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ORIGINAL INVESTIGATION

How spatial constraints afford successful and unsuccessful penetrative passes in elite association football

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ABSTRACT

Background: The aim of the present study was to examine the spatial relations between teams (macro-level) and groups of players (meso-level) that afford successful penetrative passes (off-ball advantage) in elite football.
Methods: Three balanced home matches from a Premier League team with 91 ball possessions in which a pass was performed into the opposition defensive area and overpassed the first defensive line, promoting a perturbation of the defensive team equilibrium, were selected for analysis. The spatial relations between teams were measured through spatial variables that captured the areas occupied by the teams, while the spatial relations between players were measured through variables that captured the distances and angles between attacking and defending players near the ball.
Results: Results revealed, at the macro-level, higher values of width ratio between teams and the width of the attacking team for unsuccessful penetrative passes (UPP), when compared to successful penetrative passes (SPP). At the meso-level, a general decrease in distances and an increase in angles between attacking and defending players were observed between successful to unsuccessful penetrative passes.
Conclusions: These findings highlight the importance of using positional data analysis to identify teams' tactical profiles and to potentiate coaches' interventions.

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KEYWORDS
Performance analysis; patterns of play; tactical behaviour; passing actions; game sub-phases

Introduction

Performance analysis in sports allows reliable and objective methods of collecting, analysing and interpreting individual and collective behaviours during competitive environments (Hughes and Franks 2015). It provides coaches with accurate feedback of competitive performance through the identification of strength and weaknesses in several performance domains (i.e., physical, technical, tactical), to describe activity patterns or players' profiles of play, and also, to evaluate and relate game dynamics with moments of perturbations throughout the game (Sarmento et al. 2014). Over the last few years, performance analysis in football has progressed from using notational analysis methods, which provided information regarding discrete performance indicators, towards more holistic analyses using positional data that captures the patterns of play that support individual and collective tactical actions (Travassos et al. 2013; Sarmento et al. 2018; Coito et al. 2020).

Improvements in technology has allowed continuous data collection from players' positioning in their natural environments, allowing the development of new insights to enhance the understanding of performance (Folgado et al. 2014; Gonçalves et al. 2018). These data provide information about players with respect to the individual and collective principles of play, the opponents' behaviour, and the contextual circumstances. Such information creates new challenges for researchers and performance analysts, such as developing metrics that capture the patterns of play that describe the functional spatiotemporal principles of play that sustain players and teams tactical behaviour (Rein and Memmert 2016; Fernández and Bornn 2020).

In line with the ecological dynamics approach, to capture the spatiotemporal principles of play, it is important to identify, for example, the spatial information constraints that regulates players' and teams' tactical behaviour during competition. This implies understanding, for different game sub-phases, the cooperative and competitive tendencies between players and how the spatiotemporal relations between them are exploited for the creation of successful or unsuccessful actions (Passos et al. 2011; Travassos et al. 2013). That is, the affordances (i.e., possibilities for action upon the variations on spatiotemporal relations between players and teams) (Fajen et al. 2009) that support players' movement behaviours according to immediate goals and the game principles of the team (Travassos et al. 2012b, 2013).

In general, when in ball possession, a football team aims to progress on the field through dribbles or passes to a supporting teammate, located between defensive lines towards the opponent's goal, which could create unbalance on the attacking-defending relations and therefore opportunities to shot at goal

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(Passos et al. 2020). Previous research in football has revealed that particular affordances for passing are sustained by informational constraints such as relative distances (Travassos et al. 2012a, 2012b) and relative angles between players (Corrêa et al. 2014). In a 2 vs 1 situation, at the moment of ball reception, the variations in the distances from the defender to the ball carrier, as well as in the passing line between attackers, and the angle between the ball carrier, the defender and the ball receiver clearly allow the characterization of successful and unsuccessful passes (Travassos et al. 2012a, 2012b) and also constraint the passing directions (Corrêa et al. 2014). That is, an increase in the distance from the defender to the ball carrier, as well as in the passing line between attackers, with values of the angle between the ball carrier, the defender and the ball receiver near 90°, tend to support successful passes. Also, previous research revealed that the analysis of the relationship between team variables such as the centroid position (the gravitational midpoint of the team of players) allow to analyse the balance between attacking and defending teams in relation to different locations on the field (Coito et al. 2020).

