ORIGINAL ARTICLE

Impact of early leadership on performance in volleyball sets

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ABSTRACT

The aim of this study was to determine the impact of different contextual variables on winning volleyball sets. The variables were selected based on their significance as determined by expert coaches. The sample consisted of 1,849 sets, representing all matches played in both categories during the 2022 and 2023 Volleyball Nations League and the 2021 Olympic Games. To analyse the variables, multivariate logistic regressions and Markov chains were applied. The results showed that opponent level explained 21.6% of the variability found; being especially relevant when playing against opponents separated by two competitive levels. Winning the previous set increased the chances of winning the next set by 7.83%. Leading the score at the end of both set periods enhanced the likelihood of winning the set, reaching 87.12% when finishing ahead in both periods. Moreover, at the end of the second period, each additional point increased the likelihood of winning the set by 1.54%. These results signify an advancement in comprehending the impact of contextual variables on winning high-level volleyball sets.

Keywords: Performance analysis, Scoreline, Set period, Score difference, Contextual variables, Scoreboard.

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INTRODUCTION

The influence of contextual variables on game performance is an aspect considered relevant by elite volleyball coaches (López-Serrano et al., 2022). Various studies have investigated how contextual variables impact team performance in matches, sets, rallies, and technical actions; understanding a match as a constant dynamic interaction between two teams that affects their performance (Garciá-De-Alcaraz & Usero, 2019; Ramos, Coutinho, Silva, Davids, Guimarães, et al., 2017).

The opponent's level, as a contextual variable, has generated attention in research on team dynamics. The quality of the opponent may affect the performance of some of the individual technical actions among high-level teams, with better performances found in higher-ranked teams (Ciemiński, 2018; Drikos et al., 2021; Mulazimoglu et al., 2021; Palao et al., 2004). Although Araújo et al. (2020), did not find differences when comparing the phases of the Olympic Games, these could depend on the specific characteristics of the competition or its stage, which may affect the balance of the matches (Sánchez-Moreno et al., 2018). In this regard, López et al. (2023) observed no variations in the balance of scores at the conclusion of sets, regardless of the competition phase or team rankings. However, they noted more balanced sets in the women's Nations League and more unequal sets in the NORCECA Championship and the African Championship.

In a competitive sports context, the main objective of any team is to score as many points as possible to ensure victory at the end of the match. However, the division of matches into sets in disciplines such as volleyball may mean that the team with the most points at the end of the match does not necessarily win, due to the set-based scoring system, in what Lisi et al. (2019) called the "*Quasi-Simpson paradox*". With regard to winning sets', Marcelino et al. (2009) analysed matches from the Men's World Volleyball League and found no significant differences linking the outcome of one set to the next. This implies that a volleyball match can be seen as a series of three, four, or five independent micro-games (Marcelino et al., 2010b).

However, the number of sets in a match seems to affect the final score balance at the end of the sets. López et al. (2023) found that in high-level samples, the final scores of matches played over three sets were less balanced. In contrast, matches that extended to four or five sets in women's categories and five sets in men's categories exhibited greater balance in the scores. Moreover, each set of the match may affect physical and psychological stress differently, as well as the performance of specific game actions (Drikos & Vagenas, 2011; Giatsis et al., 2022; Marcelino et al., 2009, 2010b, 2012).

Each set is characterised by unique situations, intensified by changes in the score or the proximity of the end of the set. These circumstances can increase the psychological pressure on the players. Bar-Eli and Tractinsky (2000) discuss the concept of "*psychological phases*" throughout a match, identifying the final period as the most critical. Critical moments and score fluctuations in a match can influence the outcome of a set and may alter the tactical behaviours and technical performance of players or teams (Hill et al., 2010). In the men's category, it was noted that players utilised simpler blocking strategies and took fewer risks when serving during critical moments of the set and in tight scoring situations (Marcelino et al., 2011, 2012). However, when the score was unbalanced, the teams took greater risks (Drikos & Vagenas, 2011; Marcelino et al., 2011). In contrast, Ramos et al. (2017) found no differences in tactical performance based on the scoreline in high-level women's play, although national-level players reported greater tactical variations at critical moments of the set (Ramos, Coutinho, Silva, Davids, & Mesquita, 2017). Furthermore, scoring dynamics related to scoring sequences may influence the performance of subsequent actions (Raab et al., 2012). This notion is supported by the way volleyball coaches use time-outs to interrupt the opponent's scoring run (Fernández-Echeverria et al., 2013; Zetou et al., 2008), having reported evidence of its effectiveness in balanced sets with players in initial training (Fernández-Echeverría et al., 2019).

In accordance with the perceptions of elite coaches as provided by López-Serrano et al. (2022) about the contextual variables that influence the performance of high-level teams, the aim of this study was to investigate the impact of these variables on winning sets and matches in high-level competitions.

MATERIAL AND METHODS

Data set

A total of 1,849 sets from international volleyball events were analysed: 771 from the 2022 Nations League (VNL), 798 from 2023, and 280 from the Tokyo 2021 Olympic Games, covering all matches from these competitions. The gender distribution was balanced, with 923 sets in the men's category and 926 sets in the women's category. The data were obtained from the public and open access results found on the official website of the Fédération Internationale de Volleyball (FIVB). The research protocol received full approval from the Research Ethics Committee of the Technical University of Madrid (Spain).

Variables

In this study, fixed descriptor variables were used, including:

a) WinSet: dependent variable that includes binary values that identify whether the main team won/lost the entire set.
b) 1st Period and 2nd Period: following López-Serrano et al. (2022), these indicate whether the main team won the first period of the set (0 to 9 points) or the second period of the set (10 to 19 points), respectively.
c) SD1ºP and SD 2ºP: score difference between the two opponents at the end of the first period and second period, respectively.
d) Opposition Level (OL): determines the level differences between the two opponents, classified into five levels, following López-Serrano et al. (2022).
e) Competitive Load (CL): reflects the importance for the outcome of the match: it is considered low if the set is not decisive for the victory, and high if it is decisive (López-Serrano et al., 2022).
f) Result of the previous set (SETp): the value can be "*Tied*" at the start of the match with a 0-0 set draw, "*Lost*" if the previous set was lost, or "*Won*" if the previous set was won (López-Serrano et al., 2022).
g) Round: identifies two championship rounds, the opening round or first round and the final round.
h) Gender: male or female.
i) Competition: Volley Nations League or Olympic Games.

