

Winning patterns and predictive modeling in FIFA World Cup 2022: Analysis of spatial, temporal, goal-scoring trends, and tactical indicators

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Abstract:

Despite the increasing use of performance analytics in football, few studies have integrated spatial duel patterns with situational and technical indicators when examining match outcomes. This study analyzed all 48 group-stage matches of the FIFA World Cup 2022, comprising 96 team performances. Key variables included duel patterns by pitch zone, ball possession, passing, defensive pressure, ball progression, and goal-related indicators. Winning teams scored significantly more goals ($p < 0.001$), produced more shots (attempts) on target ($p = 0.002$), and completed more ball progressions with borderline statistical significance ($p = 0.050$) than drawing or losing teams, whereas total possession and most defensive indicators did not differ significantly by outcome. Duel patterns showed strong negative correlations between duels in the defensive and middle thirds and ball possession ($r_s = -0.793$ to -0.532 , $p \leq 0.001$), while duels in the inner attacking third were positively associated with possession ($r_s = 0.220$, $p \leq 0.05$). No significant associations were found between duel location and goals scored. Additionally, 64.2% of goals were scored in the second half, with the highest proportion occurring in the final 15 minutes, and scoring the first goal was significantly associated with winning ($p \leq 0.001$). A binomial logistic regression model identified shots (attempts) on target, received shots (attempts) on target, second balls, ball progressions, total blocks, and possession percentage as significant predictors of match outcome (win vs. draw/loss). The model achieved 82.3% accuracy and excellent discrimination ($AUC = 0.909$). These findings suggest that success in elite international football may be determined by a multifactorial interaction of offensive efficiency, territorial progression, spatial duel distribution, and key situational factors such as scoring first and goal timing.

Key Words: match outcome prediction; performance indicators; spatial duel patterns; logistic regression; offensive efficiency; situational variables

Introduction

Evolution of Performance Analysis and Match Success in Football

Football engages millions across various roles, including players, coaches, referees, and officials (FIFA, 2007; Haynes & Boyle, 2017). In recent decades, the emergence of sophisticated technologies and performance-tracking tools has transformed the analysis of football matches (Dellal et al., 2011; Plakias et al., 2023). While early assessments relied primarily on notational methods (Drust et al., 2007), contemporary semi-automated systems offer a greater level of detail in examining technical and physical aspects, particularly in differentiating possession and non-possession phases (Carling et al., 2008; Plakias et al., 2024). Historically, performance paradigms in football have evolved from direct strategies, such as rapid ball transition into offensive zones (Bate, 2013), to more possession-based approaches. Current research emphasizes the role of sustained possession in fostering goal-scoring opportunities (Araya & Larkin, 2013; Clemente, 2012; Collet, 2013; Hughes & Franks, 2005). However, possession alone does not account for competitive success; instead, multifactorial models incorporating spatial occupation, duel success, and tactical cohesion better capture match outcomes.

Several studies have examined the relationship between performance indicators and match success across major championships, including the FIFA World Cup, the UEFA European Championship, the UEFA Champions League and national leagues (Acar et al., 2008; Castellano et al., 2012; Chmura et al., 2025; Gürkan et al., 2017; Kapsalis et al., 2023; Kubayi & Larkin, 2022; Liu et al., 2015; Michailidis et al., 2013; Vantarakis & Stafylidis, 2023; Yiannakos & Armatas, 2006). Such studies consistently demonstrate that football success is determined by a complex interplay of factors rather than any single variable (De França et al., 2024; Iván-Baragaño et al., 2024; Lepschy et al., 2021; Soroka et al., 2023). For example, shots on target, pass accuracy, and duel efficiency frequently emerge as key metrics associated with positive outcomes (De França et al., 2024; Iván-Baragaño et al., 2024; Lepschy et al., 2021; Soroka et al., 2023). However, large-scale empirical analyses

specifically focused on elite-level international tournaments are still limited and require continuous updating, as performance trends in football evolve over time.

Role of Duels in Football Performance

The role of duels, both defensive and offensive, has been widely examined, with evidence indicating that duel success, particularly in central and attacking zones, is closely associated with improved chance creation, shooting accuracy, and ultimately goal conversion (Soroka et al., 2023; Stafylidis et al., 2024a; Stafylidis et al., 2024b; Szwarc, 2004; Szwarc et al., 2017). However, duel performance should not be interpreted in isolation, as it is closely linked to spatial awareness, technical precision, and tactical execution (Bekris et al., 2020; Gioldasis et al., 2022; Ispyrilidis et al., 2024; Konefał et al., 2019; Mohammed, 2016). For instance, lower technical error rates in duels and greater passing efficiency have been observed in more successful teams. In addition, teams demonstrating higher shot accuracy, goal conversion, and passing volume consistently outperform their opponents (Castellano et al., 2012; Clemente, 2012; Janković et al., 2011). Spatial and temporal analyses further indicate that early-match duel success in midfield zones may serve as a predictor of overall match outcome (Szwarc et al., 2017). Finally, duel involvement varies by playing position, with midfielders and defenders typically engaging more frequently and with greater intensity (Ispyrilidis et al., 2020; Mitrotasios et al., 2021; Mitrotasios et al., 2024).

Defensive Behavior and Tactical Adaptation

Defensive behavior plays a key role in performance modeling. Analyses of World Cup matches indicate that recovery patterns, tackle timing, and pressing zones vary by team and opponent ranking, influencing match dynamics and outcomes (Fernandes et al., 2019; Fernandes et al., 2020). Similarly, predictive models based on Poisson and regression techniques highlight the significant contribution of specific indicators, such as counterattack goals, aerial duels, and defensive errors, to win probability (Groll et al., 2015; Lepschy et al., 2021; Liu et al., 2015). A recurring theme across studies is the importance of adapting tactical styles to match contexts. Teams that demonstrate flexibility in transitioning between high-possession and direct-play strategies tend to perform better in knockout tournaments (De França et al., 2024; Iván-Baragaño et al., 2024). For example, successful teams in the 2018 and 2022 FIFA World Cups exhibited dynamic combinations of ball circulation, high pressing, and space compression, whereas less successful teams relied more heavily on long balls and static defensive structures (Kubayi & Larkin, 2022; Soroka et al., 2023).

Temporal Patterns and Predictors of Success

Time-dependent patterns such as goal distribution provide valuable insights. Empirical evidence confirms that a substantial proportion of goals are scored in the final 15 minutes of the matches, reflecting intensified offensive efforts and defensive fatigue (Biswas & Bandyopadhyay, 2018). Similarly, the significance of scoring the first goal has been well documented, with such teams increasing their chances of winning regardless of duel distribution across zones (Janković et al., 2011; Kubayi & Larkin, 2022).

Szwarc et al. (2017) investigated the effectiveness of 1v1 duels in relation to pitch zones and match timing, analyzing data from World Cup and European Championship knockout matches, and reported that duel success, particularly in the early stages of a match and in midfield areas, was significantly higher among winning teams. Comparable findings were reported by Castellano et al. (2012), who analyzed World Cups from 2002 to 2010 and identified goals scored, shots on target, and ball possession as key indicators of success. Janković et al. (2011) further demonstrated that winning teams in the 2010 World Cup exhibited superior attacking success, ball possession, and passing accuracy. These findings align with earlier work (Grant et al., 1999; Szwarc, 2004), highlighting the importance of efficient shooting and tactical organization. Clemente (2012) reinforced these observations, demonstrating that successful teams emphasized open-play goals and midfield passing, thereby strengthening the link between tactical structure and performance.