In line with that, Fernández and Bornn (2020) and Passos et al. (2020) recently developed a computational method to represent the variations in the spatiotemporal configurations of attacking and defending teams and how passing lines that surround the ball carrier emerges at each instant, using some of the previously defined variables. Their approach allows the calculation of the pass probability for each teammate, but also to understand the target spaces that offensive players should cover to receive a pass. Complementarily, Llana et al. (2020) calculated the off-ball advantage of a player to receive a potential pass and progress on the field according to the positioning of the defensive team. Gonçalves et al. (2019) revealed that the ability of a team to create penetrative passing lines to progress on the field are not only dependent upon interpersonal relations between players, forged by distances and angles in a group relationship, but also by changes in the effective playing space of the team and by the variation in ball speed over time. Accordingly, analysing the balance between attacking and defending teams at macro- and meso-levels seems to be a key information to explain the success of the attack and the defence sub-phases (Moura et al. 2012; Vilar et al. 2013a), while considering the pitch location were the actions occur (Headrick et al. 2011; Travassos et al. 2014).

Moreover, there is a need to translate the analysis of spatio-temporal configurations for coaches and clearly identify the informational variables that help to explain and improve specific game sub-phases. Based on the previous considerations, the present study aims to examine the spatial relations between teams (macro-level) and the groups of players near the ball (meso-level) that afford successful penetrative passes (off-ball advantage) in elite football. Passes that overpass the first defensive line and promote a disruption in the defensive system and progression of attacking team (successful penetrative passes) were compared with passes that overpass the first defensive line but were intercepted by the defence (unsuccessful penetrative passes). We hypothesised that successful penetrative passes (SPP) were characterized by higher distances and angles between players (meso-level) and a higher ratio between attacking and defending teams' areas in comparison to unsuccessful penetration passes (UPP). We also hypothesized an effect of pitch location on teams' spatial relations which supports SPP and UPP.

Method

Sample

Three balanced home matches (i.e., that ended with one goal of difference) from a Premier League team with 91 ball possessions (match 1 = 29; match 2 = 32; match 3 = 30), in which a pass was performed into the opposition defensive area and overpassed the first defensive line were selected for analysis. The 91 offensive plays were selected by three expert coaches (more than 10 years of practice as coaches and high-level performance analysts) based on the following criteria: i) a penetrative pass occurred; and ii) the penetrative pass occurred at the midfield or forward sector of the pitch. Three expert coaches performed the selection procedure with an inter-observer percentage of agreement of 94.51% (James et al. 2007).

Data collection

The two-dimensional coordinates of the 22 outfield players were registered during the entire game using a multi-camera system positioned at the top of the stadium (ProZone3$^{(R)}$, Prozone Holding Ltd, Leeds, UK) with a 10 Hz sampling frequency (O'Donoghue and Robinson 2009).

Data processing

The 91 sequences of offensive play were divided accordingly to their outcome: i) SPP – penetrative passes that overpassed the first defensive line, and the ball was received and controlled by a targeted teammate promoting a disruption on the defensive system and progression of attacking team (n = 65); and ii) UPP – penetrative passes that overpassed the first defensive line and ended with a defender's interception (n = 26). The sequences of offensive plays were also classified according to the field location of the pass. The field location was divided into three sectors according to the distance to the goal (defensive, midfield and forward) (Hughes and Franks 2008), however the defensive third was not considered as passes only performed in the offensive half were accounted for. Accordingly, sequences of play in which the pass occurred in the midfield sector were registered as midfield (Mf) (n = 45) and those that occurred in the forward sector were registered as forward (Fd) (n = 46).

The spatial relations between players and teams that afforded SPP and UPP were analysed considering two different levels: macro- and meso-level. For the macro-level of analysis (Frencken et al. 2011; Folgado et al. 2012; Travassos et al. 2012c), the variables centroid position (that represents the (gravitational) midpoint of the team and is calculated by considering mean value of the position of all outfield players for each time stamp), length and width (that represents the longitudinal and lateral dispersion of players in a team and are calculated as the longitudinal or lateral distance between the most distant players) were registered (Coito et al. 2020). From the mentioned variables for each team, the following relational variables were computed to better understand the balance between teams: i) the distance between centroids, which results from the computation of the absolute distance between the centroid of both teams; ii) the length ratio between teams,

