ORIGINAL ARTICLE

Defensive behaviour against crosses in elite football: Spatial constraints, crossing characteristics, and tactical defensive adaptations (2022–2023)

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ABSTRACT

This study investigated the defensive behaviours adopted by the top five teams in the English, Spanish, and German leagues during the 2023–2024 season against crosses delivered into the penalty area. The analysis focused on three variables: (1) the crosser's dominant leg, (2) ball trajectory, and (3) defensive behaviour type. A total of 1,428 opposition crosses were examined using frequency and percentage analyses, while relationships between variables were assessed through Crosstabs and the chi-square (χ^2) test. The findings revealed that the crosser's leg significantly influenced defensive outcomes within the 11–5.5 m delivery zone ($p < .05$). Defensive failure rates were substantially higher for opposite-foot crosses (31.3%) than for same-side-foot crosses (13.9%). Ball trajectory also demonstrated a significant effect on defensive success in the LS: 5.5–0 m zone ($p < .05$). High-curved crosses generated the highest defensive failure rate (19.7%), whereas penetrating or cut-back passes resulted in the lowest failure rate (3.8%). Although the defensive behaviour type did not produce a statistically significant overall effect, frequency analysis indicated that the "*Opposite Diagonal*" defensive approach yielded the lowest failure rate (6.8%) compared with "*Zone Defence*" (15.2%).
Keywords: performance analysis; ball trajectory; types of defence; crosses.

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INTRODUCTION

In modern football, performance optimisation is a central objective for coaches and performance staff, requiring a systematic understanding of tactical, technical, physical, and psychological components of performance (Weineck, 1992; Dost et al., 2015; Owen, 2022). Within this context, match performance analysis has become an essential tool for evaluating team behaviour, identifying opponent tendencies, and informing training design and match preparation processes (Salvo et al., 2015).

Contemporary performance analysis increasingly focuses on the structural organisation of match phases, commonly conceptualised through the cycle of play: defensive organisation, offensive organisation, and transitional phases. Within this framework, game models reflect context-dependent tactical interpretations shaped by competitive constraints and coaching decisions (Bordonau et al., 2019). These micro-interactions can be better understood through a constraints-led and ecological dynamics perspective, where behaviour emerges from task and environmental constraints.

Among these micro-interactions, attacking actions into the penalty area—particularly crosses—represent decisive events in goal-scoring sequences. Empirical evidence consistently demonstrates the importance of crossing situations in goal creation across elite competitions. For instance, Breen et al. (2006) reported that a substantial proportion of goals are preceded by passing and crossing actions, with approximately 70% of goals in the 2006 FIFA World Cup involving such sequences. Similarly, Pulling et al. (2018) identified 1,332 open-play crosses during the 2014 FIFA World Cup, resulting in 42 goals (3.2% conversion rate), highlighting both the frequency and limited efficiency of these actions.

Further research has examined cross typologies and their effectiveness. Mitrotasios et al. (2022) found that in-swinging, out-swinging, and straight crosses differ in their contribution to goal-scoring opportunities during the 2018 FIFA World Cup. In addition, spatial distribution analyses indicate that most goals following crosses are scored within the central penalty area, particularly between the penalty spot and the goal area (Jacquet et al., 2002; Kyranoudis et al., 2024). These findings suggest that both delivery characteristics and spatial context are key determinants of attacking success.

From a defensive perspective, existing research has primarily focused on pressure applied to the crosser rather than defensive organisation inside the penalty area. For example, Pulling et al. (2018) reported that medium (48.0%) and high pressure (42.9%) were the most frequently applied defensive pressures during crossing situations, while low pressure occurred less frequently (9.1%). Although these findings highlight the importance of the initial defensive action, they provide limited insight into how defensive line behaviour within the penalty area influences outcome effectiveness.

Despite the growing body of literature on crossing and goal-scoring dynamics, a notable gap remains in understanding collective defensive organisation inside the penalty area during crossing situations at the elite competitive level. Specifically, the interaction between cross characteristics, spatial delivery zones, and defensive structural responses remains underexplored as a coupled dynamic system in elite football.

Therefore, the aim of this study was to examine how spatial constraints, crossing characteristics, and defensive organisational structures interact to shape defensive effectiveness against crosses in elite football. The study specifically investigates how these interacting constraints influence defensive outcomes in relation to:

- Crosser foot dominance,

- Ball trajectory type,
- Defensive organisational structure inside the penalty area.

By integrating these variables, the study seeks to provide a more mechanistic understanding of defensive success against crosses in elite football.

