Routledge
Taylor & Francis Group

A spatial analysis of ball recovery locations, ball recovery methods and eventual possession outcomes in elite women's football using a Bayesian network approach

Mikael Jamil ⓘ[a], Christopher McElduff[a], Lucas Adshead[a], Joseph Welsh[a], Adnane Ezzizi[b] and Marco Beato[a]

[a]School of Allied Health Sciences, University of Suffolk, Ipswich, UK; [b]School of Technology, Business and Arts, University of Suffolk, Ipswich, UK

ABSTRACT

The aim of this study was to investigate the impact ball recovery tactics had on attacking performance in women's football. As such, in this study ($n = 19,040$), occurrences of open-play possession regain events in professional women's football across professional European leagues were analysed. A Bayesian Network model was applied to the data and the results revealed some unique insights. Organised pressing was revealed to be effective throughout the pitch but its pay-off mainly depends on where the ball is won. Successful pressing occurrences that resulted in the regaining of possession in the attacking right-hand side of the playing surface produced the highest likelihood of creating goal-scoring chances. Furthermore, the results of this study revealed that interceptions are the dominant recovery method, especially in central zones and tackling becomes more influential in wide areas of the pitch. In addition, this study revealed that team quality and recovery method both influenced outcomes, but only indirectly via their effect on regain location, while venue has no detectable impact on possession outcomes. Whilst this study did discover some similar trends in ball recovery patterns to those discovered previously in men's football, some unique findings specific to women's football were also discovered.

1. Introduction

In recent years, there has been quite a lot of academic interest on the tactical performance aspect of possession regains in football (soccer) and how this strategy can influence general attacking and defensive performances (Hughes & Lovell, 2019; Iván-Baragaño et al., 2021; Jamil, 2019; Oliva Lozano et al., 2025). One of the reasons for this increased level of attention is because possession regains that occur in open-play can often initiate what are commonly referred to as offensive or defensive transitions depending on whether the ball has been won or lost (Jamil, 2019; Maneiro et al., 2019; Vogelbein

et al., 2014). Specifically offensive transitions refer to any technical and tactical actions a team makes after regaining possession of the ball in order to take advantage of the opponents collective re-organisation – a time when the opponent themselves will be in a defensive transition (Maneiro et al., 2019). The tactic of the "counter-attack" is also a type of offensive transition that has been revealed in previous studies to be an effective means of creating goal scoring opportunities, further highlighting the importance of regaining possession of the ball (Sarmento et al., 2014). Previous research examining the performance aspect of possession regains have discovered contrasting results with regard to how effective this strategy can be and the locations on the playing field where these occurrences are most frequent. Whilst some research has discovered possession regains that occur closer to the opponents goal are most effective with regards to creating goal scoring opportunities (Hughes & Lovell, 2019; Jamil, 2019), other research has discovered possession regain instances that occur deeper in their own (defensive) half of the pitch are more productive (Almeida et al., 2014; Barreira et al., 2014; Gómez et al., 2012). Part of the reason for these mixed results is because different teams will use the possession regains (and the resulting offensive transitions) in different ways (Maneiro et al., 2019). Some teams will adopt a more direct and rapid offensive transition in search of an immediate goal scoring opportunity, whereas other teams will adopt a more patient and more elaborate offensive transition as they look to gradually build an attacking opportunity (Maneiro et al., 2019).

There are however, two things that seem to have been relatively ignored in previous studies on this performance aspect of possession regains. Firstly, there hasn't been too much attention awarded to the specific movements of players just prior to open play possession regain instances and how these movements often trigger the possession turnover and thus initiate the offensive transition. For the purposes of this study, these specific player movements will be referred to hereafter as organised pressing movements (OP). This action of organised pressing is defined as a direct movement by a player (or players in unison) towards an opponent in possession of the ball or the opponent who would be the potential receiver of a pass. Secondly, there appears to be very little research on how OP movements can initiate ball recoveries in women's football and how effective the resulting possession regains can be with regard to initiating offensive transitions. This is somewhat surprising given that there are proven gender differences between men's and women's football with regard to physical, technical and tactical performance (Bradley et al., 2014; Casal et al., 2020; Pappalardo et al., 2021).