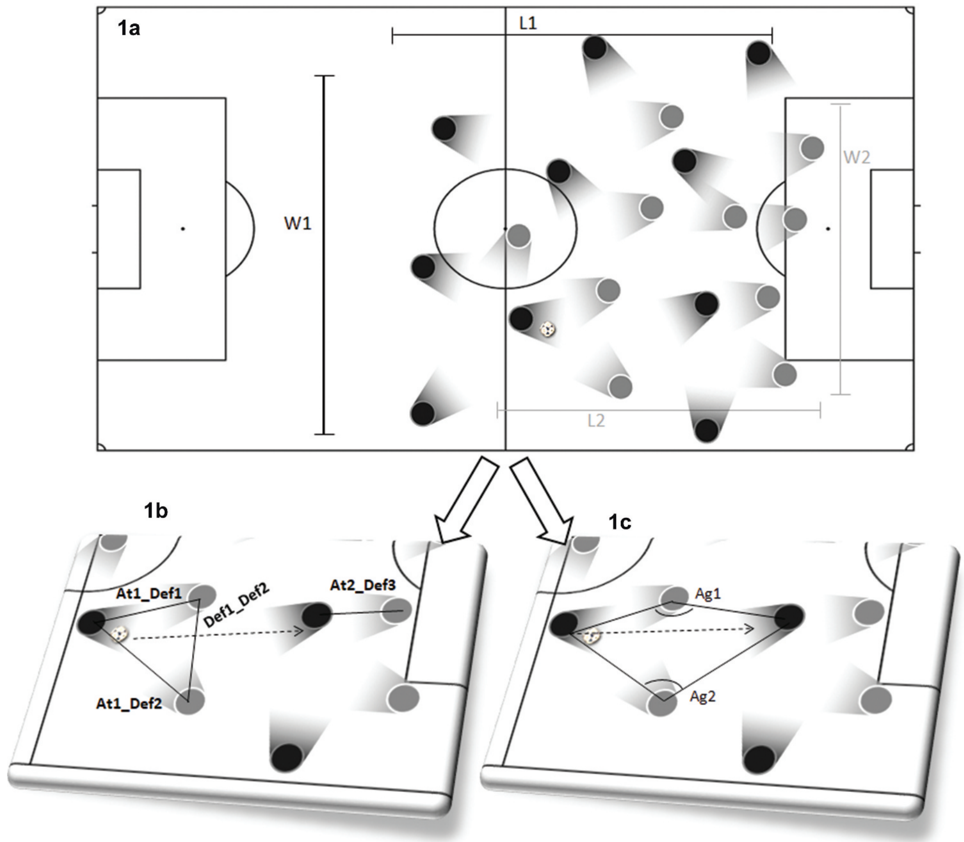

Figure 1. Exemplar spatial relations between players and teams that afforded SPP and UPP. (a) Representation of macro-level relations (L1 and L2 – Length of teams; W1 and W2 – Width of teams). (b) Representation of distance variables for meso-level of analysis (At1-Def1- ball carrier and 1st defender; At1-Def2 – ball carrier and 2nd defender; AT2-Def3 – targeted teammate and 3rd defender; Def1-Def2 – 1st defender and 2nd defender). (c) Representation of angle variables for meso-level of analysis (Ag1 – ball carrier, 1st defender and targeted teammate; Ag2 – ball carrier, 2nd defender and targeted teammate).

that results from the computation of the ratio between the length of the offensive and defensive team, respectively; and iii) width ratio between teams that results from the computation of the ratio between the width of the offensive and defensive team, respectively (see Figure 1(a)).

For the meso-level of analysis only the spatial relations between the five key players that surrounded the ball were considered (Travassos et al. 2012b; Corrêa et al. 2014). For that, computation was conducted for the distances between: i) the ball carrier and the 1st defender (At1-Def1); ii) the ball carrier