Univariable logistic regression model

Logistic regression was used to understand how the independent variables *1st Period, 2nd Period, SD1ºP, SD2ºP, Gender, Competition, OL, CL* and *SETp*, affect the probability of winning a set (*WinSet*).

The relationship between the dependent variable (WinSet) and each independent variable is modelled using the following logistic function:

$$\text{logit}(p) = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X$$

In the text, *p* is the probability that the event of interest (winning the set) occurs. *logit(p)* is the logistic transformation of *p*. β_0 is the intersection. β_1 is the coefficient of the independent variable *X* (i.e. *SD1ºP* or *SD2ºP*).

The probability of winning the set is calculated by inverting the logistic function:

$$p = \frac{e^{\beta_0+\beta_1 X}}{1+e^{\beta_0+\beta_1 X}}$$

For each change in *SD1ºP* and *SD2ºP*, the likelihood of winning the set was estimated using a logistic regression model.

Multivariable logistic regression models

Two multivariate logistic regression models were run to assess the combined effect of multiple variables. The first model assessed the influence of the score difference in the first part of the set (*SD1ºP*). This means understanding how an early score difference in the set influences the likelihood of winning the set and how other variables such as *OL*, *CL*, *Gender*, *Competition* or *SETp* affect this likelihood of winning (*WinSet*). The second model analysed the score difference in the second half of the match similarly (*SD2ºP)*.

The relationship between the binary dependent variable *WinSet* and the independent variables is modelled using the logistic function:

$$p(X) = \frac{1}{1+e^{-(\beta_0+\beta_1 X_1+\beta_2 X_2+\cdots+\beta_k X_k)}}$$

Where $p(X)$ is the probability of winning the set, $X1$, $X2$,...,Xk are the independent variables, and β_0, β_1,...,β_k are the coefficients of the model.

Markov chain analysis

A stochastic Markov chain model was used to investigate how wins in each period of a set affect the likelihood of winning the entire set. The scoreline was divided into three sections: the outcomes of the two periods and the conclusion of the set. According to this model, the likelihood of winning the set depends only on the current results of the periods and is unaffected by earlier events or previous sets.

To represent the possible outcomes in the different periods of the set, the states were defined as:

- State 'Lost vs Lost': Lost both periods (first and second).
- State 'Lost vs Win': Lost the first period but won the second.
- State 'Win vs Lost': Won the first period but lost the second.
- State 'Win vs Win': Won both periods.

A transition matrix *P* of size 4 × 2 was calculated, where P_{ij} represents the likelihood of transitioning from state *i* (*1st Period* and *2nd Period* combinations) to state *j* (*WinSet*), with *j* being 0 or 1. This matrix was calculated as follows:

$$\mathrm{P}_{ij} = \frac{\text{Number of transitions from } i \text{ to } j}{\text{Total observations in state } i}$$

Additionally, the transition matrices were calculated by incorporating an additional variable: OL and SETp, mathematically defined as follows:

$$P\ (i, v \rightarrow j) = \frac{\text{Number of transitions from (i, v) to j}}{\text{Total transitions from the combined state (i, v)}}$$

Where:

- (i, v) represent the combination of the transition state i and the value of the additional variable v (*OL* or *SETp*, in each case).
- j is the next state of *WinSet*.
- The numerator denotes the frequency of transition from the combined state (i, v) to j.
- The denominator represents the total number of transitions originating from the combined state (i, v).

Heat maps were used to illustrate the probabilities derived from different transition matrices. These represented the combination of states (*1st/2nd period*) and additional variables (*OL* and *SETp*) on the axes, while the colours reflected the probability of winning the entire set, visually showing the effect of winning specific set period in different playing conditions.

Likelihood curves

Probability curves were created using logistic regression models based on score difference to show how the probability of winning a set is altered with each unit change in *SD1ºP* and *SD2ºP*. The probability *p* was calculated for each value within the range using the previously mentioned equation.

To find the critical point (or inflexion point) on a probability curve of a logistic regression model, differential calculus is used. Specifically, we look for the point at which the second derivative changes, indicating the largest change in the slope of the curve.

To find the inflexion point, we need to calculate the second derivative of *p*(*X*) and identify the value of X where this derivative equal zero. The first derivative of *p*(*X*) is:

$$p'(X) = \frac{d}{dX}\left(\frac{1}{1 + e^{-(\beta_0 + \beta_1 X)}}\right) = \frac{\beta_1 e^{-(\beta_0 + \beta_1 X)}}{(1 + e^{-(\beta_0 + \beta_1 X)})^2}$$

The second derivative, p''(X), where we need to find the inflexion point, is the derivative of p'(X). We calculate this as:

$$p''(X) = \frac{d}{dX}\left(\frac{\beta_1 e^{-(\beta_0 + \beta_1 X)}}{(1 + e^{-(\beta_0 + \beta_1 X)})^2}\right)$$

The numerical calculation of the second derivative of the probability function is carried out to identify the inflection inflexion point, though its expression in closed form is complex due to the characteristics of the exponential and logistic functions. Once this value of X has been identified, it is replaced in the probability function to determine the corresponding p-coordinate.

Therefore, the point coordinates of the critical point ($X_{inflexion}$, $p_{inflexion}$) are the value of *X* where the second derivative reaches its absolute maximum, and the value of *p* computed from the probability function for that *X.*

Effectiveness of models

ROC (Receiver Operating Characteristic) curves were used to evaluate predictive models of score differences per period, depending on the opposition level. These curves represent the true positive rate (sensitivity) versus false positive rate (1 - specificity) for different decision thresholds. Mathematically, for a threshold t, the sensitivity and specificity are calculated as:

$$\text{Sensitivity: } TPR(t) = (TP(t))/(TP(t)+FN(t))$$

$$\text{Specificity: } FPR(t) = (FP(t))/(FP(t)+TN(t))$$

Where TP, FP, TN y FN are, respectively, true positives, false positives, true negatives and false negatives. An AUC of 1 denotes perfect discrimination, while an AUC of .5 suggests performance no better than random.