In addition, predictive modeling approaches have been used to identify determinants of match outcomes. Liu et al. (2015) employed generalized linear models and identified 24 predictors, among which shots on target, possession, and counterattacks were the most influential, whereas red cards and blocked shots had a negative impact. Biswas and Bandyopadhyay (2018) further examined goal-scoring patterns in the 2018 World Cup, identifying temporal trends and significant correlations among shots, yellow cards, and scoring intervals. Kubayi and Larkin (2022) compared advancing and eliminated teams from the 2018 World Cup group stage, identifying accurate passing, counterattacks, and set-piece efficiency as key determinants of progression. Recent studies have expanded this perspective by exploring strategic diversity and tactical adaptation. De França et al. (2024) applied k-means clustering to the 2022 tournament, identifying three distinct playing styles and confirming that flexibility and tactical adaptation enhance success. Lepschy et al. (2021), using logistic regression, identified defensive errors and counterattack goals as critical predictors, while discounting the relevance of possession or team value. Similarly, Iván-Baragaño et al. (2024) identified 12 key indicators of progression in World Cup 2022, including high defensive lines, space compression, and rapid defensive transitions. Soroka et al. (2023), using OPTA data, compared high- and low-possession teams, demonstrating that while high possession is associated with offensive superiority, low-possession teams exhibit greater defensive resilience. Collectively, these findings emphasize the dual importance of possession strategies and defensive organization in determining match outcomes.

Research Gap and Study Aim

Collectively, this body of literature underscored the multifactorial nature of football success at the World Cup level. Indicators such as duel effectiveness, shot accuracy, passing metrics, tactical flexibility, and defensive transitions repeatedly emerge as significant predictors of performance. Despite these insights, an important research gap remains: most existing studies have focused on isolated performance indicators or narrow tactical dimensions. There is limited evidence that integrates spatial duel patterns across different pitch zones with a broader multivariate performance model that reflects the complex interactions determining match outcomes in elite football. This gap highlights the need for comprehensive analyses that simultaneously account for duels and key performance indicators in predicting success at the World Cup level.

In light of this gap, the primary objective of the present study was to provide a more comprehensive understanding of performance determinants in elite football. Specifically, this study examined both spatial duel patterns (defensive, middle, and attacking thirds) and key performance indicators, including goals scored, shots on target, ball possession, and ball progression. The aim was to identify the variables most strongly associated with match outcomes at the highest level of competition. To address this objective, the following hypotheses were formulated: (1) winning teams would exhibit significantly superior performance across key indicators compared to drawing and losing teams; (2) duels in all pitch zones would be significantly associated with performance variables, such as ball possession; (3) duels in the attacking third would have a stronger positive influence on offensive actions and goal scoring than duels in other zones; (4) the majority of goals would occur in the second half, particularly in the final 15 minutes; (5) scoring the first goal would significantly increase the probability of winning, regardless of duel distribution across zones; and (6) a predictive model would significantly improve the classification accuracy of match outcomes (win vs. draw/loss), with key performance indicators contributing meaningfully to win probability.

Material & Methods

Sample

The present study analyzed 96 team performances ($N = 96$) derived from 48 group-stage matches of the FIFA World Cup 2022. This stage of the tournament involved 32 national teams divided into eight groups of four teams each. Matches from the knockout phase were excluded from the analysis, as some included extra time, which could have affected data comparability. The study focused on 96 match performances, categorized as wins ($n = 38$), draws ($n = 20$), and losses ($n = 38$), to examine differences in performance indicators and the impact of scoring the first goal on match outcome. For the temporal analysis of goal scoring, all goals scored during regular time and referee-awarded additional time (0'–90', including stoppage time) were analyzed.

Data Collection and Analysis

The data collection and analysis process was conducted between November 20, 2022, and December 31, 2023. During this period, matches from the group stage of the FIFA World Cup 2022 were closely observed. The study followed a retrospective observational, non-interventional design. The data were derived from analysis and official statistical indicators provided by the FIFA Training Centre (<https://www.fifatrainingcentre.com>). The validity and reliability of the TRACAB Gen5 multi-camera optical tracking system, as used in the FIFA Training Centre platform, have been confirmed and supported through its application in previous peer-reviewed studies and systematic reviews of tracking technologies in elite football (Song et al., 2024; Yang et al., 2024; Castellano et al., 2014). Data collection, categorization, and analysis were carried out by the researcher, a certified UEFA B football coach with a specialization in football performance analysis. Comparable studies have also used official FIFA data to analyze team performance, such as Clemente's (2012) research on the 2010 World Cup, the study by Biswas and Bandyopadhyay (2018) on the 2018 World Cup, and the recent work by Huang et al. (2024). Other researchers have relied on external platforms such as Whoscored and Kicker to evaluate team success in World Cups, including the study by Lepschy et al. (2021) on the 2018 tournament, and by Moura et al. (2015) for the UEFA Euro 2012.

The statistical data and performance indicators obtained from the official FIFA website (Post Match Summary Reports) included variables such as duel locations, goals, shots, passes, ball possession, and other metrics related to performance in the defensive, middle, and attacking thirds of the field. To analyze duel-related performance, the football pitch was divided into three longitudinal zones: the defensive third, the middle third, and the attacking third. This spatial segmentation followed the methodological framework proposed by Fernández-Navarro et al. (2016) and was operationalised using visual data extracted from official FIFA World Cup match reports and pressure maps. Specifically, representations of defensive pressure metrics, defined as any intentional action by a defending player or group of players aimed at constraining the ball carrier's options, accelerating ball recovery, or disrupting the opponent's build-up play, as obtained from the FIFA digital performance platform, were used to manually code and categorize duels based on their field location. Each duel instance was assigned to one of the three thirds of the pitch, facilitating subsequent statistical analysis of positional trends in relation to match outcome and performance indicators. Furthermore, entries into the final third were operationalised as instances in which the ball was successfully advanced beyond the opponent's midfield line into the attacking third through controlled passes or dribbling, whereas ball progression referred to

the successful advancement of the ball through opponents' defensive lines toward the attacking third, thereby contributing to territorial gain and offensive momentum. Intra-rater reliability for duel occurrence categorization was assessed using the intra-class correlation coefficient (ICC, two-way mixed model, absolute agreement), with coefficients exceeding 0.90, indicating excellent consistency.

Statistical Analysis

The statistical analysis of the data was conducted using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA), and correlation heatmaps were generated using JASP Version 0.19.3.0 for Windows (JASP Team, Amsterdam, The Netherlands) and Jamovi Version 2.6 (The Jamovi Project, Sydney, Australia). Descriptive statistics included the calculation of means (M), standard deviations (SD), and frequencies for all variables. The influence of the first goal scored on match outcomes and differences in goal-scoring timing were assessed using chi-square (χ^2) tests. Normality was assessed using the Shapiro–Wilk test, with parametric tests applied to normally distributed variables and non-parametric tests used when the assumption of normality was violated. Specifically, differences among winning, losing, and drawing teams across match performance indicators were examined using the Kruskal–Wallis H test for variables that did not meet the assumption of normality. For variables that were normally distributed, as determined by the Shapiro–Wilk test, one-way analysis of variance (ANOVA) was applied. This methodological approach aligns with established practices in performance analysis research (Stafylidis et al., 2024a; Stafylidis et al., 2024b; Harrop & Nevill, 2014), where ANOVA/Kruskal–Wallis tests and binomial logistic regression have been successfully applied in parallel. Effect sizes for Kruskal–Wallis tests were estimated using epsilon squared (ϵ^2) and interpreted as negligible (<0.01), small ($0.01–0.08$), medium ($0.08–0.26$), or large (>0.26) effects (Cohen, 1988). For ANOVA, effect sizes were reported using partial eta squared (η_p^2) and interpreted as small ($0.01 \leq \eta_p^2 < 0.06$), medium ($0.06 \leq \eta_p^2 < 0.14$), and large ($\eta_p^2 \geq 0.14$), based on conventions proposed by Cohen (1988) and Richardson (2011). Spearman's (r_s) rank-order correlation analyses were conducted to explore associations between various performance indicators (e.g., duels in different zones in relation to ball possession).