Women's football is rapidly growing in terms of popularity and is becoming an internationally competitive sport (Scanlan et al., 2020). Consequently, female participation in the sport has been steadily increasing for some years now at both grassroots and professional levels (Harkness-Armstrong et al., 2022). The rapid growth of women's football has been elicited by numerous factors such as the formation of professional women's leagues, increased television coverage of league fixtures and international tournaments, more extensive and more positive media coverage and a growth in participation (Griffin et al., 2020; O'Donoghue & Beckley, 2023; Petty & Pope, 2019). Burgeoning investment in women's football and particularly in performance-based research has also played a part in enhancing the professionalism of the sport and decreasing of the performance gaps between male and female football (Griffin et al., 2020). Some of this performance-based research has been focussed on physical

performance (Datson et al., 2019; Griffin et al., 2020; McCormack et al., 2015; Vescovi & Falenchuk, 2019), whilst other research has focussed more on tactical and technical performance (Kubayi, 2022; Kubayi & Larkin, 2020; Lopes et al., 2025; Mara et al., 2012; O'Donoghue & Beckley, 2023; Scanlan et al., 2020; Wang & Qin, 2020).

Whilst some of these studies have examined important tactical and technical aspects of performance such as the importance of ball possession as well as the creation of goal scoring opportunities in women's football (Kubayi, 2022; Kubayi & Larkin, 2020; Mara et al., 2012; O'Donoghue & Beckley, 2023), there is relatively little research tactical aspects of play such as, the open-play turnovers of possessions, their causes and the most frequent locations in which they occur in women's football. Furthermore, what is also lacking in research on women's football (and lacking depth in men's football) is how specific player movements in the form of organised pressing tactics can facilitate a recovery of possession in open-play and thus initiate these transitions. Although some studies have specifically examined high-pressing strategies in men's football they too have discovered some contrasting results. On one hand, it has been advised that teams should adopt a high-pressing strategy sparingly or only in cases where they have numerical superiority (Low et al., 2018, 2021). Whilst other research has discovered high-pressing strategies to be particularly effective (Jamil, 2019). Although Jamil (2019) did caution that the evaluation of this type of strategy should be assessed on a case-by-case basis as successful implementation of it depends largely upon the abilities of the players available.

Taking the points raised above in to consideration, this study will exclusively focus on elite-level women's football and specifically examine 19,040 instances of OP movements that led to successful ball recovery. Specifically, this study will examine the outcome of the ball recovery instigated by OP, the location in which ball recoveries and thus OP occurred and the method of ball recovery. This study will therefore explicitly examine how the factors above as well as factors such as venue (match location) and league standing of teams can impact attacking performances in women's football.

2. Methods

2.1. Design and data

In this retrospective study, a total of ($n = 19,040$) instances of successful OP were analysed. The outcome of each instance was recorded as either "possession lost", "possession maintained non-progressive" or "possession maintained progressive". Possession lost referred to cases where the team/player regaining the ball were unable to play a single successful pass to a team-mate due to them immediately surrendering possession (by either kicking the ball out of play or losing it to an opponent). In these cases, the team regaining possession of the ball had no controlled possession of the ball immediately after the turnover of possession occurred. Possession maintained non-progressive referred to cases where the team/player regaining the ball were able to play at least one successful pass to a team-mate and therefore enjoy some controlled possession of the ball, but that spell of possession did not result in a goal scoring opportunity. This would have included cases where teams passed the ball multiple times following the turnover of possession before eventually winning a foul for their team or eventually surrendering possession back to their opponent (by either kicking the ball out of play or losing it to an opponent).
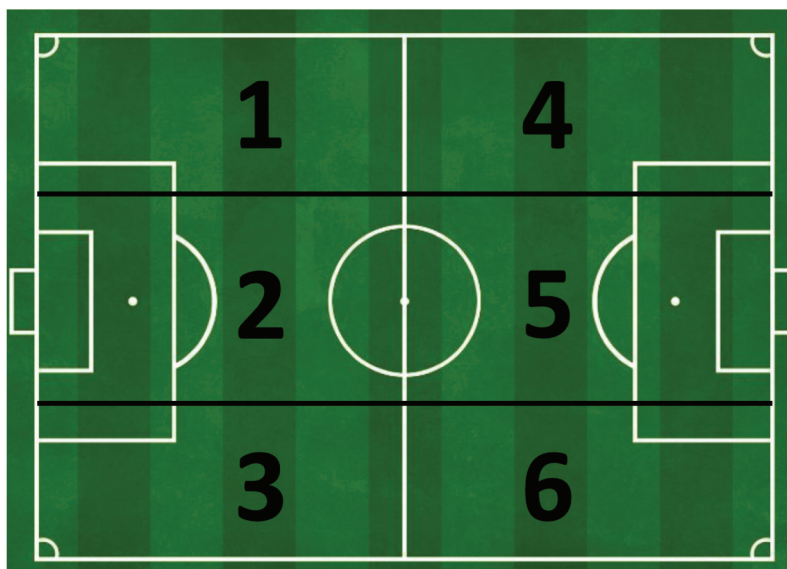
Figure 1. The 6 playing zones where all organised pressing instances were recorded.