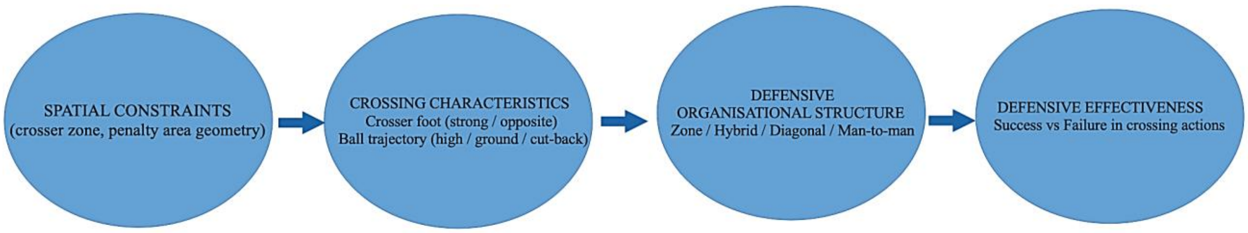


Figure 1. Conceptual framework of the study.

MATERIAL AND METHODS

Research sample

The sample consisted of the top five teams from the 2022/2023 season in three of Europe's elite leagues:

- Premier League: Manchester City, Arsenal FC, Manchester United, Newcastle United, Liverpool FC.
- La Liga: FC Barcelona, Real Madrid, Atletico de Madrid, Real Sociedad, Villarreal CF.
- Bundesliga: FC Bayern Munich, Borussia Dortmund, RB Leipzig, FC Union Berlin, SC Freiburg.

These teams were selected based on their status as the highest-performing clubs within their respective national leagues. Their consistent competitive success ensured a high standard of both attacking and defensive actions, with an expectation of advanced tactical organization, particularly in defensive phases.

The study employed a cross-sectional observational design and analysed 60 matches, comprising 1,428 defensive sequences, to assess the tactical behaviour of the defensive line during crosses into the penalty area. A defensive sequence was defined as the phase of play following loss of possession and lasting until possession was regained, the ball exited the penalty area, or play was interrupted.

Inclusion and exclusion criteria

Sequences were selected according to specific inclusion criteria:

- They occurred during full-time or extra-time periods of play.
- Only open-play defensive sequences were considered.
- Sequences were analysed using video recordings to ensure precise and reliable identification of all variables under examination.

Exclusion criteria included:

- Defensive actions resulting from set-piece situations or any subsequent developments.
- Sequences following penalty kicks, including actions after goalkeeper saves from penalties.
- Any defensive sequences that resulted in goal-scoring opportunities which were later deemed irregular according to the Laws of the Game (e.g., offsides or fouls).

This methodological approach ensured that the analysis was focused exclusively on defensive actions occurring during open play. By doing so, the study aimed to provide an accurate and objective measure of the tactical defensive effectiveness demonstrated by elite teams competing at the highest level of professional football.

Procedures

Data collection was conducted using the Wyscout® platform (Genoa, Italy) by selecting video footage that recorded all offensive actions performed by the teams under consideration during standard match conditions. All events were coded using predefined operational criteria, with each defensive sequence independently classified according to cross type, spatial zone, and defensive organisation at the moment of ball delivery. A filter was applied to focus exclusively on sequences involving opponent attacks from the flanks, followed by a detailed analysis of the defensive reactions exhibited by the teams in each instance. This analysis was carried out as many times as necessary, either at real-time speed or using the pause and frame-by-frame functions to ensure accuracy and clarity.

Definitions and tactical framework

The technical and tactical indicators recorded in this study were designed to evaluate the effectiveness of the defensive line's tactical behaviour in response to opponents' offensive actions. These indicators are defined as follows:

Leg of the crosser

- Side Leg: The ball was kicked with the leg on the same side as the ball's location (i.e., the player's strong-side foot), causing the ball to curve away from the goal.
- Opposite Leg: The ball was kicked with the opposite leg (the foot farthest from the ball's location), causing the ball to curve towards the goal.