Data analysis

Python 3 was used to analyse Markov chains, create heat maps, and generate probability curves. A cluster analysis was used to classify the teams into three competitive levels. The variables used to establish the groups were: points scored per win (two points for a victory, one for a defeat), the ratio of won to lost sets, the points won versus lost, and the percentage of sets won (Marcelino et al., 2011). Logistic regressions were checked for correct diagnosis and all tests were performed using the SPSS v.26 statistical package (IBM Corp., Armank, NY, USA). The significance was set at $p < .05$.

RESULTS

Univariate logistic regression

The logistic regression results, shown in Table 1, assess the probability of winning a set in volleyball, based on wins in the *1st Period*, and *2nd Period*, in addition to *SD1ºP* and *SD2ºP*, respectively, *Gender*, *Competition*, *OL*, *CL* and the *SETp.*

Our findings show that certain factors are significant ($p < .001$) for predicting the likelihood of winning a set in volleyball. These include *1st* and *2nd Period* wins, *SD1ºP* and *SD2ºP*, *OL* and *SETp*, indicating:

1st Period and *2nd Period*

Low values of .105 and .130 suggest high reliability of these estimates. Significantly, the high odds ratios (ORs) of 7.569 for the *1st period* and 30.235 for the *2nd period* show that securing these periods considerably boosts the likelihood of winning the set, with the *2nd period* being especially decisive.

Furthermore, R^2_N values, 26.9% for the *1st period* and 54.2% for the *2nd*, indicate that both periods are strong predictors of winning a set, with the *2nd period* being particularly influential.

Finally, values close to 1 for VIF and Tolerance suggest there are no multicollinearity problems, meaning these variables function independently in prediction.

Table 1. Influence of score differences and other contextual variables on the probability of winning a set in volleyball: A univariate and multivariate logistic regression analysis.

Predictor	Estimator	EE	Z	*p*-value	OR	R^2_N	IC(95%) OR	IC(95%) OR	Collinearity analysis	
							Inf	Sup	VIF	Tolerance
Constant	-.878	.074	-11.83	<.001**	.416		.359	.481	2.10	.475
1st Period	2.024	.105	19.19	<.001**	7.569	.269	6.155	9.306	1.00	1.00
Constant	-1.72	.098	-17.64	<.001**	.179		.148	.216	2.26	.442
2nd Period	3.41	.130	26.25	<.001**	30.235	.542	23.439	38.998	1.00	1.00
Constant	.140	.054	2.596	.009*	1.150		1.035	1.278	1.00	.998
SD1ºP	.375	.019	19.331	<.001**	1.455	.318	1.401	1.512	1.00	1.00
Constant	-.001	.065	-.021	.983	.998		.878	1.135	1.01	.990
SD2ºP	.443	.019	22.743	<.001**	1.558	.584	1.499	1.618	1.00	1.00
Constant	.261	.148	1.769	.077	1.299		.972	1.735	10.01	.990
Gender	-.072	.093	-.775	.438	.930	.000	.775	1.117	1.00	1.00
Constant	.191	.111	1.721	.085	1.210		.974	1.504	5.64	.177
Competition	.019	.051	-.378	.705	.981	.000	.888	1.083	1.00	1.00
Constant	.064	.051	1.250	.211	1.066		.964	1.179	1.01	.987
Opposition Level (OL)	-1.036	.065	-16.014	<.001**	.345	.216	.312	.403	1.00	1.00
Constant	.058	.140	.413	.679	1.059		.805	1.394	9.02	.111
Competitive Load (CL)	.070	.097	.718	.473	1.072	.000	.886	1.298	1.00	1.00
Constant	-.043	.072	-.60	.535	.957		.831	1.103	2.40	.416
SETp	.215	.061	3.55	<.001**	1.239	.009	1.101	1.396	1.00	1.00
Constant	.416	.304	1.370	.171	1.517		.836	2.754	41.97	.024
Round	-.138	.158	-.878	.380	.870	.001	.639	1.186	1.00	1.00
Predictor	**Estimator**	**EE**	**Z**	**p-value**	**OR**	**R^2_N**	**IC(95%) OR**	**IC(95%) OR**	**Collinearity analysis**	
							Inf	**Sup**	**VIF**	**Tolerance**
Constant	-1.594	.201	7.925	<.001**	4.924		3.320	7.304	11.85	.084
SD1ºP	.357	.021	17.331	<.001**	1.429	.427	1.373	1.488	1.08	.928
Gender : Masc – Fem	.186	.116	1.604	.109	1.204		.959	1.511	1.01	.993
Competition: VNL22 & 23 – JJOO21	.062	.059	.984	.325	1.064		.940	1.204	1.01	.994
Opponent Level (OL): 5 Level	-9.401	.073	-12.850	<.001**	.390		.338	.450	1.11	.903
Competitive Load (CL): High Load – Attenuated Load	.153	.130	1.182	.237	1.166		.904	1.503	1.17	.850
SETp: Tied– Lost– Won	.138	.080	1.731	.083	1.148		.981	1.343	1.19	.835
Predictor	**Estimator**	**EE**	**Z**	**p-value**	**OR**	**R^2_N**	**IC(95%) OR**	**IC(95%) OR**	**Collinearity analysis**	
							Inf	**Sup**	**VIF**	**Tolerance**
Constant	1.342	.239	5.615	<.001**	3.827		2.395	6.114	12.13	.082
SD2ºP	.435	.021	21.082	<.001**	1.545	.631	1.501	1.621	1.14	.876
Gender: Masc – Fem	.272	.137	1.980	.048*	1.313		1.483	1.608	1.01	.994
Competition: VNL22 & 23 – JJOO21	-.070	.074	-.094	.925	.983		.858	1.149	1.00	.994
Opponent Level (OL): Equal-One-Two Level	-.858	.087	-9.869	<.001**	.424		.357	.502	1.17	.885
Competitive Load (CL): High Load – Attenuated Load	1.113	.156	.724	.469	1.119		.825	1.519	1.17	.850
SETp: Tied– Lost– Won	.127	.096	1.326	.185	1.135		.941	1.369	1.19	.835

