critical match situations with higher precision (Anderson, 2021; Wright et al., 2012). Researchers have emphasized that the objective assessment of game-related statistics enables coaches to shift from subjective evaluation toward data-informed strategies, thereby improving tactical planning and player development (Dunarea de Jos University, Romania & Harabagiu, 2021; Prakoso & Lumintuarso, 2021). Such analytical frameworks offer deeper insight into the technical and tactical elements that differentiate winning from losing performances, ultimately contributing to a more systematic and effective model for competitive success (Drikos et al., 2009).

A volleyball match report is a comprehensive document that includes team and player statistics, used to analyse frequencies and provide easily understood information for players and coaches to apply in training and match situations. A study by (Giatsis, 2023) on women's Olympics (2016-2021) and world championships (2014-2018) serves, block, and attack, and opponent error, which showed a dominant predictor in 3-0 and 3-1 set matches. In 3-2 set matches, block points are the primary predictor of match success. Similarly, (Giatsis et al., 2023) study on the men's Olympics (2016-2021) and world championships of 2014-2018 revealed that attack, block, and serve came to be the predictors for team success in 3-0 and 3-1 set matches. On the other hand, 3-2 set matches serve and block points become the key factors determining the team's success. In addition, Drikos et al. (2024) compared men's and women's Asian competition (AVC Challenge Cup 2023) and found that for men's team's attack win percentage and serve win percentage were the predictors, and for women's teams, attack win percentage after reception was the discriminating factor. In their study, (Stankovic et al., 2019) point-scoring plays during the U23 Men's Volleyball World Championship under new regulations, to examine which aspects of these plays affected the match outcome of sets and each player's role in the game. The author's findings suggested that if those tested experimental rules are implemented in future competitions, the development of blocking, serving, and attacking skills may have a greater influence on set outcomes.

Notational analysis is essential for coaches and sports scientists seeking objective, quantifiable data of athletes' performance across tactical, technical, and physical dimensions (Hughes & Franks, 2007). Technical elements were the most critical predictors of winning and losing in international competitions. Technical elements refer to executing skills such as attack, block, and serve. High-level men's volleyball results were primarily determined by these performance indicators: attack, block, serve, and opponent error (Drikos & Vagenas, 2011; Mocanu et al., 2024; Rodriguez-Ruiz et al., 2011). As a result, these four performance indicators were selected for this study because they are the only scoring elements that consistently discriminate performance in high-level volleyball competitions. The Volleyball Nations League, with its highly competitive, unique tournament format and participation of the world's top-ranked 16 teams of comparable skill levels, creates an exceptional opportunity to identify the most significant performance discriminators determining winning at the high-level men's international volleyball competition.

To our knowledge, there are limited recent studies in the literature on the Men's Volleyball Nations League, and most studies have examined the performance indicators for the Olympics and the World Championship.

Further results should be of considerable value to coaches and researchers concerning improving team performance in different contexts, determining the trends, and making effective practice plans and match strategies. The present study examines the impact of performance indicators between winning and losing teams in the Volleyball Nations League (2023-2024), depending on the final score difference of matches.

METHODOLOGY

Study participants

This study includes 208 matches from two consecutive Volleyball Nations League 2023 and 2024 seasons. It includes 104 matches from each league season. The data were collected from the official website of FIVB (volleyball world). All the matches are played per the Federation of International de Volleyball rules.

Research procedures

The performance indicators selected for the study were adopted from the previous literature. The performance indicators examined in this research included Attack Points, Block Points, Serve Points, and Opponent Error Points. The matches were analysed from two different editions, and the combined year-wise data were also analysed. Matches were systematically categorized according to their final set score.

Statistical analysis

Descriptive statistics (mean and standard deviation) were calculated for each performance indicator of winners and losers of the Volleyball Nations League across different set types. The normality of data was verified using the Kolmogorov-Smirnov test, after which an independent sample t-test was employed to compare the difference between winners and losers for all indicators of 5-set, 4-set, and 3 set matches of Volleyball Nations League. For the variable that did not follow a normal distribution, the Mann–Whitney U test was used instead.

To understand the differences for the t-test, the standardized mean differences, i.e., Cohen's d effect size, was calculated and interpreted as d less than 0.2 trivial, d between 0.2 to 0.5 small, d between 0.5 to 0.8 medium, and greater than 0.8 large effect. Whereas the effect size for Mann–Mann-Whitney U test was calculated using the formula $r = z/\sqrt{n}$. The effect size was small if r is less than 0.3, r between 0.3 and 0.5 indicates medium effect, r greater than 0.5 means large effect Karadimitriou S. M., Marshall, E. & Knox, C., Mann-Whitney U Test (Sheffield Hallam University, 2018, Volker, 2006).