To identify predictors of match outcome, a binomial logistic regression was conducted using a forward stepwise (Wald) selection method. Model selection was initially performed in IBM SPSS Statistics (Version 29.0) using a forward stepwise (Wald) procedure. The final model (M_8), including the selected predictors, was subsequently re-estimated in Jamovi (Version 2.6), where parameter estimates, standard errors, Z statistics, and confidence intervals were obtained. The dependent variable was match outcome, coded as 0 = loss/draw and 1 = win, with loss/draw (0) set as the reference category. Independent variables included a range of offensive, defensive, and transitional match performance indicators. At each step, predictors were added if they significantly improved model fit, as determined by the likelihood ratio test ($\Delta\chi^2$), changes in model deviance, and reductions in the Akaike Information Criterion (AIC). Model performance was assessed using McFadden's pseudo- R^2 , classification metrics (accuracy, sensitivity, specificity), and the area under the receiver operating characteristic (ROC) curve (AUC), with a cut-off value of 0.5. Log-odds coefficients and odds ratios were computed for all predictors, along with standard errors, Z statistics, p-values, and 95% confidence intervals. Prior to analysis, continuous predictors were screened for linearity with the logit function, and multicollinearity diagnostics were performed to ensure the stability of estimates. The final model (M_8) included Possession Total (%), Attempts at Goal on Target, Received Attempts at Goal on Target, Second Balls, Ball Progressions, Completed Line Breaks, Blocks Total, and Duels Total. Statistical significance was set at $p \leq 0.05$.

Results

Key Performance Indicators by Match Outcome

The results of the statistical analyses examining team performance in relation to match outcomes (win, draw, or loss) are presented in Table 1. Winning teams scored significantly more goals ($M = 2.29$) than both drawing ($M = 0.60$) and losing teams ($M = 0.55$), as indicated by the Kruskal–Wallis H test ($p < 0.001$, $ES = 0.488$). They also recorded a higher number of shots on target ($M = 5.08$) compared to the other groups ($p = 0.002$, $ES = 0.132$) and demonstrated more ball progressions, with a borderline statistically significant difference ($p = 0.050$, $ES = 0.062$). By contrast, total ball possession did not significantly differ among winning, drawing, and losing teams (ANOVA, $p = 0.919$). Although winning teams forced more turnovers through defensive pressure, the difference was not statistically significant (ANOVA, $p = 0.083$). Similarly, although winning teams completed more line breaks, these differences were not statistically significant for either completed line breaks ($p = 0.839$) or defensive line breaks ($p = 0.080$; see Table 1).

Table 1. Match Statistics (Key Performance Indicators).

Variable	Win (n = 38)	Draw (n = 20)	Loss (n = 38)	Test Statistic	p	ES
	M ± SD	M ± SD	M ± SD			
Ball Possession Total %	43.8 ± 13.8	44.5 ± 8.53	45.0 ± 12.8	F=0.0849	.919	.002
Goals	2.29 ± 1.31	0.60 ± 0.94	0.55 ± 0.72	H=46.4042	.001*	.488
Attempts at Goal	12.53 ± 6.74	9.55 ± 3.47	10.08 ± 5.39	H=2.8966	.235	.030
Attempts on Target	5.08 ± 2.84	2.90 ± 2.05	3.03 ± 2.07	H=12.6167	.002*	.132
Total Passes	481.84 ± 192.17	485.80 ± 104.85	489.97 ± 155.82	H=0.8529	.653	.008

Variable	Win (n = 38) M ± SD	Draw (n = 20) M ± SD	Loss (n = 38) M ± SD	Test Statistic	p	ES
Total Passes Complete	414.26 ± 195.50	411.80 ± 108.43	416.53 ± 155.22	H=0.4864	.784	.005
Pass Completion Percent	83.76 ± 7.18	83.80 ± 4.89	83.71 ± 5.62	H=0.1497	.928	.001
Completed Line Breaks	96.00 ± 32.95	92.40 ± 22.83	89.61 ± 25.47	H=0.3521	.839	.003
Defensive Line Breaks	10.95 ± 5.64	9.70 ± 4.55	8.61 ± 5.94	H=5.0613	.080	.053
Receptions in Final Third	99.11 ± 30.90	92.45 ± 20.51	93.95 ± 29.18	H=1.2154	.545	.012
Crosses	18.26 ± 7.98	18.25 ± 7.23	18.03 ± 8.17	H=0.0237	.988	.000
Ball Progressions	22.63 ± 8.26	18.10 ± 6.37	19.26 ± 7.10	H=5.9713	.050 [†]	.062
Defensive Pressures Applied	291.11 ± 90.01	280.65 ± 55.51	279.13 ± 89.86	H=0.4006	.818	.004
Defensive Pressures (Direct Pressures)	48.34 ± 12.26	48.75 ± 10.41	46.21 ± 11.52	F=0.448	.640	.010
Second Balls	65.40 ± 12.27	67.15 ± 7.71	66.61 ± 12.64	F=0.180	.836	.004
Total Distance Covered (km)	113.52 ± 5.23	113.51 ± 5.74	112.07 ± 5.40	F=0.822	.443	.017
High Speed Distance Covered (km)	14.84 ± 1.59	15.48 ± 2.11	14.82 ± 1.64	F=1.13	.327	.024

Note: M±SD – Mean±Standard Deviation, H – Kruskal–Wallis H statistic, F – ANOVA statistic, p – p-value, ES – Effect Size.

*Win ≠ Loss (p ≤ .05) | [†]Win ≠ Draw (p ≤ .05)

Directional Distribution of Defensive Pressure by Pitch Zone

Table 2 presents the results for the direction of defensive pressures and actions applied in the defensive, middle, and attacking thirds (final thirds). No statistically significant differences were found between winning, drawing, and losing teams for any variable (all p > 0.05). This included pressures in outer, inner, neutral, and rear (from behind) positions across all thirds of the pitch. The only variable approaching significance was rear pressures in the attacking third (H = 5.11, p = 0.078, ES = 0.053), but this did not reach the statistical threshold.

Table 2. Direction of Defensive Pressures and Actions in the Defensive, Middle, and Attacking Thirds.

Variable	Win (n = 38) M ± SD	Draw (n = 20) M ± SD	Loss (n = 38) M ± SD	Test Statistic	p	ES
Defensive Third Shown Outside	53.45 ± 28.16	48.50 ± 16.61	53.79 ± 27.07	H=0.2893	.865	.003
Defensive Third Shown Inside	10.74 ± 6.24	8.75 ± 4.54	11.24 ± 7.48	H=1.2162	.544	.012
Defensive Third Neutral	6.21 ± 4.76	6.25 ± 3.45	6.37 ± 5.00	H=0.2517	.882	.002
Defensive Third From Behind	14.76 ± 7.61	14.20 ± 4.10	14.21 ± 6.65	H=0.1176	.943	.001
Middle Third Shown Outside	76.82 ± 27.31	73.60 ± 21.46	70.68 ± 26.86	H=0.7205	.697	.007
Middle Third Shown Inside	26.39 ± 7.79	24.75 ± 8.35	24.39 ± 10.14	H=1.2751	.529	.013
Middle Third Neutral	13.45 ± 6.48	11.30 ± 3.36	11.08 ± 6.98	H=2.9273	.231	.030
Middle Third From Behind	27.24 ± 8.51	26.40 ± 7.79	25.66 ± 7.72	F=0.365	.695	.008
Final Third Shown Outside	23.18 ± 10.54	29.55 ± 15.04	25.87 ± 13.61	H=2.5152	.284	.026
Final Third Shown Inside	10.50 ± 5.07	10.75 ± 6.66	9.92 ± 4.74	H=0.1413	.932	.001
Final Third Neutral	3.50 ± 2.02	4.30 ± 2.56	3.26 ± 2.42	H=2.5963	.273	.027
Final Third From Behind	9.55 ± 5.32	9.60 ± 4.10	7.53 ± 3.98	H=5.1076	.078	.053

Note: M±SD – Mean±Standard Deviation, H – Kruskal–Wallis H statistic, F – ANOVA statistic, p – p-value, ES – Effect Size.