*Note. Estimators represent the log odds of "Win set = False" vs. "Win set = True"; EE - standard error; Z - Wald value. ; p-value - p-value of the Wald test; OR – Odds ratio; IC 95% OR - confidence intervals for the odds ratio; R2N: R2 de Nagelkerke ; VIF – Variance Inflation Factor (1 / (1 - R^2). Tolerance: Proportion of variance (1/VIF); Significance (bilateral): ** p < .001; * p < .05.*

SD1ºP and SD2ºP
Low standard error (SE) values, such as 0.019, denote precise estimates. Conversely, ORs of 1.455 and 1.558 indicate that larger point margins increase the likelihood of winning a set. The R^2_N of 31.8% y 58.4% respectively, show that these variables are significant in explaining variability in wins.

OL
With a low EE of .065 and an OR of .345, the values indicate that an increase in the opposition level decreases the probability of winning. The R^2_N value of .216, shows that this variable explains 21.6% of the probability of winning the set.

SETp
An OR of 1.239 suggests that winning a set marginally increases the likelihood of winning the next, while the R^2_N of .009 shows that its impact on the overall win is minimal.

A high p-value ($p > .05$) associated with the other variables of Gender, Competition, *OL* and *CL*, suggest that there is no statistically significant relationship with winning a set. Furthermore, an R^2_N of .000 in all instances signifies that they do not contribute to explaining the variability in winning a set.

Multivariate logistic regression
The logistic regression data (see Table 1) reveal that both, *SD 1ºP* and *SD 2ºP models* are significant predictors of winning a set ($p < .001$). The OR values of 1.429 and 1.545 indicate that each additional point increases the likelihood of winning the set by a factor of 1.429 and 1.545, respectively. Moreover, the R^2_N values (.427 for *SD 1ºP* and .631 for *SD 2ºP*) indicate that both models are relevant for predicting set victories, with the *SD 2ºP* explaining a greater variability (63.1%) in the outcomes.

The data showed that the *OL* variable is significant in both periods ($p < .001$), indicating a substantial influence. The *Gender* variable is relevant only in the second period (*SD 2ºP*), with an OR of 1.313. This suggests that male teams are 1.313 times more likely to win sets when starting with an advantage. However, the *Competition* and *CL* variables did not show a significant impact.

Markov chain analysis
Figure 1 illustrates the probabilities of winning or losing a set based on the various combinations of outcomes during each period of the set.

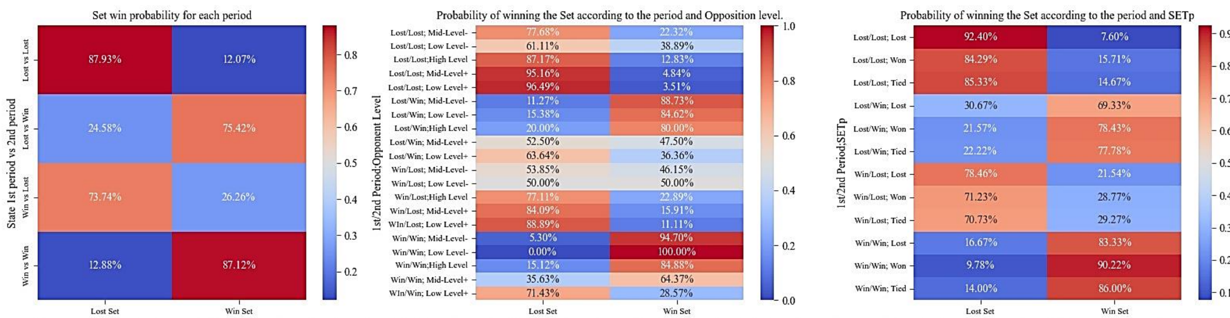
- State 'Lost vs Lost': 87.93% chance of losing the set and 12.07% chance of winning it.
- State 'Lost vs Win': 24.58% chance of losing the set and 75.42% chance of winning it.
- State 'Win vs Lost': 73.74% chance of losing the set and 26,26% chance of winning it.
- State 'Win vs Win': 12.88% chance of losing the set and 87.12% chance of winning it.

Figure 1, Graph 2, shows how the probabilities of winning a set change with the *OL* and *SETp* variables during the *1st period*.

- Victory achieved 100% probability by winning both periods of the set (Win/Win) against an opponent two levels lower (Low level-).
- Winning both periods (Win/Win) and against a lower level opponent (Mid-level-), gives a high probability of 94.70% of winning the set.
- Losing the first period, but winning the second (Lost/Win), against Mid-level- opponents, generates a winning probability of 88.73%, while against Low-level- opponents it is 84.62%.

In Graph 3 of Figure 1, the probabilities of winning a set are shown based on different values of the *OL* and *SETp* variables during the second period.

- The highest probability of losing a set (92.40%) is found when losing both periods of the set (Lost/Lost) and losing the previous set (*SETp*/Lost).
- The greatest probability of winning the set (90.22%) is given by winning both periods of the set (Win/Win) and the previous set (*SETp*/Won).



Note. Note. OL: Opposition level variable; SETp: Result previous set; Lost vs Lost: defeat in both periods of the set; Lost vs Win: defeat in the 1st period of the set and victory in the 2nd period; Win vs Win: victory in both periods of the set; Win vs Lost: victory in the 1st period of the set and defeat in the 2nd period; Low Level-:Opponent two levels lower; Mid-level-:Opponent one level lower; High level: Equal level opponent; Low level+:Opponent two levels higher; Mid-level+:Opponent one level higher; SETp-Lost: previous set lost; SETp-Tied: previous set won, SETp-Tied: no previous set.

Figure 1. Heat maps from the Markov chain transition matrix about the different states.