Variables that showed significant differences between two groups were selected for discriminant analysis. In a significant discriminant function, if the absolute value of the structural coefficient (SC) was greater than 0.30 (Sampaio et al., 2006), then a performance indicator was considered a meaningful contributor to differentiating winners from losers. The alpha level was set at $p < .01$ for all tests. All analyses were conducted using Statistical Package for the Social Sciences 24 (SPSS Inc., Chicago, IL, United States).

RESULTS

Tables 1 and 2 show the descriptive statistics and comparison of the performance indicators between winning and losing teams in different set-type matches of the Volleyball Nations League.

In 3-2 set matches, winners outperform losers in performance indicators, including attack ($p < .01$, Cohen's $d = 0.53$) and serve points ($p < .01$, $r = 0.286$). It was noted that the average winning team scored 62.95 points from direct attack, and the losing team scored 59.04.

Table 1. Descriptive statistics.

Performance Indicators	Set 5 (n = 53)		Set 4 (n = 73)		Set 3 (n = 82)	
	Winner	Loser	Winner	Loser	Winner	Loser
Attack	62.92 (7.6)	59.04 (6.92)	54.24 (5.01)	50.72 (5.52)	40.92 (4.7)	35.09 (4.26)
Block	10.11 (3.57)	10.4 (3.65)	9.24 (3.07)	6.66 (2.43)	7.86 (2.99)	4.95 (2.48)
Serve	6.58 (2.59)	5.21 (2.87)	6.15 (2.4)	4.2 (2.04)	5.23 (2.51)	2.89 (1.76)
Error	30.53 (5.25)	30.32 (6.16)	27.29 (4.94)	25.53 (4.46)	22 (4.15)	17.79 (4.1)

Table 2. Results of independent t-test and Mann-Whitney U test along with their effect size.

Performance indicators	Independent T-test			Mann-Whitney U Test			Effect Size ("Cohen's d" or "r")		
	Sig. value			Sig. value					
	Set 5	Set 4	Set 3	Set 5	Set 4	Set 3	Set 5	Set 4	Set 3
Attack	0.007	0	0	NA	NA	NA	0.53 ^M	0.671 ^M	1.3 ^L
Block	NA	NA	0	NA	0	NA	-0.08 ^T	0.423 ^M	1.05 ^L
Serve	NA	NA	NA	0.003	0	0	0.286 ^S	0.412 ^M	-0.486 ^M
Error	NA	NA	0	NA	0.015	NA	NA	0.202 ^S	1.02 ^L

Note. Effect Size "Cohen's d" – for independent t-test; Effect size "r" – for Mann-Whitney U Test; S – Small Effect Size; M – Medium Effect Size; L – Large Effect Size; NA – Not Applicable.

In contrast, in the case of 3-1 set matches univariate result showed that the most important indicator is attack, block and serve points. More specifically observed that in 3-1 set matches winners demonstrate a significant higher percentage of points from block (Mean = 9.24, $p < .01$, Cohen's $d = 0.423$), as compared to losing teams (Mean = 6.66, $p < .01$, $r = 0.423$).

In 3-0 set matches, the teams were successful (winners) had scored more points through direct attack (Mean = 40.92, $p < .001$, Cohen's $d = 1.3$) as compared to the unsuccessful teams (losers) (Mean = 35.09, $p < .001$, Cohen's $d = 1.05$). In addition, winning teams in the 3-0 set matches had an average of 7.86 points from the opponent error, but for losers it was an average of 4.95 points.

The discriminant functions (Table 3) proved to be effective in discriminating between the winners and losers because the reclassification accuracy rates were 0.156, 0.602, and 0.72 in 3-2 set matches, 3-1 set matches, and 3-0 set matches respectively.

Table 3. Discriminant function Structure Coefficients (SC) and tests of statistical significance.

Performance indicators	Set 5	Set 4	Set 3
Attack	0.628	0.273	0.399
Serve	0.591	0.358	0.33
Block	-0.399	0.381	0.325
Error	#	0.154	0.314
Eigenvalue	0.185	1.511	2.668
Wilks Lambda	0.844	0.398	0.273
Canonical correlation	0.395	0.776	0.853
Chi-Square	17.465	130.752	207.942
Significance	<.001	<.001	<.001
Reclassification	67.00%	91.80%	94.50%

Note. SC discriminant value $\geq .30$ | # means that the variable was not significant and was not used in discriminant analysis.

The performance indicators that significantly contributed to the discriminant function in 3–2 set matches were attack points, serve points, and block points, with structural coefficients (SC) for the winning group ranging from –0.39 to 0.62.

Conversely, in 3-1 set matches, performance indicators, contributed to the discriminant function were serve points and block points, with $|SC|$ value ranging from- 0.35 to 0.38.

According to 3-0 set matches, performance indicators, contribute to the discriminant function were attack points, serve points, block points, and opponent error points, $|SC|$ ranging from-0.31 to 0.39.