Ball trajectory

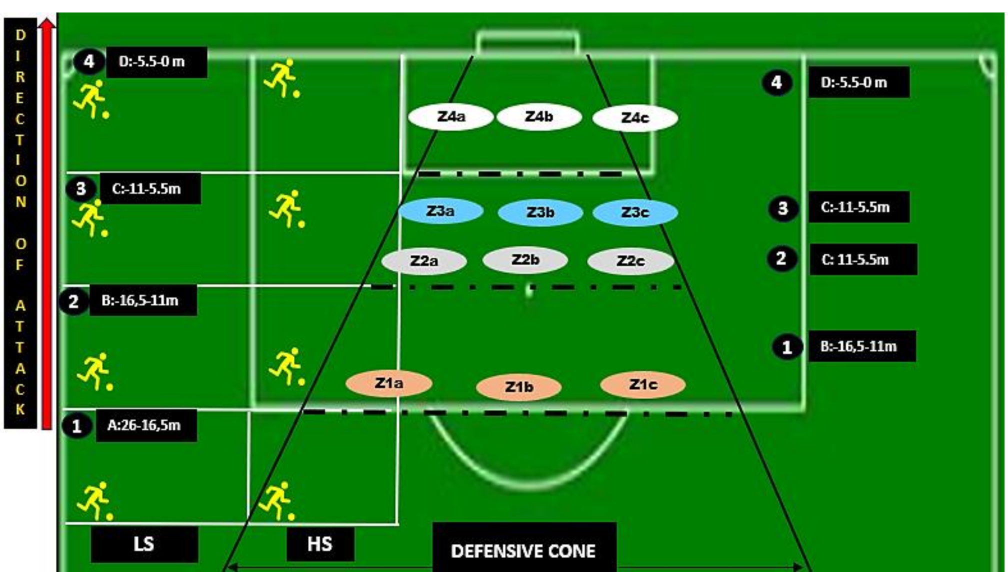
- High curved cross: A cross delivered either at mid-height or high, with significant curve and power, into the opponent's penalty area (Bisanz & Gerisch, 2010, pp. 335-342).
- Ground crosses:
  - Penetrating ground cross: A fast, low cross typically executed with the strong-side foot from around or beyond the 16.5m mark. It follows a diagonal trajectory towards either the near post (first post) or the far post (second post) (Hamici et al., 2021; Marziali & Mora, 2011, p. 275).
  - Cut-back pass: A pass delivered by a player who reaches the end of the pitch and plays the ball back toward teammates positioned in the penalty area. This pass can be executed either along the ground or through the air (Hamici et al., 2021).

Type of defensive behaviour

The defensive line was analysed based on its formation and positioning when defending crosses inside the penalty area. The defensive structure typically consisted of three defenders (in a three-centre-back system) or four defenders (two centre backs and the far-side fullback). The near-side fullback either covered space or marked an opposing attacker positioned near the ball.

The defensive line adjusted its height and alignment depending on the ball's location and was organized within the defensive cone, adopting one of the following formations:

- Zone defence: The defenders are positioned in a flat line at varying depths from the goal line depending on the ball's location. Zones were classified as Z1a/b/c, Z2a/b/c, Z3a/b/c, and Z4a/b/c (see Figure 1) (Marziali & Mora, 2011, pp. 69-74; Longo & Aquino, 2012, pp. 148-149; Lucchessi, 2018, p. 115; Lucchessi, 2019, pp. 87-95).
- Zone with man-to-man defence: Initially arranged as in Zone Defence (see Figure 1), but defenders switch to marking attackers man-to-man as they enter their zone (Marziali & Mora, 2011, pp. 217-218, 225-226).
- Diagonal defence:
  - Normal diagonal: The first defender is positioned approximately in line with the near post (DZ1a, DZ2a, DZ3a) ; the second defender is diagonally placed relative to the first, functioning as a sweeper(DZ1b, DZ2b, DZ3b), while the third defender (usually the far-side defender) aligns with the second defender (DZ1c, DZ2c, DZ3c in Figure 2) (Longo & Aquino, 2012, p. 149).
  - Opposite diagonal: Defenders are positioned in a diagonal line opposite the direction of the incoming cross, typically when the cross originates from positions close to the goal line (DZ4a, DZ4b, DZ4c in Figure 2) (Marziali & Mora, 2011, pp. 75-76; Longo & Aquino, 2012, p. 150).
- Castle defence: A zone defence structure where the central defender positions closest to the goal (CAS1), while the other two defenders hold higher positions in front of him (CAS2, CAS3 (see Figure 2) (Longo & Aquino, 2012, p. 151).
- Mixed defence 1: The defender closest to the ball covers the space at the height of the near post, while the remaining defenders mark attackers man-to-man (Lucchessi, 2018, p. 114).
- Mixed defence 2: The first two defenders, in relation to the ball, cover the space in front of and behind the near post, while the other defenders engage in man-to-man marking (Lucchessi, 2018, p. 114).
- Man-to-Man defence: Each defender marks a specific opponent inside the penalty area within the defensive cone. When possible, defenders position themselves with their backs toward the goal and maintain physical contact with their assigned opponent (Marziali & Mora, 2011, p. 158).