Possession maintained progressive referred to cases where the team/player regaining the ball were able to play at least one successful pass to a team-mate and therefore enjoy some controlled possession of the ball, with that spell of possession eventually resulting in a goal scoring opportunity. This would have included all instances where a spell of possession immediately after a ball recovery instance eventually led to a shot off target, a shot on target or a goal being scored.

The sample consisted of a total of 264 matches from the Women's Super League (England) and the Division 1 Féminine (France). All matches took place in the 2021/2022 season and the entire season of each league was originally selected for analysis. Ultimately, a total of 2 games from the Division 1 Féminine were removed from the sample as the video footage was corrupted, not allowing a complete analysis. This resulted in a final sample of 262 matches. All matches were downloaded from the platform Wyscout (Chiavari, Italy) and all matches were manually coded on Hudl Sportscode version 11.4 (Lincoln, NE, U.S.A.). All matches were coded originally by three coders with 1–3 years of experience. A fourth coder, with over 10 years of experience was then tasked with conducting inter-operator reliability checks on the data collected. The playing surface was divided in to six roughly equal sized zones as illustrated in Figure 1. In cases where possession regains occurred on a border region, all three of the original data collectors came to a unanimous decision with regard to which one zone the possession turnover should be attributed to. Each coder was limited to a maximum of six games a day as a means of quality control. In addition to ball recovery location, data was also collated on the type of recovery (tackle or interception), the league standing of the opponent at the time of the fixture as a measure of opponent quality and the venue of the fixture.

2.2. Reliability testing

Reliability analysis was conducted akin to Jamil et al. (2020) and therefore consisted of two phases:

Phase 1 – All 19,040 successful OP movements instances that resulted in a possession regain from open play were initially recorded by a team of data collectors (C1). Intra-observer reliability testing occurred 4–6 weeks later on a random sample of 392 possession regains (C2).

Phase 2 - Inter-observer reliability was then also conducted a further 16 weeks after phase 1 reliability and was completed by an independent operator who was observing OP instances from the sample for the first time (C3). For this phase, 392 possession regains were again selected with 20% of these (78 OP instances) randomly selected out of the 392 OP instances observed during C2 and a further 314 OP instances randomly selected from the remaining 18,648 possession regain instances observed during C1. Sample sizes of 392 possession regain instances for the test-retest phases detailed above were determined by Slovin's formula (Equation 1) with a 5% error as used by (Jamil et al., 2020). The weighted kappa statistic was calculated as a means to test the inter-observer reliability of the data collection procedure as recommended by Jamil (2019). The interpretation of kappa values obtained was as follows: <0 less than chance agreement; 0.01–0.20 poor agreement; 0.21–0.40 fair agreement; 0.41–0.60 moderate agreement; 0.61–0.80 good agreement; 0.81–0.99 almost perfect agreement (Jamil, 2019; Liu et al., 2013). The kappa value for the *intra-observer* reliability (C2) was 0.9782 for the zone of the possession regain (only 7 discrepancies) and 0.9938 for the type of possession regain (only 2 discrepancies) indicating a high level of agreement (almost perfect) between the (C1) and (C2) coding attempts. The kappa value for *inter-observer* reliability was 0.9907 for the zone of the possession regain (only 3 discrepancies) revealing a very high degree of agreement between (C1) and (C3). The kappa value for *inter-observer* reliability was 0.9969 for the type of possession regain (only 1 discrepancy), also revealing a very high degree of agreement between (C1) and (C3). Overall, the reliability results revealed consistency and very high accuracy in the recording of the zones in which OP events occurred and the types of regains. Ethical approval for this study was obtained by the ethics committee of the local institution.