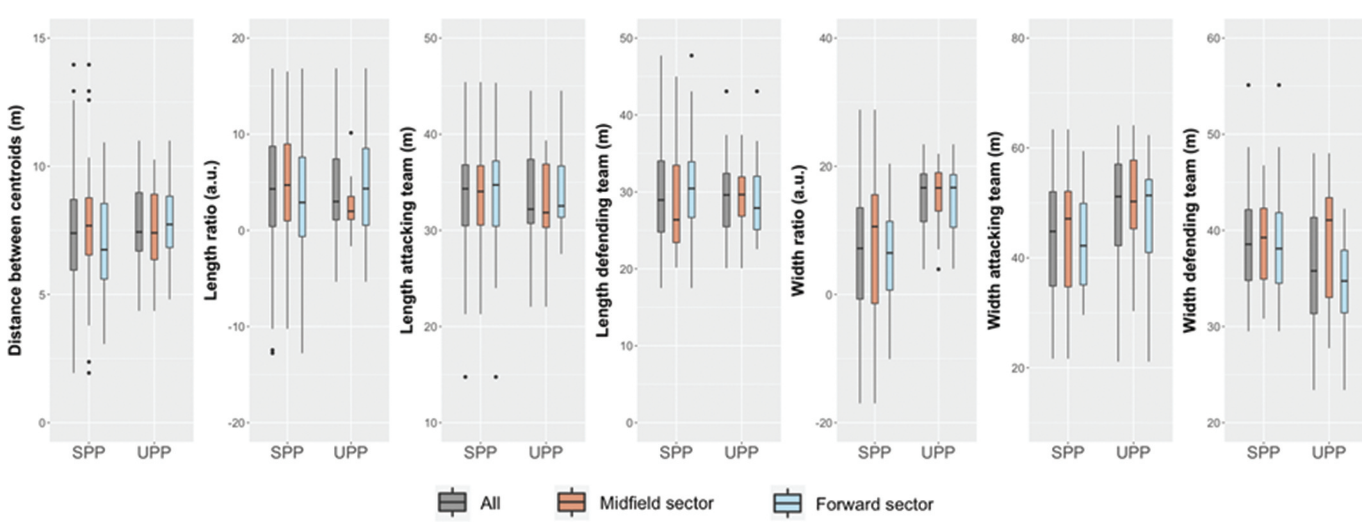

Figure 2. Box plot of the descriptive analysis considering the macro-level variables. The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the largest value no further than 1.5 × IQR from the hinge (where IQR is the inter-quartile range or distance between the first and third quartiles). The lower whisker extends from the hinge to the smallest value at most 1.5 × IQR of the hinge. Data beyond the end of the whiskers are called 'outlying' points and are plotted individually.

and the 2nd defender (At1-Def2); iii) the targeted teammate and the 3rd defender (AT2-Def3); and iv) the 1st and 2nd defender (Def1-Def2) (see Figure 1(b)). Angles were also computed between v) the ball carrier, the 1st defender, and the targeted teammate (Ag1); and vi) the ball carrier, the 2nd defender, and the targeted teammate (Ag2) (See Figure 1(c)). All data were computed in MATLAB(R) R2013a software (The MathWorks Inc, Natick, MA, USA).

Data analysis

Descriptive results are presented in box plots (Wickham 2009). The normality and homogeneity of the variances were tested using the Kolmogorov and Levene's statistic tests and the sample met the requirements for the assumption of normality. A two-way analysis of variance was conducted on the influence of two independent variables (penetrative pass outcome: successful, SPP and unsuccessful, UPP; and pitch sector of penetrative pass: midfield and forward sector, Md and Fd, respectively) on the macro- and meso-level variables considered. Effect size (ES) was presented as partial eta-squared (η_p^2) and interpreted by the following criteria: small (ES ≤ 0.06), medium (0.06 < ES ≤ 0.14) and large (ES > 0.14) (Cohen 1988). When appropriate the Tukey HSD was used for *post-hoc* comparisons and the Cohens' *d* was computed as effect size (ES) and the interpretation for the standardized effect size was based on the following criteria: 0.2, trivial; 0.6, small; 1.2, moderate; 2.0, large; and >2.0, very large (Cumming 2012). Statistical significance was set at $p < 0.05$ and calculations were completed using the Jamovi Project (Computer Software Version 1.2, 2020).

Results

Table 1 presents the inferential analysis while Figures 2 and Figures 3 present the descriptive results when considering the penetrative pass outcome (SPP and UPP) and the pitch sector.

At the macro-level, both the width ratio (F = 14.0, p = <0.001, ES = moderate) and the width of the attacking team (F = 5.0, p = .028, ES = small) revealed statistically significant lower values for SPP in contrast with UPP. In opposition, statistically significant higher values of the width of the defending team (F = 4.7, p = .033, ES = small) were observed for SPP than for UPP. No significant differences were found at the macro-level when considering the pitch sector and the interaction of the penetrative pass outcome and the pitch sector. This means that the SPP in comparison with UPP tend to occur in a similar way in different pitch sectors, through low width ratio between teams with a decrease in the width of attacking team and an increase in the width of defending team.

Table 1. Inferential results for considered factors on positional variables.