Note. Explanation of Symbols: Ball in zone 1A., defence line in zone 1B (Z1a/b/c)., Ball in zone 2B, defence line in zone 2C (Z2a/b/c)., Ball in zone 3C, defence line in zone 3C (Z3a/b/c)., Ball in zone 4D, defence line in zone 4D (Z4a/b/c).

Figure 2. Zone of the crosser and defender in zone.

Note. Explanation of Symbols: Ball in zone 1A , defence line in zone 1B (DZ1a/b/c)., Ball in zone 2, defence line in zone 2C (DZ2a/b/c)., Ball in zone 3C, defence line in zone 3C(DZ3a/b/c)., Ball in zone 4D, defence line in zone 4D (DZ4a/b/c) or (CAS 1/2/3).

Figure 3. Zone of the crosser and defenders in diagonal zone.

Reliability testing

Both intra-observer and inter-observer reliability were assessed using Cohen's kappa (κ) correlation coefficient. To evaluate intra-observer reliability, the primary observer analysed a sample of 150 randomly selected crosses on two separate occasions, with a one-week interval between observations. The calculated kappa values were greater than .80, indicating a strong level of agreement (McHugh, 2012).

For the inter-observer reliability assessment, a second independent football analyst examined the same sample of 150 crosses under similar conditions. The kappa values obtained were also greater than 0.80 across all performance indicators, demonstrating a strong level of agreement between observers (McHugh, 2012). The reliability results for each performance indicator are presented in Table 1.

Table 1. The Intra- and inter-rater reliability analysis (K) for crossing variables.

Variable	Intra-observer Kappa value	Inter-observer Kappa value
Zone of the Crosser and Leg of the crosser	1	1
Zone of the crosser and Ball trajectory	.95	.90
Zone of the crosser and type of the Defence Line	.84	.80

Data analysis

The statistical analysis of the data, which were recorded through digital video observation and coded using a computer, was performed using IBM SPSS Statistics version 29.0.0.0 (241). Descriptive statistics were applied, including frequency analysis (frequencies) and the calculation of percentage ratios. Additionally, Cross tabs and the non-parametric chi-square test (χ^2) were employed to examine the independence and possible relationships between the categorical variables.

Chi-square tests of independence were applied to examine associations between categorical variables ($p < .05$).

RESULTS

Defence and leg of the crosser

In order to calculate the frequency and effectiveness of the defensive tactical behaviour during phases in which crosses were executed, a count was made of the total number of these phases in relation to the foot used by the crosser.

The analysis of the data revealed that the predominant type of cross execution was performed with the strong-side foot (Side Leg) across all zones of the crosser (Table 2).

Table 2. Percentages of crosses executed with the strong-side foot and opposite foot.

Zone of the crosser	Side leg	Opposite leg
LS: 26-16.5 m	67.5%	32.5%
LS: 16.5-11 m	76.6%	23.4%
LS: 11-5.5 m	86.7%	13.3%
LS: 5.5-0 m	93.6%	6.4%
HS: 26-16.5 m	64.3%	35.7%
HS: 16.5-11 m	75.7%	24.3%
HS: 11-5.5 m	72.7%	27.3%
HS: 5.5-0 m	91.5%	8.5%
All heights	79.1%	20.9%

Table 3. Defensive effectiveness in relation to the crosser's foot (side vs opposite foot).

Zone of the crosser	x^2, *p*	*p*-value
LS: 2616.5 m	$x^2(1) = 0.115$	.735
LS: 16.5-11 m	$x^2(1) = 0.039$	.843
LS: 11-5.5 m	$x^2(1) = 6.176$	.013*
LS: 5.5-0 m	$x^2(1) = 0.010$	.922
HS: 26-16.5 m	$x^2(1) = 1.800$	.189
HS: 16.5-11 m	$x^2(1) = 2.370$	.124
HS: 11-5.5 m	$x^2(1) = 0.204$	.651
HS: 5.5-0 m	$x^2(1) = 1.038$	.308

*Note. *p < .05.*

Table 4. Frequency percentages (%) of defensive success and failure in relation to the crosser's foot (side vs opposite leg).