DISCUSSION

Scientific training in volleyball is rapidly growing due to technological advancements. Therefore, it is essential to constantly analyse variables that affect performance. The primary objective was to identify key performance indicators that distinguish winners from losers across various matches in the 2023- and 2024- Men's Volleyball Nations League tournaments, depending on the final score difference of matches. The results reveal critical performance differentials between winners and losers in these tournaments. Notably, the superior performance of winners across several key indicators highlights the complex nature of success in high-level matches.

Attack points

Studies consistently highlights the critical role attack points in determining match outcomes (Eom & Schutz, 1992; Rodriguez-Ruiz et al., 2011; Stankovic et al., 2019). Most studies identified attack points as the most frequent predictor in high-level volleyball tournaments both men and women's matches (Drikos et al., 2024; Silva et al., 2013). A previous study by (Drikos & Vagenas, 2011) demonstrated that attack points as an important predictor in 3-0 and 3-1 set types, and attack points' effectiveness was found to be considerably lower in 3-2 set type matches. The novel study reveals contradictory against (Castro et al., 2011; Drikos & Vagenas, 2011) in 3-1 set type matches our study reveals that the attack point is not a significant factor. The highest canonical coefficient (0.628) observed in 3-2 set type matches in our study reveals that attack effectiveness becomes increasingly critical in 3-2 set type matches. These findings challenge previous research suggesting lower attack effectiveness in 3-2 set type matches. The balanced nature of 3-2 set type matches creates scenarios where sustained attacking pressure and efficiency become the supreme element for victory, as teams must maintain high performance levels across five sets under increasing physical and psychological stress.

Serve points

Previous research highlights the critical role of serve points in determining competitive success in extending beyond three sets, previous studies corroborating the importance of serve performance (Giatsis et al., 2023; Rocha et al., 2020; Silva et al., 2014). Serve points contribute fewer total points compared to attack and opponent errors points, the differential between winners and losers (Valladares et al., 2016) teams remains stable and meaningful across with values of 2.34, 1.95, and 1.37 for sets 3, 4, and 5, respectively. The effect size of serve points demonstrates greater impact in three-set (0.486) and four-set (0.412) type matches compared to five-set type matches. This pattern aligns with findings indicating that higher-ranked men's volleyball teams exhibit superior serve point success rates (Drikos & Tsoukos, 2018; Marcelino et al., 2012; Peña et al., 2013), thereby supporting the results of the present study. Successful teams use serves tactically to disrupt opponent formations and weaken reception quality, not merely for direct scoring. This approach creates enhanced transition attack and block point opportunities for the serving team.

Block points

The ability to score by blocking becomes a decisive factor in high-level men's competitions (Giatsis et al., 2023; Mikolajec et al., 2025; Rodriguez-Ruiz et al., 2011), according to these studies, block points significant predictor of all set types of matches. Contrary to a previous study (Giatsis, 2023), this study revealed that losing teams had slightly higher block points than winners in 5-set matches (10.40 vs 10.11), with a minimal effect size (0.08). However, 3-set matches showed the largest block point effectiveness for winners, with a 2.91 point difference and substantial effect size (1.05). The present study suggests block point effectiveness varies significantly by match type.

Opponent error point

Opponent error points play a significant predictor of the match outcomes, and same time, winners have made fewer errors than the losing team (Peña et al., 2013; Rodriguez-Ruiz et al., 2011). According to (Giatsis, 2023), in 3-set and 4-set matches, the opponent's error point is statistically significant. But in the present study, the impact of opponent error was only significant in 3-set matches. The effective size of the 3-set matches was higher (1.02). These findings reveal a significant variation in the predictivity of the opponent error points between the types of matches. In 5-set matches, both teams are equally skilled, but in 3-set matches shows greater skill difference.

CONCLUSION

In conclusion, this study reaffirms the critical importance of attacking efficiency, serving effectiveness, and minimizing errors in determining match outcomes at the elite level of the Volleyball Nations League. By identifying the performance indicators that most clearly distinguish winners from losers, the research provides a deeper understanding of competitive dynamics and offers actionable insights for coaches and analysts to optimize tactical strategies. Future research could further examine these indicators across different volleyball leagues and competitive contexts, thereby strengthening the strategic framework for achieving success in professional volleyball.

AUTHOR CONTRIBUTIONS

All authors meet the criteria for authorship in accordance with established ethical guidelines. Conceptualization K.V and T.P. K.V and Mattakotttil methodology. K.V and T.P data collection. Formal analysis K.V and Mattakotttil. Investigation Sundar. Writing—review and editing K.V, T.P, Mattakotttil and Sundar. All authors have critically reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used in the generation of scientific content, including the study design, data collection, analysis, interpretation of results, or the formulation of conclusions. The authors retain full responsibility for the content of the manuscript and confirm its originality, integrity, and accuracy.

DATA AVAILABILITY

The data used in the analysis are presented in the study as Table(s) and Figure(s). Any other data requirement should be directed to the corresponding author and will be provided upon reasonable request.

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