	Outcome factor (SPP vs UPP)				Pitch sector factor (Mf vs Fd)				Outcome × Pitch sector			
				Post Hoc				Post Hoc				Post Hoc
Variables	*F*	*p*	$\eta^2 p$	Cohen d [95%CI]	*F*	*p*	$\eta^2 p$	Cohen d [95%CI]	*F*	*p*	$\eta^2 p$	Cohen d [95%CI]
Team-Level												
Distance between centroids (m)	0.5	.506	.005	n.a.	0.1	.736	.001	n.a.	1.2	.277	.014	n.a.
Length ratio (m)	0.0	.910	.001	n.a.	0.0	.880	.000	n.a.	1.6	.216	.018	n.a.
Length attacking team (m)	0.1	.830	.001	n.a.	0.4	.528	.005	n.a.	0.3	.559	.004	n.a.
Length defending team (m)	0.0	.940	.000	n.a.	0.5	.496	.005	n.a.	0.5	.494	.005	n.a.
Width ratio (m)	14.0	**< .001**	.138	−0.88 [−1.36, −0.39]	0.2	.653	.002	n.a.	0.0	.932	.000	n.a.
Width attacking team (m)	5.0	**.028**	.054	−0.52 [−1, −0.05]	0.7	.411	.008	n.a.	0.0	.894	.000	n.a.
Width defending team (m)	4.7	**.033**	.051	0.51 [0.04, 0.98]	1.7	.198	.019	n.a.	0.92	.341	.010	n.a.
Group_Level												
Distance: ball carrier to 1st def. (m)	7.9	**.006**	.083	0.66 [0.18, 1.13]	53.3	**< .001**	.380	1.71 [1.18, 2.24]	5.4	**.023**	.059	SPP_Mf vs SPP_Fd: −2.17 [−2.76, −1.57] SPP_Mf vs UPP_Mf: −1.30 [−2.01, −0.57] SPP_Mf vs UPP_Fd: −2.38 [−3.09, −1.67] UPP_Mf vs UPP_Fd: −1.08 [−1.89, −0.28]
Distance: ball carrier to 2nd def. (m)	5.1	**.027**	.055	0.53 [0.06, 1]	8.2	**.005**	.086	0.67 [0.2, 1.15]	5.4	**.022**	.059	SPP_Mf-UPP_Fd: −1.20 [−1.84, −0.56] SPP_Fd-UPP_Fd: −1.07 [−1.72, −0.42] UPP_Mf- UPP_Fd: −1.21 [−2.03, 0.41]
Distance: teammate to 3rd def. (m)	14.1	**< .001**	.139	0.88 [0.4, 1.36]	0.1	.829	.001	n.a.	0.5	.474	.006	n.a.
Distance: 1st def. to 2nd def. (m)	12.3	**< .001**	.123	0.82 [0.34, 1.3]	1.7	.191	.020	n.a.	0.5	.493	.005	n.a.
Angle: ball carrier, 1st def. and targeted teammate (°)	19.1	**< .001**	.180	−1.02 [−1.51, −0.53]	0.0	.932	.000	n.a.	0.2	.632	.003	n.a.
Angle: ball carrier, 2nd def. and targeted teammate (°)	20.1	**< .001**	.187	−1.05 [−1.54, −0.56]	0.0	.926	.000	n.a.	0.5	.500	.005	n.a.

SPP = successful penetrative passes; UPP = unsuccessful penetrative passes; Mf = midfield sector; Fd = forward sector.
The bold values represent significant differences.