Defensive Actions and Ball Recoveries

The statistical analyses of defensive actions and ball recoveries by teams, categorized by match outcome (win, draw, or loss), are presented in Table 3. Teams that drew regained possession more frequently (M = 49.70) than both winning and losing teams, but this difference, examined with the Kruskal–Wallis H test, was not statistically significant (H = 4.44, p = 0.109, ES = 0.046). Two defensive indicators showed statistically significant differences across match outcomes. Total blocks differed significantly (ANOVA: F = 3.24, p = 0.044, ES = 0.065), with post hoc tests indicating no pairwise differences at the adjusted significance level. Blocked passes also differed significantly (ANOVA: F = 5.38, p = 0.006, ES = 0.104), with Tukey's post hoc tests revealing that losing teams recorded fewer blocked passes than both winning teams (p = 0.021) and drawing teams (p = 0.017).

Table 3. Defensive Actions and Ball Recoveries.

Variable	Win (n = 38) M ± SD	Draw (n = 20) M ± SD	Loss (n = 38) M ± SD	Test Statistic	p	ES
Forced Turnovers	72.16 ± 10.94	71.45 ± 13.00	66.03 ± 13.68	F=2.56	.083	.052
Possession Regained	47.16 ± 9.78	49.70 ± 7.18	45.66 ± 7.56	H=4.4357	.109	.046
Interceptions	7.61 ± 2.92	7.60 ± 2.76	7.08 ± 2.71	H=0.5991	.741	.006
Tackles	32.40 ± 10.95	30.25 ± 7.52	32.42 ± 8.99	H=1.0729	.585	.011
Possession Actions / Defensive Action	5.23 ± 3.79	4.61 ± 1.16	5.06 ± 3.00	H=0.331	.848	.003
Blocks (Total)	23.82 ± 6.43	24.50 ± 4.56	20.92 ± 6.14	F=3.24	.044	.065

Variable	Win (n = 38) Draw (n = 20) Loss (n = 38)			Test Statistic	p	ES
	M ± SD	M ± SD	M ± SD			
Blocks - Passes	17.53 ± 5.28	18.05 ± 4.63	14.47 ± 4.25	F=5.38	.006*	.104
Blocks - Attempts at Goal	1.84 ± 1.82	1.75 ± 1.59	1.95 ± 1.99	H=0.0289	.986	.000
Blocks - Crosses	3.32 ± 2.09	3.85 ± 2.52	3.24 ± 2.39	H=0.6691	.716	.007
Clearances	0.95 ± 1.01	0.85 ± 0.75	1.26 ± 1.29	H=1.2769	.528	.013
Duels (Total)	50.42 ± 13.18	53.70 ± 11.73	50.55 ± 13.00	H=1.8548	.396	.019
Physical Duels	3.97 ± 2.50	3.80 ± 1.44	3.97 ± 2.50	H=0.0213	.989	.000
Aerial Duels	37.74 ± 11.59	40.05 ± 11.30	37.82 ± 11.34	H=1.9373	.380	.020
Other Duels	9.97 ± 9.05	9.85 ± 2.80	10.00 ± 8.71	H=2.7238	.256	.028

Note: M±SD – Mean±Standard Deviation, H – Kruskal–Wallis H statistic, F – ANOVA statistic, p – p-value, ES – Effect Size.

*Win ≠ Loss (p ≤ .05) | ‡ Loss ≠ Draw (p ≤ .05)

Defensive Pressure Characteristics and Ball Recovery Metrics

Table 4 presents the defensive pressures applied by teams during the matches, categorized by match outcome (win, draw, or loss). Winning teams applied slightly more total pressures (M = 291.11) than drawing (M = 280.65) and losing teams (M = 279.13); however, this difference, examined using the Kruskal–Wallis H test, was not statistically significant (H = 0.40, p = 0.818, ES = 0.004). Direct pressures were assessed with one-way ANOVA and did not differ significantly between groups (F = 0.45, p = 0.640, ES = 0.010). The average pressure duration was also similar across groups (ANOVA: F = 0.84, p = 0.433, ES = 0.018). Forced turnovers, reported in both this table and Table 3, were higher for winning teams but the difference was not statistically significant (ANOVA: F = 2.56, p = 0.083, ES = 0.052). Ball recovery time did not vary significantly between outcomes (Kruskal–Wallis: H = 0.23, p = 0.892, ES = 0.002). Likewise, the application of pressure in higher zones of the pitch (“Pushing On into Pressing” and total “Pushing On”) showed no significant differences (p = 0.947 and p = 0.994, respectively). The directional tendencies of pressing, either toward the inside or the outside of the field, were also comparable among winning, drawing, and losing teams (p = 0.467 and p = 0.989, respectively), showing that, within this dataset, the volume, duration, and spatial characteristics of defensive pressures were not distinguishing factors between match outcomes.

Table 4. Defensive Pressure.

Variable	Win (n = 38) Draw (n = 20) Loss (n = 38)			Test Statistic	p	ES
	M ± SD	M ± SD	M ± SD			
Total Pressures	291.11 ± 90.01	280.65 ± 55.51	279.13 ± 89.86	H=0.4006	.818	.004
Direct Pressures	48.34 ± 12.26	48.75 ± 10.41	46.21 ± 11.52	F=0.448	.640	.010
Avg Pressure Duration	1.47 ± 0.15	1.47 ± 0.10	1.50 ± 0.13	F=0.844	.433	.018
Forced Turnovers	72.16 ± 10.94	71.45 ± 13.00	66.03 ± 13.68	F=2.56	.083	.052
Ball Recovery Time	12.17 ± 4.01	11.57 ± 1.92	12.12 ± 4.57	H=0.2290	.892	.002
Pushing On into Pressing	144.39 ± 54.89	140.90 ± 31.97	139.95 ± 53.15	H=0.1099	.947	.001
Pushing On	345.61 ± 115.12	332.20 ± 72.46	340.68 ± 121.84	H=0.0121	.994	.000
Pressing Direction Inside	48.45 ± 11.63	45.30 ± 12.90	46.32 ± 16.41	H=1.5223	.467	.016
Pressing Direction Outside	165.21 ± 65.34	161.50 ± 39.06	161.84 ± 57.97	H=0.0213	.989	.000

Note: M±SD – Mean±Standard Deviation, H – Kruskal–Wallis H statistic, F – ANOVA statistic, p – p-value, ES – Effect Size.

Player Movement Patterns and Supportive Off-the-Ball Actions

No significant differences emerged from the analysis of player positioning, specifically regarding the frequency of offers to receive, defined as clear movements by a player to create a passing option for the ball carrier by adjusting their position to support possession, either by dropping, moving laterally, or advancing into space, across different thirds of the pitch (Table 5). These indicators are included within the broader category of supportive off-the-ball actions, as they reflect the players’ efforts to facilitate ball progression, maintain team structure, and enhance passing options during possession phases, which may suggest that the frequency of such supportive movements did not vary meaningfully between winning, drawing, and losing teams.

Table 5. Player Movements: Positional Analysis of Supportive Off-the-Ball Actions (Offers to Receive).

Variable	Win (n = 38) Draw (n = 20) Loss (n = 38)			Test Statistic	p	ES
	M ± SD	M ± SD	M ± SD			
Total Offers Made	558.5 ± 205.7	554.9 ± 105.1	563.4 ± 176.2	H=0.2160	.898	.002
Total Offers Received	203.4 ± 94.4	198.2 ± 48.0	198.3 ± 75.8	H=0.1040	.949	.001
Offers in Final Third	208.5 ± 93.8	191.2 ± 53.0	207.5 ± 91.1	H=0.1424	.931	.001
Offers in Middle Third	252.2 ± 111.4	257.8 ± 64.6	260.7 ± 88.0	H=0.7706	.680	.008
Offers in Defensive Third	97.9 ± 39.9	106.0 ± 31.1	95.3 ± 27.3	H=1.4319	.489	.015

Note: M±SD – Mean±Standard Deviation, H – Kruskal–Wallis H statistic, p – p-value, ES – Effect Size.