$$\frac{N}{1 + Ne^2} \tag{1}$$

2.3. Bayesian network modelling

We use Bayesian network (BN) modelling to examine how the outcome of the ball recovery (lost, non-progressive or progressive) is affected by the regain zone area (zones 1–6), the method of ball recovery (interception or tackle), league standing (top half or bottom half) and match venue (home or away). A BN is a graphical statistical model that captures dependencies among a set of variables and enable probabilistic inference among them. It captures not only the direct effect of each variable on a particular outcome variable (here, possession regain outcome) but also how various factors influence one another and interact to produce different results (e.g. does league standing affect the likelihood of regaining possession directly, or is the effect

mediated by the area in which the regain occurred?). Additional advantages of BN's include their natural handling of uncertainty – ideal for simulating "what-if" coaching scenarios, their ability to model multiple outcomes simultaneously and the possibility to incorporate expert insights into the graphical structure of the model (e.g. from coaches or performance analysts). Given these strengths, BN's have been widely adopted across a variety of disciplines (for a detailed examination of case studies, see Pourret et al., 2008). Within sports science, BNs have gained traction, for example, in analysing performance metrics (Ruiz-Pérez et al., 2019), assessing injury risk (Olmedilla et al., 2018) and predicting football match outcomes (Constantinou et al., 2012).

Bayesian networks are composed of nodes and edges. Each node in the network corresponds to a random variable (e.g. possession regain outcome). Directed edges between nodes indicate dependencies: the parent node (edge origin) can influence the child node (edge arrow), and these interactions are quantified by conditional probabilities (Russell & Norvig, 2021). At its core, a BN encodes the joint probability distribution of all variables, enabling probabilistic queries about any subset of these variables. For example, once the network is developed, it can estimate the likelihood of a progressive possession regain outcome given a particular regain method and regain zone area, expressed as Equation 2 below:

$$P(possession regain outcome = progressive | regain method = tackle, regain zone area = 5)$$

(2)

Such probabilistic inference capabilities would enable coaches to explore and simulate how various tactical adjustments might affect team performance. Besides, the network structure provides insights into how the variables interact and influence each other. Constructing a BN involves two main steps:

(1) **Determining the structure of the BN**: This includes identifying which variables should be connected by edges and the direction of these edges. For example, one needs to determine whether league standing and regain zone area are connected, and if so, which variable influences the other. The BN structure can be defined by a domain expert, learned entirely from the data or derived from a combination of both. In this study, the structure was learned exclusively from the dataset without incorporating any expert or prior knowledge, using the hill-climbing method (Russell & Norvig, 2021) with the Bayesian Information Criterion (BIC) score. However, to respect realistic constraints and domain logic, we imposed the following conditions on the learned structure: (1) no edges originating from possession outcome, ensuring it acts as the target variable in the model; (2) no edges pointing to venue or league standing, reflecting that these pre-match conditions cannot be changed by in-match events; and (3) no edge from regain method to regain area zone, recognising that regain area zone is not determined by how possession is regained. In line with recommendations by Scutari and Denis (2021), the BN structure was validated using a bootstrap-based strength analysis. Specifically, we generated 1,000 samples with replacement from the original dataset and estimated a BN for each sample. Edges that were present in more

than 85% of these bootstrapped BN models were retained, and edge directions were adopted if they appeared in more than 50% of the bootstrapped models.

(2) **Learning the model parameters**: Once the structure is fixed, the conditional probability tables (CPTs) for the nodes are estimated. Each CPT represents the probability distribution of a node given the values of its parent nodes. In our analysis, we derived these tables via maximum likelihood estimation using the available dataset.

The model structure is presented in Figure 2. All analyses were performed in R Statistical Software (v4.4.2; R Core Team, 2024), with BN modelling implemented using the *bnlearn* package (v5.0.2).

3. Results

The results of this study revealed that only the zone in which the possession regain occurred (regain area zone) directly impacted the possession outcome (as implied by the model structure in Figure 2). League standing and the method of possession regains indirectly affected possession outcome through the regain area zone; once the regain area was known, they provided no additional information regarding possession outcomes. Venue was revealed to have no impact (directly or indirectly) on possession outcome.