Zone of the crosser	Side leg success	Side leg failure	Opposite leg success	Opposite leg failure
LS: 26-16.5 m	90.5%	9.5%	91.7%	8.3%
LS: 16.5-11 m	88.3%	11.7%	89.4%	10.6%
LS: 11-5.5 m	86.1%	13.9%	68.8%	31.3%
LS: 5.5-0 m	90%	10%	90.9%	9.1%
HS: 26-16.5 m	74.1%	25.9%	84.4%	15.6%
HS: 16.5-11 m	78.6%	21.4%	94.4%	5.6%
HS: 11-5.5 m	79.5%	20.5%	75.8%	24.2%
HS: 5.5-0 m	85.7%	14.3%	76.5%	23.5%

In order to determine the effectiveness of the defence across the different zones from which the cross was delivered, in relation to the foot used by the crosser, the non-parametric chi-square test (χ^2) was applied. The results indicated a statistically significant difference ($p < .05$) in defensive effectiveness for the zone of the crosser LS: 11-5.5m (Table 3). The highest failure rates of the defence were observed when the cross was executed with the opposite foot, resulting in a 31.3% failure rate, compared to a 13.9% failure rate when the cross was executed with the strong-side foot (Table 4).

Overall, frequency analysis revealed higher defensive failure rates when the cross was executed with the side leg, with the exception of the zones LS: 11-5.5m, HS: 11-5.5m, and HS: 5.5-0m, where higher failure rates were observed when the cross was executed with the opposite leg (Table 4).

Defence and ball trajectory

In order to calculate the frequency and effectiveness of defensive tactical behaviour during phases in which crosses were delivered, a count was made of the total number of these phases in relation to the trajectory of the ball.

The analysis of the data revealed that the predominant ball trajectory was high curved across all zones of the crosser, except for the zones HS: 11-5.5m and HS: 5.5-0m, where the ground trajectory was the most frequently observed (Table 5).

Table 5. Percentages of ball trajectories from different crosser zones.

Zone of the crosser	Ground	Hight curved
LS: 26-16.5 m	25.8%	74.2%
LS: 16.5-11 m	42.5%	57.5%
LS: 11-5.5 m	46%	54%
LS: 5.5-0 m	40.6%	59.4%
HS: 26-16.5 m	14.4%	85.6%
HS: 16.5-11 m	43.1%	56.9%
HS: 11-5.5 m	65.9%	34.1%
HS: 5.5-0 m	66.2%	33.8%

Table 6. Defensive effectiveness in relation to the ball trajectory.

Zone of the crosser	x^2	p-value
LS: 26-16.5 m	$x^2(1) = 0.837$	.360
LS: 16.5-11 m	$x^2(1) = 1.593$	.207
LS: 11-5.5 m	$x^2(1) = 0.109$	.741
LS: 5.5-0 m	$x^2(1) = 6.769$	.009*
HS: 26-16.5 m	$x^2(1) = 0.416$	.519
HS: 16.5-11 m	$x^2(1) = 2.259$	.133
HS: 11-5.5 m	$x^2(1) = 2.368$	.124
HS; 5.5-0 m	$x^2(1) = 1.529$	.216

*Note. *p < .05.*

In order to determine the effectiveness of the defence across the different zones from which the cross was delivered, in relation to the trajectory of the ball, the non-parametric chi-square test (χ^2) was applied.

The results indicated a statistically significant difference for the LS: 5.5-0m zone (Table 6), where the defence was more effective against ground crosses, with a success rate of 96.2%, compared to a success rate of 80.3% against high curved crosses (Table 7).

In general, more defensive failures were recorded when the trajectory of the cross was high curved (except for the zone HS: 16.5-11m). On the other hand, fewer defensive failures were observed when the trajectory of the cross was ground (Table 7).

Table 7. Frequency percentages (%) of defensive success and failure in relation to ground and high curved crosses.

Zone of the crosser	Ground success defence	Ground failure defence	High curved success defence	High curved failure defence
LS: 26-16.5 m	92.9%	7.1%	89.1%	10.95%
LS: 16.5-11 m	90.1%	9.9%	83.35%	16.7%
LS: 11-5.5 m	82.5%	17.5%	80.7%	19.3%
LS: 5.5-0 m	96.2%	3.8%	80.3%	19.7%
HS: 26-16.5 m	81.3%	18.8%	73.7%	26.3%
HS: 16.5-11 m	71.4%	28.6%	85.5%	13.5%
HS: 11-5.5 m	76.7%	23.3%	61.3%	38.7%
HS: 5.5-0 m	83%	17%	74.5%	25.5%

Type of defence behaviour

In order to calculate the frequency and effectiveness of defensive tactical behaviour during phases in which crosses were delivered, a count was made of the total number of these phases in relation to the type of defence employed.