Correlations Between Duels, Goals, and Ball Possession

Table 6 presents the correlations between duels across pitch zones, goals scored, and ball possession percentage. Specifically, duels in the defensive third, showed strong negative correlations with ball possession, with the strongest association observed in the outer defensive zone ($r_s = -0.793$, $p \leq 0.001$). Similarly, negative correlations were observed in the inner and neutral areas of the defensive third, with values of $r_s = -0.609$ and $r_s = -0.602$, respectively ($p \leq 0.001$). In the middle third, duels in the outer area were negatively correlated with ball possession ($r_s = -0.724$, $p \leq 0.001$), with similar negative correlations observed in the inner ($r_s = -0.532$, $p \leq 0.001$) and neutral areas ($r_s = -0.584$, $p \leq 0.001$). In the attacking (final) third, only duels in the inner area were positively correlated with ball possession ($r_s = 0.220$, $p \leq 0.05$), whereas duels in the outer and neutral zones were not significantly associated with ball possession. Overall, duels in the defensive and middle thirds demonstrated strong negative correlations with ball possession, whereas those in the attacking third showed a weak positive correlation. No significant correlations were found between duels and goals scored (Table 6 and Figure 1).

Table 6. Spearman's Correlation Coefficients (r_s) Between Duels, Goals Scored, and Ball Possession Percentage.

Variable	Goals Scored	Ball Possession Total %
Ball Possession Total %	0.037	
Defensive Third Shown Outside	-0.065	-0.793 ***
Defensive Third Shown Inside	-0.036	-0.609 ***
Defensive Third Neutral	-0.095	-0.602 ***
Defensive Third From Behind	-0.056	-0.585 ***
Middle Third Shown Outside	-0.048	-0.724 ***
Middle Third Shown Inside	-0.016	-0.532 ***
Middle Third Neutral	0.055	-0.584 ***
Middle Third From Behind	0.027	-0.325 **
Final Third Shown Outside	-0.116	0.078
Final Third Shown Inside	0.017	0.220 *
Final Third Neutral	-0.107	0.070
Final Third From Behind	0.081	0.196

*** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$

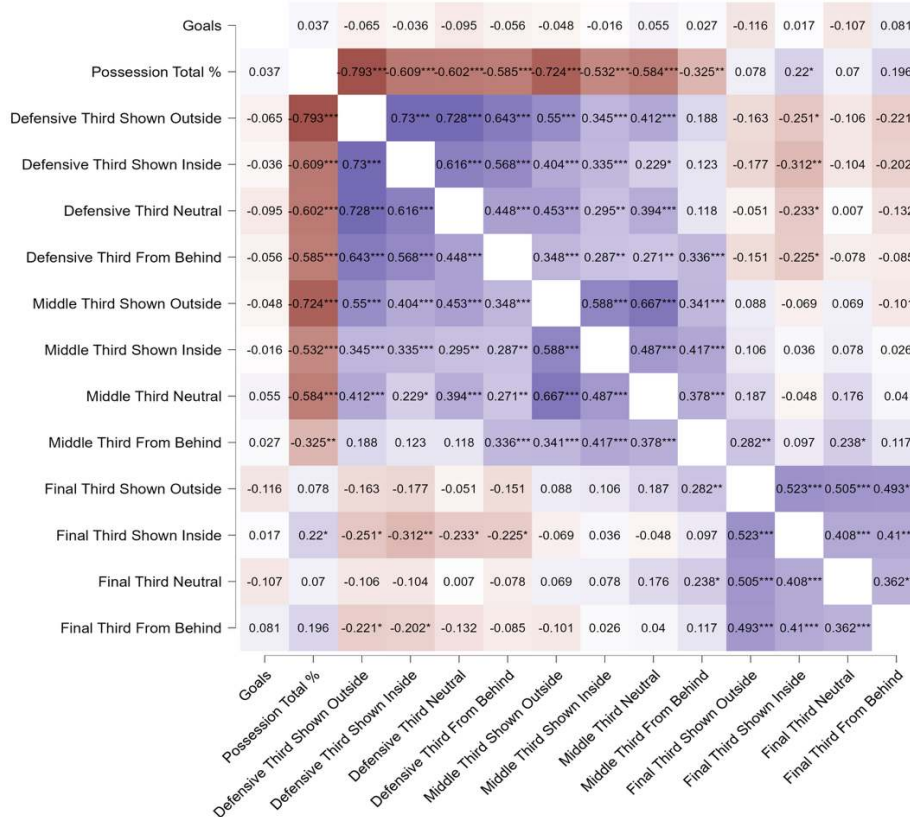


Figure 1. Spearman's rho (r_s) Correlation Heatmap of Duels, Goals Scored, and Ball Possession Percentage.

Note: Positive correlations are shown in deep purple and negative correlations in red; colour intensity reflects correlation strength.

*** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$.

Goal Distribution Across Match Periods

The analyses in this subsection examined all goals scored during regular time and referee-awarded stoppage time (0'–90'). Goal distribution was evaluated both by half and by 15-minute intervals (Table 7 and Figure 2). A Chi-squared (χ^2) test was conducted to assess the distribution of goals between the first and second halves, as well as their distribution across 15-minute segments within a match. The first test revealed a statistically significant difference in the distribution of goals between the two halves, $\chi^2(1) = 9.63$, $p = 0.002$, with a higher proportion of goals scored in the second half (64.2%) compared to the first half (35.8%). A second Chi-squared (χ^2) test examined the distribution of goals scored across 15-minute match intervals, normalized within each half. In the first half, goal frequency increased steadily, culminating in 51% of first-half goals occurring in the 30'–45' interval. Similarly, the second half demonstrated a concentration of goals in its final stages, with 40% of second-half goals scored between the 75th and 90th minute. These descriptive patterns reflect the influence of accumulated match intensity, tactical adjustments, and increased urgency as the match approaches full time, supporting the notion that later stages of each half are more prolific in terms of scoring opportunities. Lastly, scoring the first goal was significantly associated with match outcome, indicating a higher likelihood of winning for teams that scored first.

Table 7. Summary of Chi-Squared (χ^2) Tests for Goal Distribution by Half, 15-Minute Match Intervals, and the Impact of the First Goal on Match Outcome.

Variable	χ^2	p
Goal Scoring by Half	9.63	.002 **
Goal Scoring in 15-Minute Intervals	16.8	.005 **
Impact of Scoring the First Goal on Final Outcome	24.5	.001 ***

*** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$

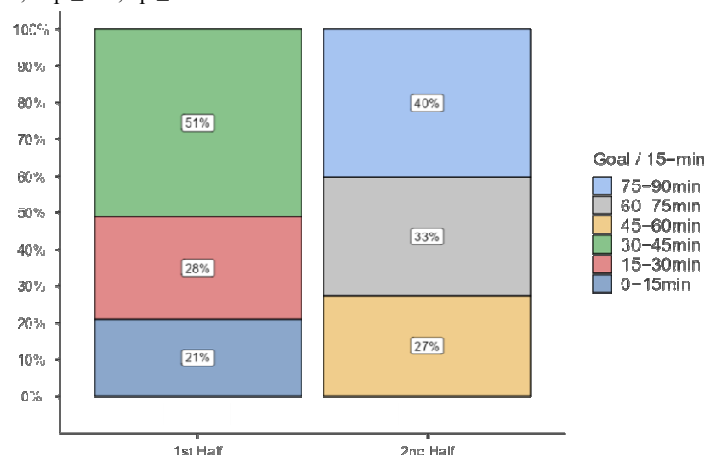


Figure 2. Percentage distribution of goals scored across 15-minute intervals within each match half during regulation time in the FIFA World Cup 2022 (0'–90', including stoppage time).

Note: The figure presents the relative distribution of goals within each half, with percentages normalized to sum to 100% separately for the first half and second half. In the first half, goals were distributed as follows: 0–15 min (21%), 15–30 min (28%), and 30–45 min (51%). In the second half, goals were distributed as follows: 45–60 min (27%), 60–75 min (33%), and 75–90 min (40%). Across all matches, the overall goal distribution by 15-minute intervals was: 0–15 min (7.5%), 15–30 min (10.0%), 30–45 min (18.3%), 45–60 min (17.5%), 60–75 min (20.8%), and 75–90 min (25.8%). Overall, 35.8% of goals were scored in the first half and 64.2% in the second half.