As revealed in Figure 3, possession regains that occurred close to the subject teams' own goals had the highest probability of being non-progressive possession spells, with central zone regains in the defensive half having the highest probability. Conversely, possession regains that occurred in the opponent's half had higher probabilities of being progressive possession spells, with the wide right zone being revealed as having the
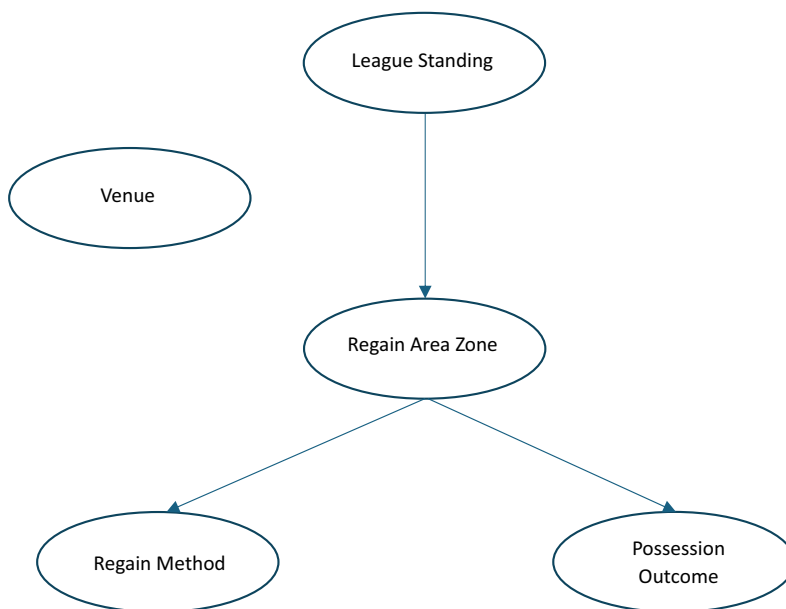

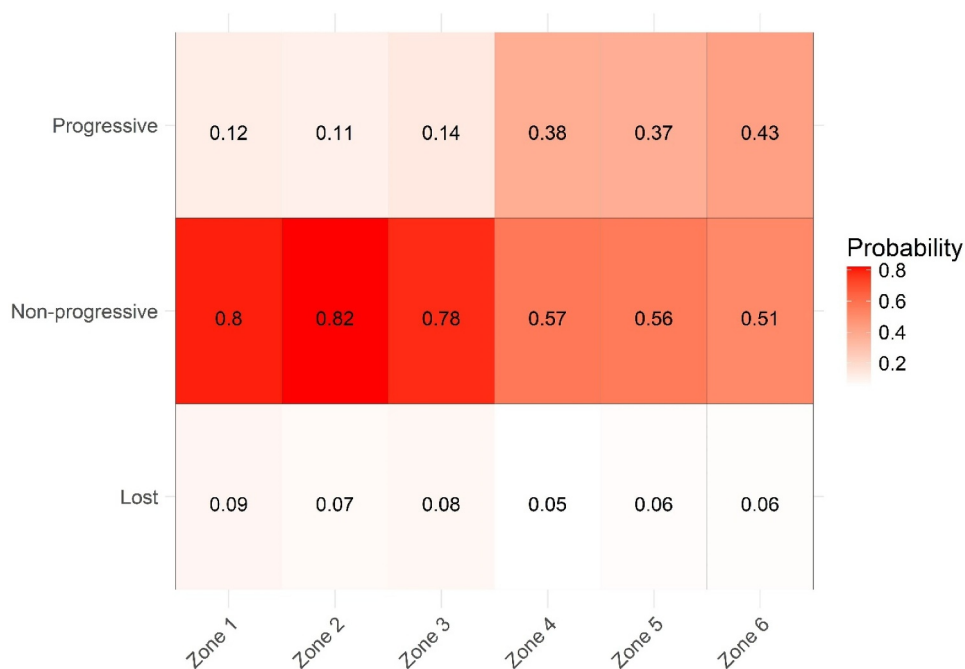**Figure 2.** Learned Bayesian network structure.

Figure 3. Estimated conditional probability distribution of possession regain outcome given zone area.

highest probability. In addition, top-half teams were revealed to have slightly higher probabilities of progressive possession spells following a regain, than bottom half teams who were also revealed to have higher probabilities of non-progressive possession outcome (Figure 4).

Furthermore, both bottom-half and top-half teams were revealed to have the highest probability of regaining possession of the ball in the central zone in their own half (Figure 5). With regard to method of regain (Figure 6), both tackling and interceptions were revealed to have an equal probability of impacting possession outcomes (0.72 non-progressive and 0.21 progressive, 0.007 lost). The results revealed in Figure 7 reveal a much higher probability of regains occurring via interceptions in central zones, with the highest probability revealed to be in the central zone of opponent's half. Tackling as a method of regaining the ball was revealed to have a higher probability of occurrence on the wings, particularly on the defensive left side. Whilst this study did discover some similar trends in ball recovery patterns to those discovered previously in men's football, some unique findings specific to women's football were also discovered.