The analysis of the data revealed that the predominant defensive strategy was Zone Defence, except in the zones LS: 5.5-0m and HS: 5.5-0m, where Diagonal Defence was the most frequently used (Table 8).

Table 8. Percentages of defensive types used against crosses in the penalty area.

Zone of the crosser	Zone Defence (%)	Zone in man-to-man (%)	Diagonal Defence (%)	Castle Defence (%)	Mixed defence 1 (%)	Mixed defence 2 (%)	Man-to-man (%)	Else (%)
LS: 26-16.5 m	69.8	10.8	12.9		2.7			3.7
LS: 16.5-11 m	75.1	14.9	7		1.5			1.5
LS: 11-5.5 m	76.3	12.9	3.3		3.7			3.7
LS:5.5-0 m	27.5	12.6	52.7	3	1.2	1.2		1.8
HS: 26-16.5 m	59	11.5	26.2					3.3
HS: 16.5-11 m	56.2	19.2	24.7					
HS: 11-5.5 m	81.8	18.2						
HS: 5.5-0 m	27.9	13.7	49.2	2		1		6.1

In order to determine the effectiveness of the defence across the different zones from which the cross was delivered, in relation to the type of defence employed, the non-parametric chi-square test (χ^2) was applied.

The results indicated that there was no statistically significant difference in the effectiveness of the various types of defence at any cross delivery position (Table 9).

The frequency analysis of the different types of defence revealed generally higher success rates and lower failure rates when Zone Defence was employed.

An exception was noted in the zone HS: 5.5-0m, where Diagonal Defence demonstrated the highest success rates and the lowest failure rates (Table 10).

Table 9. Cross delivery zones and type of defence.

Zone of the crosser	x^2	*p*-value
LS: 26-16.5 m	$x^2(4) = 3.655$	.455
LS: 16.5-11 m	$x^2(4) = 5.515$	.238
LS: 11-5.5 m	$x^2(4) = 4.303$	.367
LS: 5.5-0 m	$x^2(6) = 7.953$	.242
HS: 26-16.5 m	$x^2(3) = 6.072$	.108
HS: 16.5-11 m	$x^2(2) = 0.647$	.724
HS: 11-5.5 m	$x^2(1) = 0.982$	.322
HS: 5.5-0 m	$x^2(5) = 9.726$	.083

*Note. *p < .05.*

Table 10. Frequency percentages (%) of defensive success and failure by type of defence.

Ball position	Zone Defence (%)		Zone in man-to-man (%)		Diagonal Defence (%)		Castle Defence (%)		Mixed defence 1 (%)		Mixed defence 2 (%)		man-to-man (%)		Else (%)	
	S	F	S	F	S	F	S	F	S	F	S	F	S	F	S	F
LS: 26-16.5 m	91.3	8.7	84.4	15.6	89.5	10.5			100	0					100	0
LS: 16.5-11 m	87.4	12.6	93.3	6.7	100	0			66.7	33.3					66.7	33.3
LS: 11-5.5 m	84.8	15.2	74.2	25.8	87.5	12.5			100	0					77.8	22.2
LS: 5.5-0 m	84.8	15.2	95.2	4.8	93.2	6.8	80	20	50	50	100	0			100	0
HS: 26-16.5 m	70.8	29.2	100	0	81.3	18.8									75	25
HS: 16.5-11 m	85.4	14.6	78.6	21.4	77.8	22.2										
HS: 11-5.5 m	76.8	23.2	86.4	13.6												
HS: 5.5-0 m	85.5	14.5	85.2	14.8	87.6	12.4	100	0			50	50			58.3	41.7

Note. S = Success, F = Failure.

DISCUSSIONS

Defence and leg of the crosser

The frequency analysis revealed that, across all zones of the crosser, 79.1% of crosses were executed using the strong-side foot, while 20.9% were executed with the opposite foot. Notably, there was an increased frequency of crosses performed with the strong-side foot when the delivery took place close to the goal line, specifically in zones LS: 5.5-0m and HS: 5.5-0m, with percentages of 93.6% and 91.5%, respectively. This pattern may reflect increased spatial and temporal pressure near the goal line, which constrains decision-making options for attackers.

In their studies, Pulling et al. (2018) and Mitrotasios et al. (2022) classified types of crosses not by the foot used but according to the trajectory of the ball—specifically distinguishing between Out-swinging crosses (curving away from goal), In-swinging crosses (curving towards goal), and Straight crosses (with no curve). They reported similar frequencies of Out-swinging crosses (77.8%, 69.1%), In-swinging crosses (13.4%, 16.9%), and Straight crosses (8.9%, 14%) in their respective studies.