Predictive Model of Match Outcome

A binomial logistic regression analysis (Table 8) was conducted to examine the association between selected performance indicators and match outcome (winning vs. non-winning outcomes [draw/loss]). The overall model was statistically significant, $\chi^2(8) = 57.9$, $p < 0.001$, indicating that the set of predictors reliably distinguished between winning and non-winning outcomes. The final model demonstrated a good fit to the data, with a model deviance of 71.0 and an AIC of 89.0. McFadden's pseudo- R^2 was 0.449, suggesting that approximately 45% of the variance in match outcome was explained by the model. Table 8 presents the model coefficients and odds ratios for each predictor. Attempts at Goal on Target (OR = 2.13, $p < 0.001$), Received Attempts at Goal on Target (OR = 0.45, $p < 0.001$), Second Balls (OR = 0.86, $p < 0.001$), Ball Progressions (OR = 1.16, $p = .007$), and Blocks Total (OR = 1.18, $p = .021$) were statistically significant predictors. Ball Possession Total % was negatively associated with winning (OR = 0.85, $p = .005$). Completed Line Breaks ($p = 0.072$) showed a non-significant trend, whereas Duels Total ($p = 0.128$) was also not significantly associated with match outcome. Collinearity diagnostics revealed that variance inflation factors (VIFs) for all predictors were below the conventional threshold of 10, indicating no serious multicollinearity issues. The highest VIF was observed for Possession Total % (VIF = 5.36), which remains within an acceptable range. Classification performance of the

model was high, with an overall accuracy of 82.3%. The model correctly classified 84.5% of draw/loss outcomes and 78.9% of wins. ROC analysis yielded an AUC of 0.909, indicating excellent discriminatory ability of the model in distinguishing between winning and non-winning outcomes (Figure 3).

Table 8. Binomial Logistic Regression Predicting Match Outcome (Win vs. Draw/Loss)

Predictor	B	SE	Z	p	OR	95% CI (Lower)	95% CI (Upper)
Intercept	3.56	2.79	1.28	.202	35.22	0.15	8371.42
Ball Possession Total %	-0.17	0.06	-2.82	.005**	0.85	0.76	0.95
Attempts at Goal on Target	0.76	0.19	3.96	.001***	2.13	1.47	3.10
Received Attempts at Goal on Target	-0.81	0.22	-3.67	.001***	0.45	0.29	0.69
Second Balls	-0.15	0.04	-3.40	.001***	0.86	0.79	0.94
Ball Progressions	0.15	0.06	2.69	.007**	1.16	1.04	1.30
Completed Line Breaks	0.04	0.02	1.80	.072	1.04	1.00	1.09
Blocks Total	0.16	0.07	2.32	.021*	1.18	1.03	1.35
Duels Total	0.05	0.03	1.52	.128	1.05	0.99	1.11

Note: OR = Odds Ratio. CI = Confidence Interval. Match Outcome: 0 = draw/loss; 1 = win. *Model statistics:* $N = 96$; $AIC = 89.0$; $McFadden's R^2 = .449$; $AUC = .909$; $accuracy = 82.3\%$.

*** $p \leq .001$, ** $p \leq .01$, * $p \leq .05$

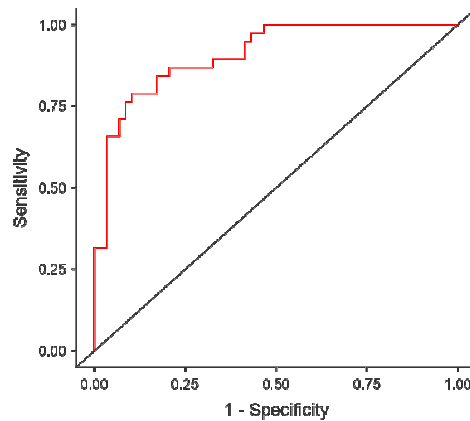


Figure 3. Receiver Operating Characteristic (ROC) Curve for the Binomial Logistic Regression Model.

Note: The ROC curve illustrates the model's ability to discriminate between winning (1) and non-winning (0 = draw/loss) match outcomes. The area under the curve (AUC) is 0.909, indicating excellent classification performance. The red curve represents the sensitivity-specificity trade-off across thresholds, while the diagonal line represents a model with no discrimination (AUC = 0.50).

Discussion

This study examined duel patterns, key performance indicators, goal distribution, and match outcome prediction during the FIFA World Cup 2022. The main findings showed that winning teams scored more goals, produced more shots on target, and completed more ball progressions than drawing or losing teams, whereas ball possession and most defensive pressure variables did not differ significantly by outcome. In addition, duels in the defensive and middle thirds were negatively correlated with ball possession, while only inner-area duels in the attacking third were positively associated with ball possession. Goal-scoring analysis further showed that most goals were scored in the second half, particularly in the final 15 minutes, and that scoring the first goal was significantly associated with winning. Finally, the logistic regression model identified offensive and defensive indicators, including shots on target, received shots on target, ball progressions, second balls, blocks, and possession percentage, as significant predictors of match outcome.

Key Performance Indicators and Match Success

The first hypothesis, suggesting superior performance in key indicators among winning teams, was largely confirmed by the results. Specifically, winning teams recorded significantly more goals ($M = 2.29$) than drawing ($M = 0.60$) and losing teams ($M = 0.55$) and also achieved more shots on target ($p = 0.002$). These findings reinforced the notion that offensive accuracy and the ability to capitalize on scoring opportunities are crucial for success. The lack of a significant difference in ball possession ($p = 0.919$) may be attributed to strategic game management, with winning teams focusing on exploiting specific moments rather than maintaining possession throughout. This aligned with previous research (Castellano et al., 2012; Kubayi & Larkin, 2022), which emphasized efficiency over possession as a more critical determinant of performance. However, winning teams performed more ball progressions ($p = 0.050$), reaching borderline statistical significance, supporting the hypothesis that effective advancement into attacking zones is related to success. This finding is supported by studies such as those by Clemente (2012) and Soroka et al. (2023), which have shown that progressive movement and penetration into attacking areas are strongly linked to the creation of scoring opportunities and overall team performance.

Duels Across Pitch Zones and Ball Possession

The second hypothesis, concerning the correlation between duels in different pitch zones and ball possession, was also supported. Duels in the defensive third demonstrated a significant negative correlation with ball possession ($r_s = -0.793$), suggesting that teams frequently engaged in duels within their own defensive zones tend to have lower ball possession. This observation is consistent with earlier studies indicating that successful ball retention reduces the necessity for duels in the defensive zone while facilitating more effective game control (Kubayi & Larkin, 2022; Soroka et al., 2023). In the middle third, negative correlations were also evident, with duels in the outer areas showing significant negative relationship with ball possession ($r_s = -0.724$). This likely reflects the importance of controlling space in the midfield, as teams that lose possession in this area are often forced into more duels, thereby reducing overall ball retention. These results are in agreement with Stafylidis et al. (2024b), who highlighted that teams with higher possession levels tend to engage in fewer duels in both the defensive and middle thirds.

The third hypothesis, predicting a stronger positive impact of attacking-third duels on goal scoring and offensive actions, was partially supported. Duels in the inner attacking third showed a significant positive correlation with ball possession ($r_s = 0.220$), suggesting that possession in this zone is linked to increased duel frequency. However, these duels did not significantly correlate with the number of goals scored. This implied that while duels in the attacking third contribute to sustained possession and offensive potential, they do not directly determine goal outcomes. These findings align with the study by Szwarc et al. (2017), which found that while duels in the attacking third facilitate chance creation, defensive duels are often more decisive for match outcomes. The link between attacking possession and duel frequency appears to enhance offensive efficiency, although it is not sufficient on its own to guarantee scoring success. Recovering possession higher up the pitch, while maintaining balanced positioning and adopting an intense approach, seems to be a recommended strategy (Freitas et al., 2023).