4. Discussion

This study sought to investigate how organised pressing movements (co-ordinated and deliberate) tactics in elite women's football can elicit mistakes from opposing players leading to their surrendering of possession. By modelling the conditional dependencies among regain method, regain area zone, league standing, venue and possession regain
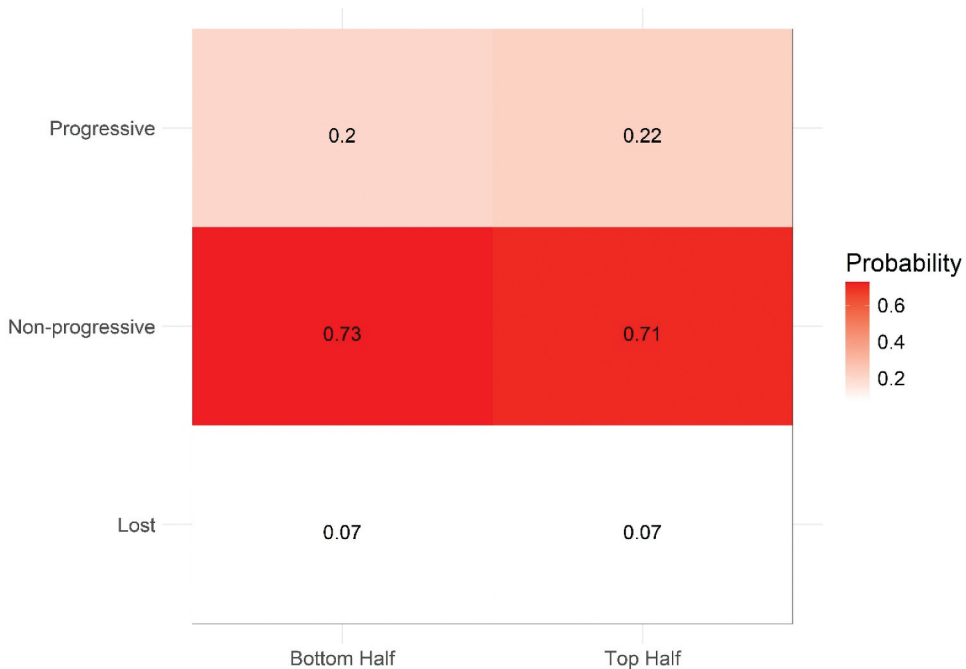
Figure 4. Estimated conditional probability distribution of possession regain outcome given league standing.

outcome with a Bayesian Network, we uncovered influence pathways that would have been obscured by statistical univariate or multivariate regression techniques, typically employed in sports analytics. The results revealed that OP movements work effectively in both halves of the playing field in terms of regaining and maintaining possession of the ball. However, the results also revealed that only the zone in which the regain occurred directly impacts the possession outcome. Interestingly, league standings and the method of possession regains impacted possession outcomes only indirectly through their effect on the regain zone.

The results of this study revealed a higher probability of non-progressive possession regains occurring in the central zone of the defensive half of the playing field. This finding does conform somewhat to previous research in men's football where it has been discovered that teams often deploy compact, deep-defending styles of play, that involve deliberately waiting until the ball is located in deeper positions before making concerted efforts to recover it (Almeida et al., 2014; Cooper & Pulling, 2020; Low et al., 2018). However, interestingly, this study has revealed that these regains have a high probability of being non-progressive. This could be partly explained by the distance between the attacking team (team that just won possession) and the opposing goal and the likely greater number of defenders in between the ball and the opposing goal (Casal-Sanjurjo et al., 2020).