Table 2 displays the average OL and SETp for both set periods. Competing against higher-level opponents offers merely a 26.52% chance of winning a set, in contrast to a 65.68% probability when facing lower-level adversaries. Against opponents of an equal level (Equal), the chances of victory are balanced. In addition, winning the previous set increases the probability of victory to 53.28%, while losing it reduces it to 45.45%. Therefore, these results show that winning the previous set increases the probability of winning the current set by 7.83% compared to losing it.

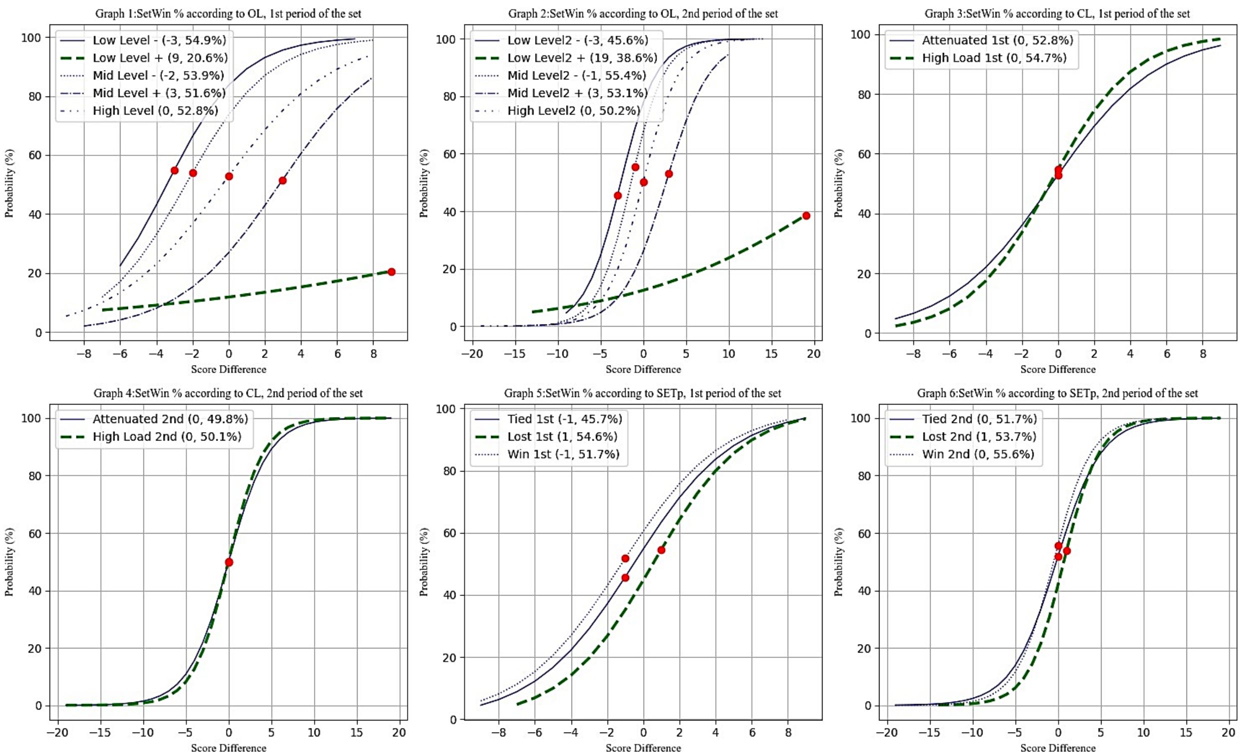
Table 2. Set win probability averages as a function of the outcome in each set period, OL and SETp.

Averages	**Lost Set**	**Win Set**
Gathering by opponent level		
Low Level-	31.62%	68.38%
Mid-level-	37.02%	62.98%
High Level	49.85%	50.15%
Low Level+	80.11%	19.89%
Mid-level+	66.85%	33.15%
Opponent level grouping		
Lower	34.32%	65.68%
Higher	73.48%	26.52%
Equal	49.85%	50.15%
Gathering by SETp		
Lost	54.55%	45.45%
Won	46.72%	53.28%
Tied	48.07%	51.93%

Note. Lower - Includes Low Level- and Mid-Level ; Higher - Includes Low Level+ and Mid-Level+ ; Equal: Includes High Level.

Probability curves

In Figure 2, we complement the heat maps in Figure 1 with curves representing the evolution of the probabilities of winning the set as a function of the score differences in both periods, regarding *OL* level, *CL* and *SETp*. In addition, the values and slopes of these curves for all *score differences*, expressed as a percentage, are presented in Table 3.



Note. OL - Opposition Level; High level: same opposition level; Low level-:opponent two levels lower; Low level+; opponent two levels higher; Mid-level-: opponent one level lower; Mid-level+: opponent one level higher; CL: Competitive Load; Attenuated: Non-decisive sets; High Load - Decisive Sets - SETp - result of the previous sets; Tied - start 0-0 ; Lost - Lost previous set; Won - Won previous set.

Figure 2. Probability curves of how the probability of winning the set varies as a function of the differences in the score in the 1st and 2nd period of the set, opposition level, competitive load and SETp.

Below are the differences in the evolution of the variables across the two periods of the set:

- With regard to the *OL*, the curve indicating competition against significantly weaker opponents (*Low Level-*) shows a marked increase in the likelihood of winning the set based on the score difference. The most significant change in the inflexion points occurs at -3 points. Therefore, reducing the disadvantage to -2 would maximise our possibility of victory. Against weaker teams, starting the *1st period* with a -3 point disadvantage gives a 54.9% chance of winning. However, against *high-level* opponents, achieving a draw (0 points difference) on the scoreboard becomes crucial, maximising the chances of victory, which rise to 45.6% in the *2nd period*.
- During the second period, the curves have a greater slope around the inflexion points, indicating a stronger sensitivity to changes at this point difference. All curves show an inflexion point at a point difference of 0, either in non-decisive (*Attenuated*) or decisive (*High Load*) sets. Under high-load conditions, the likelihood of winning the set marginally increases compared to under attenuated load (52.8% vs. 54.7% in the first period). In short, breaks in the scoreboard maximise the probability of winning in *High Load*.