Goal Distribution and the Importance of Scoring the First Goal

The fourth hypothesis, that more goals are scored in the second half was confirmed. The results showed that 64.2% of all goals were scored in the second half, with a notably higher proportion in the final 15 minutes (25.8% goals). This supports the view that teams intensify offensive efforts towards the end of matches in an attempt to influence the final outcome, a finding supported by previous research (Alberti et al., 2013; Armatas et al., 2007; Biswas & Bandyopadhyay, 2018; Stafylidis et al., 2022; Stafylidis et al., 2024b; Stafylidis et al., 2024c). The increased offensive activity in the final stages of play reflects the tactical urgency to either overturn or secure the scoreline. Importantly, this trend may also be influenced by psychological parameters, such as mental fatigue, which can impair performance parameters (Staiano et al., 2025) and soccer-related skills (Smith et al., 2017), like decision-making and defensive organization, thereby increasing vulnerability to conceding goals during the closing moments of a match. Whereas Greve et al. (2020) mentioned that goals scored right before halftime are also critical, Stafylidis et al. (2024c) report that higher-ranked teams scored significantly more goals during both halves. Our results extend these findings by highlighting that, at the World Cup level, the majority of goals occurred during the final 15 minutes of play, underscoring the decisive influence of late-match phases in international tournaments.

The fifth hypothesis, concerning the impact of scoring the first goal on the likelihood of winning, was also confirmed with statistically significant results. Teams that scored first had a considerably higher probability of winning the match. This finding is consistent with Janković et al. (2011), who showed that scoring the first goal allowed teams to control the match tempo. Similar conclusions were drawn by more recent studies (Stafylidis et al., 2022; Stafylidis et al., 2024a). Further reinforcing this pattern, recent studies for the FIFA Club World Cup 2025 (Stafylidis et al., 2025) showed that teams scoring the first goal were also significantly more likely to secure victory, with only a small proportion of such matches ending in draws or losses.

Physical Performance, Running Demands, and Load Management

Recent evidence suggests that reductions in total distance and high-intensity running during specific five-minute intervals are significantly associated with goal concessions in elite football, underscoring the importance of pacing strategies and real-time physical monitoring for coaching decisions (Chmura et al., 2025). Notably, position-specific analyses from UEFA Champions League matches have demonstrated that physical performance varies according to match outcome, with offensive players (e.g., wingers and forwards) covering greater high-intensity running distances in winning matches, whereas defensive players (e.g., central defenders and fullbacks) exhibit higher demands in losing matches (Modric et al., 2025). Additionally, findings on positional physiological-load relationships emphasize the need for individualized load management across positions, which may also impact performance sustainability during critical late-match phases (Vardakis et al., 2024).

In the present study, total distance covered did not differ significantly between winning (113.52 ± 5.23 km), drawing (113.51 ± 5.74 km), and losing teams (112.07 ± 5.40 km) during the FIFA World Cup 2022. High-speed running distance also showed no statistically significant differences across outcomes (Win: 14.84 ± 1.59 km; Draw: 15.48 ± 2.11 km; Lose: 14.82 ± 1.64 km). These findings suggest that, although total and high-speed distances are general indicators of physical output, they may not be decisive in determining match outcomes at

the highest competitive level. This aligns with previous research in UEFA Euro 2024, where winning teams exhibited slightly higher distances without reaching statistical significance (Stafylidis et al., 2024a). However, these aggregated metrics should be interpreted with caution, as they may not reflect match-defining moments or overall performance quality. Our findings confirm that 64.2% of all goals were scored in the second half, as mentioned above, with a notable 25.8% of goals occurring during the final 15 minutes. This supports the hypothesis that offensive efforts intensify toward the end of matches (Greve et al., 2020), as mentioned above, often driven by tactical urgency and psychological pressure. While the current study did not directly examine the relationship between physical output and goal timing, the observed goal distribution highlights the need to evaluate performance within temporal segments rather than using whole-match metrics.

Predictive Modeling of Match Outcomes

The sixth hypothesis posited that a predictive model incorporating selected performance indicators would significantly enhance the classification accuracy of match outcomes (win vs. draw/loss) during the FIFA World Cup 2022. The results of the binomial logistic regression analysis supported this hypothesis, offering significant insights into the performance variables most associated with success. Notably, shots on target emerged as the strongest positive predictor of winning, reaffirming previous findings from both the UEFA Euro 2024 (Stafylidis et al., 2024a) and the FIFA Club World Cup 2025 (Stafylidis et al., 2025), which emphasized the decisive role of shooting efficiency. Similarly, in the UEFA Euro 2024 dataset, each additional shot on target more than doubled the odds of winning ($OR = 2.13$), confirming the decisive role of goal-directed offensive actions (Stafylidis et al., 2024a).

Defensive indicators were equally significant. Specifically, conceded shots on target negatively predicted match success, highlighting the value of defensive stability. This outcome aligns with findings from the 2014 and 2018 FIFA World Cups, where Lepschy et al. (2021) identified defensive errors and inefficiencies as primary determinants of defeat. Similarly, total defensive blocks were positively associated with winning, reflecting the importance of disrupting opposition attacks, a point supported by Iván-Baragaño et al. (2024) in their analysis of technical-tactical performance in the FIFA World Cup 2022. Interestingly, second ball recoveries demonstrated a significant negative association with winning. This may suggest that lower-performing teams engaged more in reactive, unstructured phases of play, indicative of tactical instability. While this finding has received limited direct attention in prior literature, it aligns indirectly with De França et al. (2024), who noted that less successful teams in the FIFA World Cup 2022 often adopted less structured, more direct playing styles, relying heavily on defensive set-pieces and long passes.

Ball progressions also contributed significantly to match success, underlining the importance of territorial advancement and offensive build-up. This finding resonates with the work of De França et al. (2024), who identified progressive passing, player movement, and penetration as hallmarks of high-performing teams in the 2022 World Cup. Contrary to traditional beliefs, possession percentage exhibited a significant negative relationship with winning. This challenges the long-standing narrative of possession dominance as a proxy for control and superiority. Supporting this perspective, Soroka et al. (2023) demonstrated that while teams with high ball possession in the 2022 World Cup were more effective in advanced zones, possession alone did not guarantee success. Instead, sterile possession, unaccompanied by offensive penetration, may reflect tactical inefficiency. This is further validated by ROC curve results from the 2025 FIFA Club World Cup (Stafylidis et al., 2025), which showed limited predictive power of possession-related indicators when not combined with attacking outputs.

Variables such as completed line breaks and total duels approached, but did not reach, statistical significance. Despite this, their contextual value cannot be disregarded. In tournaments such as the 2014 and 2018 FIFA World Cups, Lepschy et al. (2021) emphasized the importance of dueling success and attacking transitions, particularly counterattacks, as key to unlocking compact defenses.

The predictive model in the present study achieved a classification accuracy, correctly identifying over 82% of match outcomes and yielding an AUC of 0.909, showing higher classification performance than previous models from both national and club-level tournaments. For instance, the final model in the 2025 FIFA Club World Cup achieved 80.2% accuracy and an AUC of 0.85 (Stafylidis et al., 2025), while in the UEFA EURO 2024, accuracy reached 80.6% (Stafylidis et al., 2024a). These findings highlight the enhanced discriminative capacity of the current model, particularly due to its incorporation of indicators related to transition play, shooting precision, and defensive effectiveness. In conclusion, the findings suggest that match success in elite football, particularly at international level, depends not solely on possession or isolated metrics, but rather on a complex interplay of offensive precision, defensive proactivity, and transitional effectiveness. As emphasized by De França et al. (2024), successful teams demonstrate not only technical and physical superiority, but also the tactical flexibility to adapt their styles to match contexts, a crucial element for success in global tournaments such as the FIFA World Cup 2022.