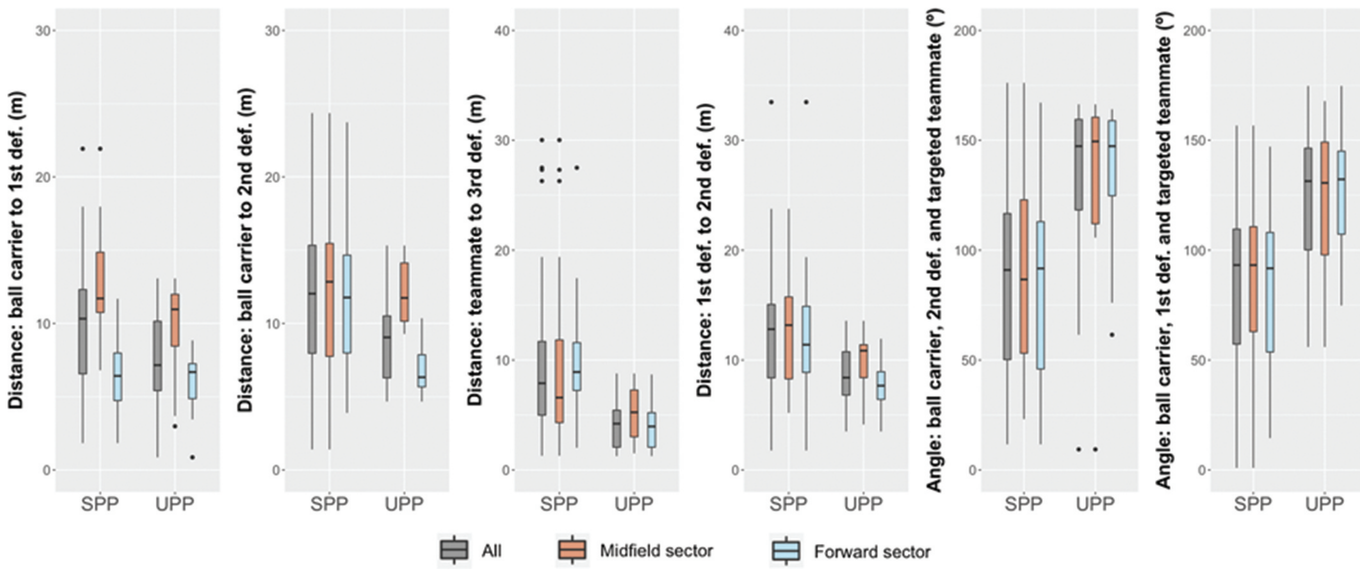

Figure 3. Box plot of the descriptive analysis considering the macro-level variables. The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the largest value no further than 1.5 × IQR from the hinge (where IQR is the inter-quartile range or distance between the first and third quartiles). The lower whisker extends from the hinge to the smallest value at most 1.5 × IQR of the hinge. Data beyond the end of the whiskers are called 'outlying' points and are plotted individually.

At the meso-level, the distances for At1-Def1 (F = 7.9, p = 0.006, ES = moderate), At1-Def2 (F = 5.1, p = 0.027, ES = small), At2- Def3 (F = 14.1, p = <0.001, ES = moderate), and Def1-Def2 (F = 12.3, p < 0.001, ES = moderate) revealed statistically significant higher values for SPP in contrast with UPP. Significant lower values of Ag1 and Ag2 (both p < 0.001, ES = moderate) were observed for SPP than for UPP. That is, SPP tend to occur with higher distances and lower angles between the ball carrier and defenders.

Considering the pitch sector factor, penetrative passes performed in the Mf demonstrate significantly higher values of distance for At1-Def1 (F = 53.3, p = <0.001, ES = large and At1-Def2 (F = 8.2, p = 0.005, ES = moderate) compared to penetrative passes performed in the Fd sector. This means that the spatial relations between the ball carrier and defenders were higher in the Mf than in the Fd sector for the occurrence of penetrative passes.

The interaction between penetrative pass outcome × pitch sector showed significant differences in the distance of the At1-Def1 (F = 5.4, p = 0.022) with the following pairwise comparisons: SPP at the Mf vs SPP at the Fd (ES = very large); SPP at the Mf vs UPP at the Mf (ES = large); SPP at the Mf vs UPP at the Fd (ES = very large); and UPP at the Mf vs UPP at the Fd (ES = moderate). Differences were also found in the distance of At1-Def2 (F = 5.4, p = 0.022) with pairwise comparison: SPP performed at the Md vs UPP performed at the Fd (ES = large); SPP performed at the Fd vs UPP performed at the Fd (ES = moderate); and UPP performed at the Md vs UPP performed at the Fd (ES = large).

Discussion

This study analysed the spatial relations between teams (macro-level) and players (meso-level) that differentiate between successful and unsuccessful penetrative passes (off-ball advantage) in elite football. Results partially confirm our hypothesis that different spatial relations at the macro- and meso-level constrained the success of penetrative passes; however, it was highlighted that the passing outcome is more influenced at the meso- rather than at the macro-level.