This study also revealed a higher probability of possession regains resulting in progressive possession outcomes on the attacking right-hand side of the playing field.
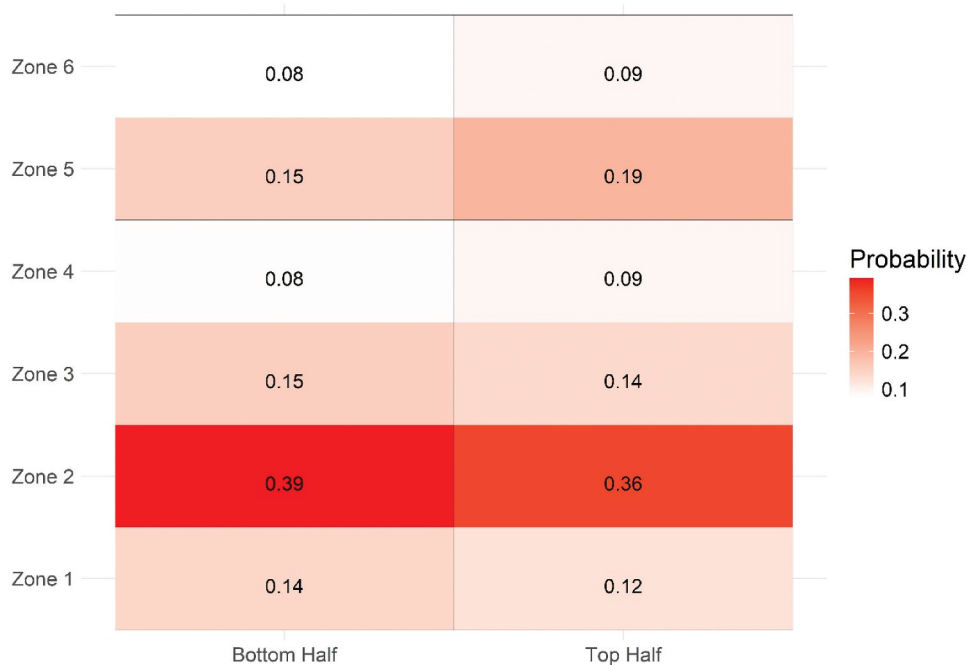
Figure 5. Estimated conditional probability distribution of zone area given league standing.

This result also conforms to similar results discovered in men's football where a strong relationship has been discovered between regaining the ball close to the opponents goal and successful attacking outcomes (Hughes & Lovell, 2019; Jamil, 2019); however, these results from previous studies have suggested regaining the ball in central zones close to the opponents goal is most effective (Wright et al., 2011). Conversely, the results of this study reveal that possession regains that occur on the right-hand side of the playing field (zone 6) have the highest probability of resulting in progressive possession outcomes that result in goal-scoring opportunities. This could be partly explained by the voluntary (or involuntary) use of inverted full-backs or inverted wingers (Plakias et al., 2023). Furthermore, this finding could be partly explained by teams adopting a strategy of deliberately targeting opposing players performing in wide defensive positions as a trigger for their press (Jamil, 2019). However, this particular finding requires further research.

The results of this study also revealed that top-half teams had a higher probability of regaining possession that then went on to result in progressive possession outcomes and a lower probability of regains that resulted in non-progressive outcomes. This result is perhaps not too surprising as better-ranked teams have been revealed in previous studies to be more proficient at regaining possession of the ball, regain it quicker and regain it closer to the opponents goal (Low et al., 2021; Santos et al., 2017; Vogelbein et al., 2014). This study also revealed interceptions to be much more likely to occur than tackling as a means of regaining possession in all areas of the playing field, conforming with previous research in men's football (Cooper & Pulling, 2020). Furthermore, this study has revealed a higher probability of interceptions occurring in the central areas of both halves of the
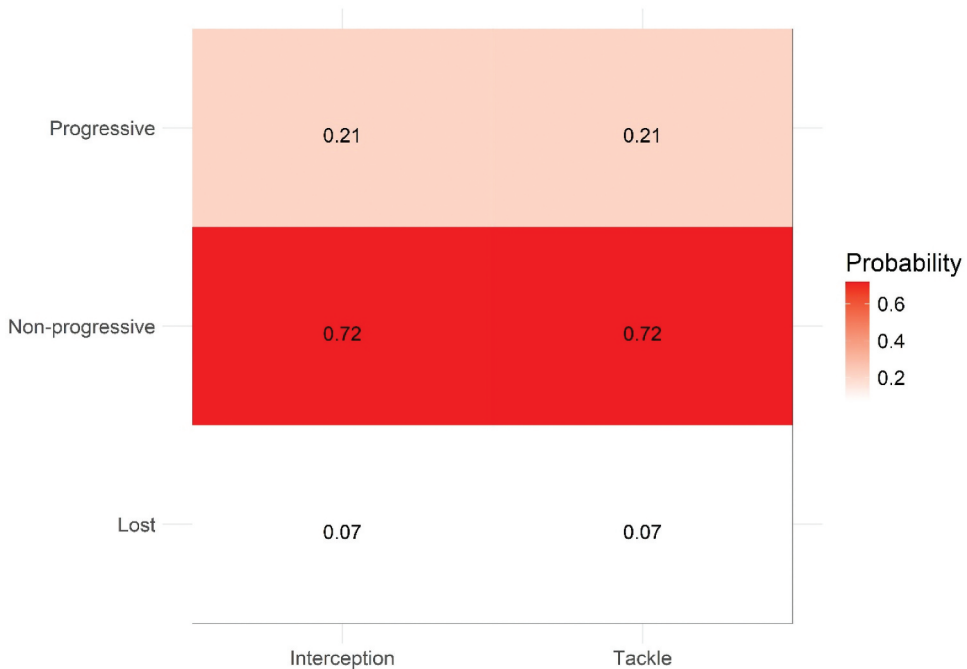
Figure 6. Estimated conditional probability distribution of possession regain outcome given regain method.