Practical Implications

Collectively, all the findings offer important practical implications for coaches, analysts, and practitioners working at the elite level of international football. First, the strong association between match success and offensive indicators, such as goals scored, shots on target, and ball progressions, underscored the

necessity of designing training sessions and tactical plans that prioritize offensive efficiency. Teams should allocate significant preparation time to improve chance creation, shooting accuracy, and effective progression of play beyond opposition lines. Importantly, the lack of significant differences in total ball possession across outcomes suggested that possession dominance alone is insufficient for securing victory; thus, coaches may benefit from focusing on purposeful possession that leads to clear scoring opportunities rather than maintaining possession for its own sake. Furthermore, although defensive pressure metrics and duel frequency did not significantly differentiate between winning, drawing, and losing teams, the observed spatial patterns of duels, particularly the strong negative correlations between duels in the defensive and middle thirds and ball possession, underscore the importance of controlling duels in advanced areas of the pitch. Specifically, teams should aim to initiate and win duels in the attacking third, as these were weakly but positively associated with possession and may contribute to sustained attacking phases. Finally, the clear link between goal timing and match outcomes, most notably the critical importance of goals scored in the final 15 minutes of the game and the significant advantage gained by scoring first, emphasized the need for strategies that maintain offensive intensity late in matches and prioritize early goal-scoring efforts. These insights should inform match preparation, in-game decision making, and player conditioning programs designed to sustain performance under pressure.

Building on these insights, the results from the binomial logistic regression and ROC analysis further enhance the practical application of performance data in elite football environments. For coaches and analysts, the fact that each additional shot on target more than doubles the odds of winning ($OR = 2.13$) reinforces the importance of constructing attacking patterns that consistently result in on-target finishes. Simultaneously, reducing received attempts on target ($OR = 0.45$) must be a defensive priority, calling for compact defensive structures and minimizing central penetration. Strength and conditioning coaches should place emphasis on repeated high-intensity actions such as ball progressions and blocking, which were both positively associated with winning outcomes, indicating the value of conditioning players for sustained, explosive efforts. The negative association of second ball recoveries with success ($OR = 0.86$) suggests that reliance on unstructured or reactive play may be detrimental; thus, technical sessions should emphasize clean first-ball control and minimizing turnover scenarios. Coaches are also encouraged to de-emphasize sterile possession ($OR = 0.85$) and instead promote purposeful ball retention aimed at progressing play into advanced areas. With an AUC of 0.909 and classification accuracy of 82.3%, the model provides a highly reliable reference for performance benchmarks, allowing staff to set match targets (e.g., ≥ 4 shots on target, ≤ 2 conceded) and evaluate execution accordingly. These results empower practitioners to apply data-driven thresholds to tactical planning, real-time monitoring, and post-match review processes.

Limitations

Despite the valuable insights generated by this study, certain limitations should be acknowledged. Firstly, not all matches of the FIFA World Cup 2022 were included in the analysis, as originally intended. Specifically, matches from the knockout stage were excluded, as in previous studies (Liu et al., 2015; Stafylidis et al., 2024a), due to the presence of extra time in several of them, which could have substantially influenced performance indicators and biased the comparability of data. This decision was made to maintain consistency in match duration and ensure comparability of data across the analyzed matches. As a result, the findings may not be generalizable to the entire tournament, given that the knockout stage presents distinct tactical, technical, and temporal dynamics. Although this exclusion enhanced comparability by ensuring a consistent match duration and avoiding the variability associated with extra time, it also limited the scope of the analysis. Knockout-stage matches, particularly those involving extra time, could exhibit different patterns in goal distribution, duels, and other key performance indicators due to the additional minutes of play and the heightened tactical demands. Although similar studies have adopted this exclusion criterion to enhance comparability across matches of standard duration, future research might consider alternative methodologies to account for the contribution of extra-time periods to match dynamics and performance indicators.

Another important limitation concerns the lack of consideration for team formations and tactical systems. The study did not account for the specific formations used by each team, which could significantly influence spatial occupation, pressing strategies, and duel frequency in different thirds of the pitch. Since formations play a crucial role in shaping team behavior and individual responsibilities, their absence from the analysis may have limited the interpretative depth regarding tactical variation. Future studies should consider integrating formation-related variables to provide a more comprehensive understanding of how tactical structure interacts with performance indicators. In addition, the application of multiple statistical analyses may increase the risk of Type I error, and therefore the results should be interpreted with appropriate caution.

Future Research Directions

Future research could expand on these findings by exploring similar performance dynamics across different competitions, leagues, or levels of play, including comparative analyses between national team tournaments, such as the FIFA World Cup, and international club competitions, such as the FIFA Club World Cup. Such comparisons could reveal differences in tactical patterns, technical demands, and contextual influences across club and national football. Moreover, future studies could investigate the role of contextual factors such as opponent quality, match location, or environmental conditions. To obtain a more comprehensive

understanding of tournament formats, future studies should examine both the group and knockout phases, as performance under elimination pressure in the latter may differ significantly from the dynamics observed in the group stage. Lastly, longitudinal analyses may further help assess how these indicators evolve over time and inform the development of predictive models for match outcomes and player development.

Conclusions

The present study provides a comprehensive, data-driven examination of the performance indicators associated with match outcome in elite football, offering both theoretical clarification and applied insight. The findings demonstrate that winning teams are primarily distinguished by offensive efficiency rather than by traditional volume-based metrics. Specifically, winning teams scored more goals and produced more shots on target than drawing and losing teams, whereas variables such as total possession, passing volume, and pass completion did not differentiate outcomes. These results reinforce the view that possession alone is not a decisive indicator of success unless it is transformed into high-quality offensive output. Accordingly, the ability to convert possession phases into goal-scoring opportunities, while simultaneously limiting the opponent's shots on target, emerges as a central determinant of success at the elite level.

A key contribution of the study lies in identifying ball progression as a functional link between possession and attacking effectiveness. Winning teams achieved higher values in ball progression, and this variable remained a significant predictor in the multivariable model. This finding suggests that purposeful advancement of play, characterized by verticality, penetration, and spatial exploitation, is a more meaningful indicator of attacking quality than non-threatening ball circulation. From a defensive perspective, the results indicate that success is related more to the effectiveness of defensive actions than to their overall volume. Total blocks emerged as a significant predictor of match outcome, highlighting the importance of disrupting opposition attacks and reducing the quality of final actions, whereas broader defensive pressure metrics did not distinguish successful from unsuccessful teams.

The study also extends current literature through a spatial and temporal interpretation of performance. Duel distribution across pitch zones was strongly associated with possession dynamics, with more frequent duels in the defensive and middle thirds corresponding to lower possession levels, while duels in central attacking areas showed a weak positive association with possession. Although duels were not directly associated with goal scoring, they appear to reflect territorial contest and match flow. In addition, goals were scored more frequently in the second half, particularly in the final 15 minutes, and scoring the first goal was strongly associated with winning. These findings underline the importance of match-state dynamics, tactical adaptation, and performance sustainability during decisive phases of play.

From a practical perspective, the findings suggest that coaches, analysts, and practitioners should prioritize the development of attacking efficiency, particularly the creation and conversion of shots on target; structured ball progression into advanced areas; and defensive organization aimed at limiting opponents' shooting opportunities and increasing effective blocking actions. Furthermore, the results emphasize the need to prepare teams for critical match moments, especially late-game periods and tactical transitions following the first goal. Overall, the study supports a shift from volume-based indicators toward efficiency-, context-, and interaction-based metrics in the evaluation of elite football performance. In this respect, its main contribution is to show that success in World Cup football is best understood not through isolated statistics, but through the combined influence of offensive precision, territorial progression, defensive effectiveness, and temporal match dynamics.

Generative AI Statement - The authors declare that no artificial intelligence (AI) tools were used in the collection, analysis, or interpretation of the data. All scientific content, study design, statistical analyses, and interpretation of results were performed solely by the authors. AI-assisted tools were used exclusively for language editing purposes, including improving linguistic clarity and checking grammar and spelling during manuscript preparation. The authors reviewed and edited the content after using these tools and take full responsibility for the final version of the manuscript.

Conflicts of interest - No conflicts of interest.

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