As Mitrotasios et al. (2022) pointed out, when a cross is performed with the strong-side foot, it usually follows an Out-swinging trajectory, curving away from the goalkeeper. Conversely, crosses executed with the opposite foot tend to have an In-swinging trajectory, converging towards the goalkeeper. Therefore, the findings of this study are largely consistent with those of previous research (see Table 2).

Moreover, Sainz de Baranda, López-Riquelme, and Ortega (2011), Casal et al. (2015), Pulling et al. (2018), and Mitrotasios et al. (2022) all highlighted that Out-swinging crosses performed with the strong-side foot generally result in fewer goalkeeper interventions compared to In-swinging crosses, increasing the success rate of goal-scoring opportunities and posing greater challenges to defensive lines. However, this was not fully confirmed by the current study.

In the present analysis, higher defensive failure rates were recorded in zones LS: 11-5.5m, HS: 11-5.5m, and HS: 5.5-0m when crosses were executed with the opposite foot (In-swinging), corroborating the findings of Carling et al. (2005), who concluded that corner kicks taken with the opposite foot to the side of the pitch lead to more goals (Table 4).

Additionally, statistically significant differences ($p < .05$) were found in the defensive effectiveness related to the crosser's foot in the LS: 11-5.5m zone (Table 3).

Defensive failure rates reached 31.3% when crosses were executed with the opposite foot, compared to 13.9% when crosses were performed with the strong-side foot.

In conclusion, crosses delivered with the opposite foot from the LS: 11-5.5m zone present significant challenges for the defence, particularly when the cross is aimed: Between the second central defender and the wide defender (defensive failure rate: 31.6%), In the space between the penalty area line and the penalty spot (defensive failure rate: 29.4%), And in the area between the penalty spot and the goal area (defensive failure rate: 22.4%), based on the findings of this study. These results underline the necessity of training the defensive line to handle such specific match situations effectively.

Defence and trajectory of the ball

The analysis of the percentages related to the trajectory of the ball showed that, in the zones of the crosser HS: 11-5.5m and HS: 5.5-0m, teams predominantly opted for ground crosses. In contrast, in all other zones, high curved crosses were the preferred choice (Table 5). However, it is noteworthy that in zones farther from the goal line—specifically LS: 26-16.5m and HS: 26-16.5m—the percentage of ground passes was unexpectedly low. This finding suggests that, despite the availability of space behind the defensive line, teams preferentially targeted aerial deliveries rather than low-penetrating passes from these zones.

It seems that, from these areas, teams preferred to deliver high curved crosses instead, aiming for the space between the penalty spot and the goal area, as well as behind the second central defender. These results indicate that crossing effectiveness is influenced by both spatial exploitation and delivery type.

Regarding the effectiveness of the defence based on the trajectory of the ball, a statistically significant difference was found only in the LS: 5.5-0m zone (Table 6). From this position, the defence recorded its highest failure rates when dealing with high curved crosses, with a failure rate of 19.7%, compared to just 3.8% failure against penetrating or cut-back passes (Table 7).

This finding highlights the importance of focusing on defensive training to improve the ability to handle such scenarios, especially when defending against high curved crosses delivered from close-range positions near the goal line.

Type of defence

According to the literature, the types of defensive tactical behaviour adopted by the defensive line were categorized as: Zone Defence, Zone Defence in Man-to-Man, Diagonal Defence, Man-to-Man Defence, Castle Defence, and two variations of Mixed Defence (Ferrari, 2001; Marziali & Mora, 2011; Longo & Aquino, 2012; Lucchessi, 2018; Lucchessi, 2019). The data analysis revealed that, depending on the position of the ball, the defensive line adapted its formation. However, there was a clear tendency for certain elite-level teams to predominantly adopt Zone Defence in a majority of situations—ranging from 56.2% to 81.8%—when defending crosses from all delivery zones, with the exception of crosses delivered from zones LS: 5.5-0m and HS: 5.5-0m, where Diagonal Defence, and more specifically the Opposite Diagonal, was preferred in 49.2% to 52.7% of cases (Table 8).

With regard to the effectiveness of the defence in relation to the type of defensive formation, no statistically significant differences were found at any cross delivery zone (Table 9). However, frequency analysis indicated that Opposite Diagonal Defence, when used to defend crosses delivered from positions close to the goal line, recorded the lowest failure rates of the defensive line (6.8%) compared to Zone Defence, which showed a failure rate of 15.2% (Table 10). Other types of defence were not considered in this comparison due to their very low selection rates in these match situations.