In opposition to our expectations, lower values of the width ratio and the width of attacking team were observed for UPP than for SPP. As expected, the width of defending team revealed higher values for UPP than for SPP. The differences observed in the width ratio suggest that successful penetrative passes tend to occur with lower width values of the attacking team and higher values of the width of the defending team in comparison with unsuccessful passes. Accordingly, the spatial advantage for penetrative passes did not occur by the spread of the attacking team on the field, but most likely by a low balance and compactness of the defending team on the field in relation to ball displacement (Bangsbo and Peitersen 2002). In fact, a previous study revealed that defending teams tend to be more compact (i.e. lower values of space occupied) when they recovered ball possession than when shots at goal occurred (Moura et al. 2012). In contrast, when increasing their defensive area, it is more likely that it will open space that might be explored by the offensive team. Our study reinforces this evidence, as a higher number of SPP were performed when the defensive team width increased. However, in addition to examining defensive space occupation, there is a need to consider the behaviour of the defending team in relation to the attacking team.

Interestingly, the attacking team revealed lower values of width for successful passes when compared to unsuccessful passes. Such results are in contrast to the tactical principles of offensive phase of the game, namely, the principle of width and length (Costa et al. 2009) that assumes that the attacking team should increase their width and length, thus creating as much space to play as possible. However, while it may be expected that the offensive team increases the space of play when attacking, in turn, it is required that the attacking team maintain functional behaviours in relation to defence. For example, when the ball is on the right corridor, it may be possible that the left fullback and winger adjust their positioning towards the centre of the pitch as a result of being further from the ball location zone.

In fact, a previous study identified average values of width by the offensive team of ~44 m when facing stronger opponents and ~48 m when facing low level opponents (Gonçalves et al. 2019), which clearly reveals lower values compared to regular pitch width values (64–75 m). This positional adjustment seems to allow the team to maintain stable behaviours according to the different configurations of play (Grehaigne and Godbout 2014), such as the loss of ball possession. In addition, it may be possible that players decrease their width distance to enhance the likelihood of performing successful penetrative passes. That is, to successfully progress on the field, the team in possession seems to explore different on-ball and off-ball movements, such as creating positional numerical superiority, that may allow them to destabilize the defensive organization (Fernández and Bornn 2018; Merlin et al. 2020). To promote such misalignments on the opposing defensive line, the player in possession may stay on the ball until the closest defender presses him, and then pass to a teammate on his lateral position (e.g., the right centre midfielder passing the ball to the left centre midfielder following the pressure of an opposing midfielder) that would take advantage of the high position of the defender to perform a successful penetrative pass. Therefore, decreasing the lateral distance between the offensive players may emerge as a functional behaviour to enhance the likelihood of creating penetrative passes. In contrast, when their distances are considerably high, it would take more time for the ball to be passed and possibly, the defensive team would have time to adjust their positioning. For instance, Moura et al. (2012) also revealed that the increase on the offensive play space results in unsuccessful sequences of play.

Such variations at the macro-level are clearly dependent on the spatial adjustments at the meso-level and the attacking team, more than to spread or compact on the field, need to create supportive and penetrative passing lines according to the behaviour of the defensive line (Fernández and Bornn 2020). In this sense, it seems more appropriate to highlight the spatial interactions between attacking and defending teams, than to define strict rules of behaviour (tactical principles of the game) in offensive and defensive sub-phase of play (McGarry 2009). A deeper understanding of the performance in team sports need to account with the local dominance (numerical and spatial temporal advantage) of each team in the spaces that surrounds the ball (Castellano and Álvarez 2013; Vilar et al. 2013a). Team performance might not only be related with the amount of space but with the spatial relations between players and teams that determine the possibilities for action at the meso-level (Silva et al. 2013). However, further research should not only consider the configurations of play that sustain players' actions, but also the patterns that afford such actions.

In line with our expectations, at the meso-level, a general decrease in the distances between players and an increase in the angles between players from SPP to UPP were observed. At the meso-level, our results revealed that SPP were characterized by higher values in the distances between players and a decrease in the angles between players, in comparison with UPP. Results suggest that successful penetrative passes occur due to a lower pressure of defenders to the passing lines (decrease in At1-Def1, At1-Def2 and Def1-Def2 and increase in Ag1 and Ag2) and to the ball receiver, thereby increasing the space and time available for the ball carrier to play and for ball reception.