- Compared to the *SETp*, both curves show a steeper slope in the *2nd period* than in the *1st period*. The inflexion points indicate that a one-point lead in the first period, after losing the previous set, corresponds to a 54.6% probability of winning. This probability decreases to 53.7% in the *2nd period* (Lost 2nd . Holding a 0-point lead (Win 2nd - 0) shows a high 55.6% winning probability, indicating a greater chance of success in keeping the score balanced at the end of the set.

Table 3a. Victory probabilities and slopes by point difference (first period) and opponent level.

	1st set period											
Points	**DifP1ºP**		**Low Level -**		**Low Level +**		**Mid Level -**		**Mid Level +**		**High Level**	
	%	Slope	%	Slope	%	Slope	%	Slope	%	Slope	%	Slope
-19												
-18												
-17												
-16												
-15												
-14												
-13												
-12												
-11												
-10												
-9	3.78%										5.42%	
-8	5.41%	1.95							2.08%		7.39%	2.28
-7	7.68%	2.7			7.49%		11.83%		2.95%	1.04	9.99%	2.99
-6	10.80%	3.65	22.52%		8.01%	0.54	17.15%	6.18	4.15%	1.44	13.37%	3.85
-5	14.98%	4.8	31.90%	10.25	8.56%	0.57	24.20%	7.92	5.83%	1.98	17.68%	4.82
-4	20.41%	6.1	43.02%	11.5	9.15%	0.61	32.99%	9.48	8.11%	2.68	23.01%	5.84
-3	27.18%	7.39	54.89%	**11.61**	9.78%	0.64	43.16%	10.48	11.20%	3.57	29.36%	6.82
-2	35.19%	8.48	66.24%	10.54	10.44%	0.68	53.95%	**10.6**	15.25%	4.62	36.64%	7.61
-1	44.14%	9.15	75.97%	8.68	11.14%	0.72	64.37%	9.82	20.44%	5.79	44.58%	8.09
0	53.49%	**9.23**	83.60%	6.59	11.88%	0.76	73.59%	8.38	26.83%	6.96	52.81%	**8.15**
1	62.60%	8.7	89.15%	4.69	12.67%	0.81	81.12%	6.65	34.36%	7.97	60.89%	7.8
2	70.89%	7.7	92.98%	3.19	13.50%	0.85	86.89%	4.98	42.77%	8.63	68.42%	7.1
3	78.00%	6.43	95.52%	2.1	14.38%	0.9	91.09%	3.57	51.61%	**8.8**	75.08%	6.16
4	83.76%	5.12	97.18%	1.35	15.30%	0.95	94.04%	2.48	60.36%	8.44	80.74%	5.14
5	88.24%	3.93	98.23%	.86	16.27%	0.99	96.05%	1.68	68.49%	7.63	85.36%	4.14
6	91.61%	2.92	98.89%	.54	17.29%	1.04	97.40%	1.13	75.62%	6.55	89.03%	3.25
7	94.08%	2.12	99.31%		18.36%	1.09	98.30%	.74	81.58%	5.36	91.86%	2.49
8	95.86%	1.52			19.47%	**1.14**	98.89%		86.34%		94.01%	
9	97.12%				20.65%							
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												

Note. SD1ºP – Point difference between opponents in the 1st period; SD2ºP - Point difference between rivals in the 2nd period; Equal 1ºP– Point difference in 1st period between opponents of the same level; One Level 1ºP- Point differential in 1st period between opponents with one level of difference; Two Level 1ºP- Point differential in 1st period between rivals with two levels of difference; Equal 2ºP – Point differential in 2nd period between rivals of the same level; One Level 2ºP- Point difference in 2nd period between opponents with one level of difference; Two Level 2ºP- Point differential in 2nd period between opponents with two levels of difference.

Table 3b. Victory probabilities and slopes by point difference (second period) and opponent level.