CONCLUSIONS

Overall, defensive success against crosses is shaped by the interaction between spatial constraints, crossing characteristics, and defensive organisation, rather than by defensive structure alone. A total of 1,428 crosses were recorded and analysed. The main findings of the study are as follows:

1. Higher defensive failure rates were observed when crosses were executed with the side leg, except in zones LS: 11-5.5m, HS: 11-5.5m, and HS: 5.5-0m, where higher failure rates occurred when the cross was executed with the opposite leg.

The foot used to deliver the cross (strong-side or opposite foot) significantly influenced the effectiveness of the defence in the LS: 11-5.5m delivery zone. Defensive failure rates were 31.3% when the cross was delivered with the opposite foot, compared to 13.9% when the strong-side foot was used.

2. The predominant ball trajectory was high and curved across all crosser zones, except for HS: 11-5.5m and HS: 5.5-0m, where ground-level trajectories were most frequently observed.

The ball trajectory (ground or high curved) had a significant impact on defensive effectiveness in the LS: 5.5-0m delivery zone. From this position, defences recorded a higher failure rate when dealing with high curved crosses (19.7%) compared to ground cut-back passes (3.8%).

3. There was a clear tendency to predominantly adopt Zone Defence in most situations, except for crosses delivered from zones near the goal line, where the Opposite Diagonal was preferred.

The type of defensive behaviour did not show a statistically significant impact on defensive effectiveness. However, frequency analysis indicated that Opposite Diagonal Defence, when applied against crosses from positions close to the goal line, achieved the lowest failure rates (6.8%) compared to Zone Defence (15.2%). Other defensive types were excluded from this comparison due to their limited use in such situations.

Despite the methodological robustness and the large dataset analysed, several limitations should be acknowledged. First, the study adopts a univariate analytical approach using chi-square tests, which does not fully capture the potential interaction effects between spatial constraints, crossing characteristics, and defensive organisational structures. Future research should employ multivariate statistical models (e.g., logistic regression or machine learning approaches) to better explain the combined influence of these interacting variables on defensive outcomes.

Limitations

Despite the methodological robustness and the large dataset analysed, several limitations should be acknowledged.

First, the study adopts a univariate analytical approach using chi-square tests, which does not fully capture the potential interaction effects between spatial constraints, crossing characteristics, and defensive organisational structures. Future research should employ multivariate statistical models (e.g., logistic regression or machine learning approaches) to better explain the combined influence of these interacting variables on defensive outcomes.

Second, contextual match-related variables such as scoreline status (winning, drawing, losing), opponent quality, match importance, and temporal phase of the game were not included in the analysis. These factors may significantly influence both defensive organisation and risk-taking behaviour, potentially affecting defensive effectiveness against crosses.

Third, the study focuses exclusively on elite teams from top European leagues (Premier League, La Liga, Bundesliga), which enhances internal validity but limits the generalisability of the findings to lower competitive levels or different tactical contexts.

Fourth, while inter- and intra-observer reliability were high ($\kappa > .80$), the observational nature of the study still carries inherent limitations related to subjective event coding, despite the use of clear operational definitions and repeated video analysis.

Finally, only open-play crossing situations were included, excluding set-piece contexts such as corners and free kicks, which represent a significant proportion of crossing-related defensive scenarios in elite football.

AUTHOR CONTRIBUTIONS

All authors meet the criteria for authorship in accordance with established ethical guidelines. Contributions are specified according to the CRediT (Contributor Roles Taxonomy) as follows: Conceptualisation: Minas-Panagiotis Ispirlidis, Mert Isbilir, Theano Katsamperi, Nikolaos E. Koundourakis, and Ioannis Ispirlidis. Methodology: Minas-Panagiotis Ispirlidis, Mert Isbilir, Theano Katsamperi, Nikolaos E. Koundourakis, and Ioannis Ispirlidis. Formal analysis: Minas-Panagiotis Ispirlidis and Mert Isbilir. Investigation: Minas-Panagiotis Ispirlidis. Data curation: Minas-Panagiotis Ispirlidis. Writing – original draft: Minas-Panagiotis Ispirlidis. Writing – review & editing: Minas-Panagiotis Ispirlidis, Mert Isbilir, Theano Katsamperi, Nikolaos E. Koundourakis, and Ioannis Ispirlidis. Supervision: Ioannis Ispirlidis, Mert Isbilir.

All authors have critically reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

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

AI USE DISCLOSURE

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

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