These results are in line with the idea that the success of the defensive team is supported by the capability of defenders to coordinate their actions to constrain the space available for the ball carrier in relation to their teammates (Travassos et al. 2012b; Silva et al. 2013; Vilar et al. 2013b). Immediate defender to ball carrier and to ball receiver constraints ball trajectory from the ball carrier to minimize the distance that each player needs to cover to intercept the ball (Fajen et al. 2009). Particularly, the distance of the At2-Def3 revealed the highest difference and effect between successful and unsuccessful passes, highlighting the importance of the player of the second line (Def3) to approach the second attacker (At2) at the moment of the pass. Thus, the distance of the At2-D3 should be considered as an interesting variable for further consideration to improve the computational methods of calculating passing probability or even successful passing probability (Fernández and Bornn 2020) or off-ball advantage (Llana et al. 2020) in football. Also, this variable is a key informational variable that coaches should consider when adjusting the position of the second attacker to receive the ball inbetween lines and improving the distance to the defender of the second line. With this strategy, more than to receive the ball, the attacker ensures additional time for ball-oriented receptions to progress on the field (Travassos et al. 2012b).

More than the generalization of the observed tendencies to other teams, these findings highlight the importance of using the analysis of positional data to improve coaches' interventions. Through the identification of informational variables that sustain the spatial relations between players and teams at specific game sub-phases, it will be possible to identify team profiles of play and determine with better precision the vulnerabilities or the potential for successful performance of the team in different sub-phases of game (Travassos et al. 2013; Fernández and Bornn 2020). Further research should consider the players' directions of displacement and velocity in order to improve the understanding of such factors in the passing capabilities of defenders to avoid or intercept the pass.

Finally, an effect of pitch location on the outcome of the penetrative passes on the spatial relations between players (meso-level) was also observed. Generally, the distances between players were higher for penetrative passes that occurred in the Md than in the Fd, reinforcing the notion that different spatial relations sustained the success of penetrative passes in different places of the field.

Interpersonal distances between the immediate defenders to the ball carrier (At1-Def1 and At1-Def2) were higher in the midfield sector in comparison with the forward sector. Interestingly, while the distance between the first defensive line to the ball (At1-Def1 and At1-Def2) tend to increase from the Md to Fd sectors of the field, the second defensive line (Def1-Def2) tend to maintain the interpersonal distances between field sectors. Such results can be related to the players' understanding of the associated risk taken if he/she cannot intercept the pass, thereby exposing the team while the ball receiver progresses on the field with numerical advantage. Similar behaviours were previously observed (Headrick et al. 2011) in the analysis of 1 vs 1 sub-phases in football. When the 1 vs 1 occurred near to the goal of the defender, he/she increased the distance to the ball ensuring balance with the attacker and additional time for interception. Further research should also consider how spatial relations between players constraint penetrative passes according to variation in the field corridors (left, midfield and right) (Laakso et al. 2019).

Conclusions

In summary, successful penetrative passes were shown to be constrained by changes in spatial relations at the meso- and macro-levels between attacking and defending teams and according to the position on the pitch in which they occur. Interestingly, and in line with previous research, it seems that the emergence of unbalanced situations such as penetrative passes tend to be more constrained by spatial variations at the meso-level than at the macro-level (Ric et al. 2016).

At the macro-level, results regarding the width of the attacking team contrasted with the traditional tactical principles of offensive phase of the game. More than spreading the attacking team area of play, coaches and performance analysts need to understand the intertwined spatial relations between players and teams that afford possibilities for action within the game.

At the meso-level, for successful penetrative passes, the ball carrier should explore and increase the interpersonal distances with opponents, and particularly the ball receiver should increase the distance to the direct opponent to receive the ball in the space. The distance from the ball to the goal constraints players' spatial relations promoting different individual possibilities for passing actions.

Such informational variables need to be considered for coaches when designing practice tasks. For example, the space available for the reception of penetrative passes in between lines could be manipulated or highlighted during practice sessions to help attacking players to be more attuned to that information during play (Travassos et al. 2012c). For the development of the defensive team, coaches should promote unbalance situations that require constant adjustments in the distances between players and between lines according to the position of the ball. For example, a practice task with variable number of players (according with the system adopted by the coach) and played at different distances to the defending goal could be used to emphasize different penetrative passing possibilities. During an offensive phase, the attacking team progress towards the opponent midfield performing passes in between defensive lines aiming to create opportunities to shot at goal. To promote adaptive behaviours of the attacking team to explore different (unexpected) possibilities to perform penetrative passes, the coach could manipulate the spatial relations between defenders or changing the area of play that they need to cover. The spatiotemporal relations between defenders of the 1st defensive line in relation to ball carrier and the variation of the area of play in between defensive lines available to the attacking players receive the ball should be stressed to guide the behaviours of attacking players.

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