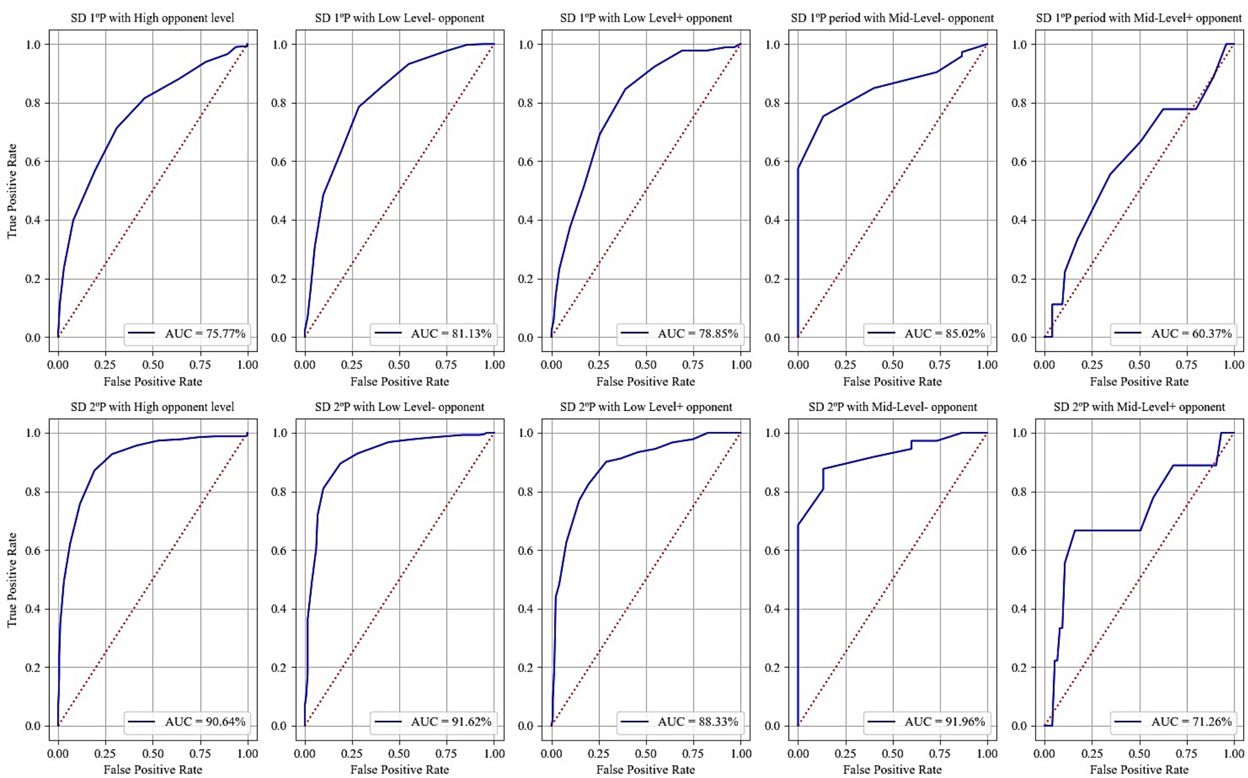
Points	2nd set period											
	DifP2ºP		**Low Level -**		**Low Level +**		**Mid Level -**		**Mid Level +**		**High Level**	
	%	Slope	%	Slope	%	Slope	%	Slope	%	Slope	%	Slope
-19	.02%	.01									.01%	.01
-18	.03%	.02									.02%	.01
-17	.05%	.02									.03%	.02
-16	.08%	.04									.05%	.03
-15	.13%	.06							.10%		.08%	.04
-14	.20%	.09							.14%	.06	.014%	.07
-13	.031%	.14			4.89%				.21%	.08	.022%	.11
-12	.049%	.22			5.27%	.39			.31%	.13	.35%	.17
-11	.075%	.34			5.68%	.42			.46%	.19	.56%	.27
-10	1.17%	.53			6.11%	.45	1.19%		.68%	.27	.89%	.43
-9	1.81%	.81	4.61%		6.57%	.48	1.97%	1.03	1.01%	.4	1.42%	.68
-8	2.79%	1.24	7.22%	3.25	7.07%	.51	3.25%	1.68	1.49%	.59	2.25%	1.07
-7	4.29%	1.86	11.12%	4.77	7.60%	.55	5.33%	2.68	2.18%	.86	3.56%	1.67
-6	6.52%	2.76	16.75%	6.67	8.17%	.59	8.61%	4.15	3.20%	1.24	5.59%	2.56
-5	9.81%	3.98	24.45%	8.74	8.78%	.63	13.63%	6.14	4.67%	1.78	8.68%	3.82
-4	14.49%	5.54	34.23%	10.56	9.42%	.67	20.90%	8.52	6.76%	2.51	13.23%	5.48
-3	20.89%	7.33	45.57%	**11.58**	10.11%	.71	30.67%	10.83	9.70%	3.48	19.64%	7.47
-2	29.15%	9.09	57.38%	11.42	10.84%	.76	42.56%	12.35	13.72%	4.68	28.16%	9.48
-1	39.06%	10.41	68.41%	10.16	11.62%	.8	55.37%	**12.47**	19.06%	6.07	38.61%	11.02
0	49.97%	**10.91**	77.70%	8.22	12.45%	.85	67.50%	11.15	25.85%	7.5	50.21%	**11.6**
1	60.88%	10.42	84.86%	6.16	13.33%	.9	77.67%	8.92	34.05%	8.74	61.80%	10.98
2	70.80%	9.1	90.01%	4.35	14.26%	.96	85.34%	6.52	43.33%	9.53	72.18%	9.41
3	79.07%	7.34	93.55%	2.94	15.24%	1.01	90.70%	4.44	53.10%	**9.66**	80.62%	7.39
4	85.48%	5.55	95.89%	1.93	16.28%	1.07	94.23%	2.89	62.64%	9.09	86.97%	5.42
5	90.17%	3.99	97.40%	1.24	17.37%	1.12	96.47%	1.82	71.29%	7.99	91.46%	3.76
6	93.46%	2.77	98.37%	.79	18.52%	1.18	97.86%	1.12	78.62%	6.6	94.50%	2.52
7	95.70%	1.87	98.98%	.5	19.73%	1.24	98.71%	.68	84.48%	5.17	96.50%	1.65
8	97.20%	1.24	99.36%	.31	21.00%	1.3	99.23%	.41	88.97%	3.89	97.79%	1.06
9	98.18%	.81	99.60%	.19	22.32%	1.36	99.54%	.25	92.27%	2.84	98.61%	.67
10	98.83%	.53	99.75%	.12	23.71%	1.41	99.72%	.15	94.65%		99.13%	.42
11	99.24%	.34	99.85%	.08	25.15%	1.47	99.83%	.09			99.45%	.27
12	99.51%	.22	99.90%	.05	26.65%	1.53	99.90%	.05			99.66%	
13	99.69%	.14	99.94%		28.21%	1.58	99.94%	.03				
14	99.80%	.09			29.82%	1.64	99.96%					
15	99.87%	.06			31.48%	1.69						
16	99.92%	.04			33.19%	1.73						
17	99.95%	.02			34.94%	1.78						
18	99.97%	.02			36.74%	1.82						
19	99.98%	.01			38.58%	**1.84**						

Note. SD1ºP – Point difference between opponents in the 1st period; SD2ºP - Point difference between rivals in the 2nd period; Equal 1ºP– Point difference in 1st period between opponents of the same level; One Level 1ºP- Point differential in 1st period between opponents with one level of difference; Two Level 1ºP- Point differential in 1st period between rivals with two levels of difference; Equal 2ºP – Point differential in 2nd period between rivals of the same level; One Level 2ºP- Point difference in 2nd period between opponents with one level of difference; Two Level 2ºP- Point differential in 2nd period between opponents with two levels of difference.

Effectiveness of models

The ROC curves in Figure 3 evaluate the predictive ability of winning a set, taking into consideration the score difference and the *OL* in the two periods of the set. The area under the curve (AUC), expressed as a percentage, assesses the model's ability to distinguish between wins and losses. The observed results indicate:

- Predictive ability improved significantly in the *2nd period*, reaching an AUC of 90.64%, compared to 75.77% in the first period, both with high-*OL*.
- Influence of the *OL* variable: The predictive ability significantly increases when competing against *low-level-* opponents, with an AUC of 81.13% and 91.62% in the *1st* and *2nd period*, respectively. However, this ability decreases against *mid-level+* opponents, with an AUC of 60.37% and 71.26%, and against *high-level* opponents, with an AUC of 75.77% and 90.64%.
- A significant reduction in probability is observed in the *1st period* when playing against higher-level opponents, from 90.64% to 75.77%.
- The lowest predictability is observed at (*mid-level+*; AUC = 60.37%) when the opponent is ahead in the *1st period*, leading to difficulty in predicting wins in such situations.



Note. AUC - Area under the ROC curve; SD 1°P - Score differences between the teams in the 1st set period; SD 2°P - Score differences between the teams in the 2nd set period.

Figure 3. ROC curves to evaluate predictive capacity for set victory in each period, according to opponent level.

DISCUSSION AND CONCLUSIONS

This study investigates the influence of competitive contextual variables, considered relevant by coaches, on winning sets and matches in high-level competitions.

The study showed that disparity in competitive levels significantly affects the probability of winning a set, especially when teams differ in two competitive levels, explaining 21.6% of the observed variability. A study using data from the European Men's Championship accurately classified set outcomes, won or lost, based on technical performance indicators in 91.1% of cases (Drikos et al., 2021). Several studies have indicated that higher-ranked teams in elite competitions tend to show superior performance in certain technical skills of the game. Thus, Ciemiński (2018) found that the top-ranked teams of both genders at the 2017 European Championships were more effective in serve, set, attack, and block; these outcomes were similar to those presented by Marcelino et al. (2010a) when analysing men's 2007 World Cup matches, reporting higher effectiveness in serve, attack, and block, while Drikos et al. (2021) reported a higher effectiveness of attack after reception and defence, and a higher success rate of break point complex at the 2019 European Men's Championships. Stutzig et al. (2015) found that in men's volleyball at the Olympic Games and in the World League, counterattacks were significantly more successful after defensive plays. This effect was amplified when attacks were carried out at medium and slow speeds. At the Women's Volleyball Club World Championship in 2016, it was observed that winning teams scored more from spikes, blocks, and serves, with fewer errors in reception and defence.

As regards tactical indicators, previous studies rejected the idea that the patterns of play among high-level teams influence their rankings and, consequently, their success in sets (Martins et al., 2021, 2022), while in a study of the Men's World Cup, it was found that teams adapted their tactics based on the level of their opponents (Marcelino et al., 2011).

Another variable that showed an association with set victory was winning the previous set. Although the effect size found was low, it increases the chances of winning the next set by 7.83% (53.28% vs 45.45%). This result does not match the independence between sets found by Marcelino et al. (2009) when analysing men's World League matches in 2005. Thus, based on the results presented in this article, a volleyball match could not be understood as a set of independent microcycles as other studies have suggested (García-de-Alcaraz et al., 2019; Marcelino et al., 2010b).

In relation to match status, winning the set periods established in this study significantly increased the likelihood of winning the set. The model indicates, via R^2_N, that the second period significantly influences the final outcome of the set (1st period R^2_N = 26.9%; 2nd period R^2_N = 54.2%). This phenomenon is often attributed in various sports to a possible psychological advantage, known as "*momentum*" (Den Hartigh & Gernigon, 2018), which seems to enhance the confidence and energy of the leading team (Morgulev et al., 2019). Winning both periods is associated with an 87.12% probability of winning the set. In addition, the level of the opponent influenced the probabilities of winning the set when an advantage was obtained in the periods; the model used showed a 100% probability of victory when a team faced an opponent two levels lower and finished the two established periods of the set with an advantage on the scoreboard.

On the other hand, the results show the relevance of recovery during matches: for instance, a team that rebounds from a loss in the first period and wins the second increases its chances of winning the entire set to 75.42%. Moreover, when the opponent was of a lower level, the likelihood of winning the set increased to 88.73%. In basketball, Martínez (2014) reported that winning the first quarter positively correlates with victory in NBA matches, though the teams' level had a more significant effect on the end result. However, in investigating Spanish men's professional basketball games, Sampaio et al. (2010) noted that teams with larger score deficits at the start of each quarter were more likely to regain points. In women's basketball, a similar effect seemed to occur, with the recovery of points being attributed to changes in the teams' intensity of play, although it was noted that a significant score disparity could lead to a decrease in the trailing team's level of performance (Gomez et al., 2013).

The results showed that larger point differences at the end of each set period, especially at the end of the second period of a set, significantly enhanced the likelihood of winning the set (R^2N *1st period* = 31.8%; R^2N

2nd period = 58.4%). Each additional point increased the likelihood of winning by 1.42% after the 1st period and by 1.54% after the 2nd period. The R^2N values showed higher indicators in both periods for the score difference variable than for the set period variable. This difference indicates that the score difference has greater discriminating power over the set victory. These results could be associated with the findings of Marcelino et al. (2012), who observed that players tended to take more risks at the beginning of a set, aiming to lead the score and widen their advantage quickly.

In conclusion, this research reveals that the variables *opposition level*, *result previous set*, and performance in the *1st* and *2nd period* of the set, together with the *score differences* in the *1st* and *2nd period*, showed an association with victory in volleyball sets. In contrast, *competition*, and the *round* and *competitive load* variables showed no relationship. These findings represent a significant advance in the understanding of the contextual variables associated with winning in high-level competitive sets. Additionally, this study supports the validity of the opinions of expert volleyball coaches on variables that obtained significance (López-Serrano et al., 2022).

A limitation of this research is that the impact of the studied variables on the performance of individual game actions has not been evaluated, which could represent a future area of research. It might be particularly interesting to examine how the variables of this study influence success in sets across training and elite categories.

AUTHOR CONTRIBUTIONS

Conceived investigation idea: López-Serrano, C. & Molina, J.J. Conceived and planned the observation: López-Serrano, C., Molina, J.J, Sánchez Morillas, P. & Hernández González, C. Performed the observation: Sánchez Morillas, P. & Hernández González, C. Interpretation of the results: López-Serrano, C., López, E. Wrote the manuscript: López-Serrano, C., López, E., Molina, J.J.

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