playing field. This result is consistent with previous research investigating gender differences in football, where it has been discovered that interceptions occur more frequently in both halves of the playing field in women's football relative to men's football (Casal et al., 2020). It has been suggested that the greater number of interceptions across the playing field in women's football is indicative of the lack of ball control in real game situations, relative to men's football (Casal et al., 2020).

The results of this study revealed a higher probability of tackling being used as a means of possession regain in wide areas of both halves of the playing field. There is some similarity here with findings discovered in men's football where it has been revealed that tackling occurs most frequently in the full-back positions (Ermidis et al., 2019). However, the results of this study also reveal that tackling is an effective means of ball recovery in wide areas of the attacking half. This could be partly explained by the greater number of ball losses in women's football (Bradley et al., 2014), which naturally means a greater number of opportunities for ball recovery in the opponent's half in women's football (Casal et al., 2020).

This study was not without limitations. Although all OP instances were recorded in only one of the six playing zones, there were some occasions where an OP was initiated in one zone, but then continued into and was completed in another. On these occasions, the ball recovery instance was recorded as having occurred in the zone where it was initiated. In addition, although every attempt was made to maintain six roughly equally sized zones, there were no visible markings on the playing surface identifying these (horizontal) zones. It is
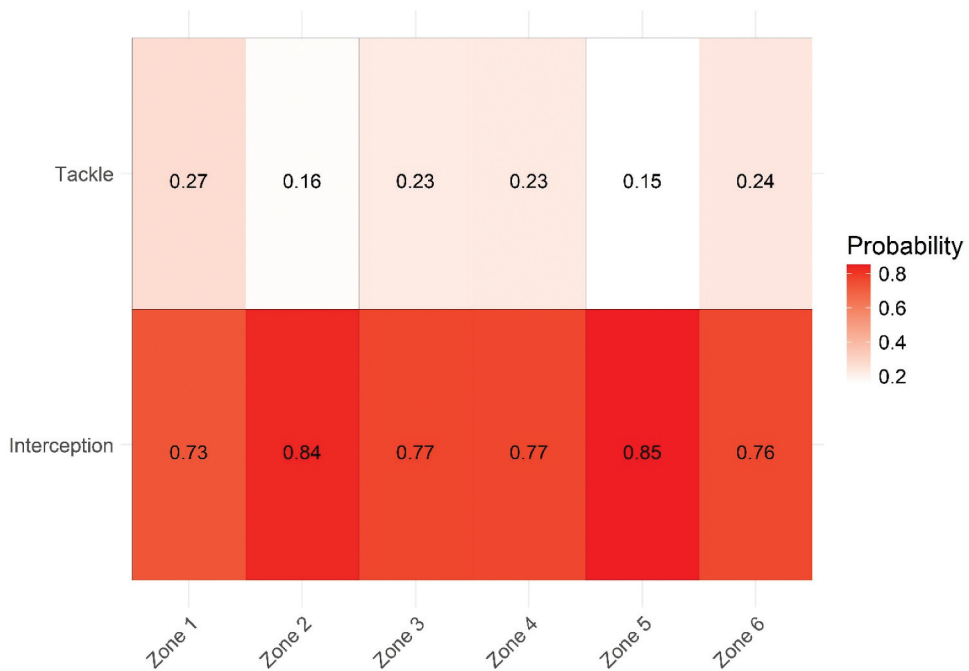
Figure 7. Estimated conditional probability distribution of regain method given zone area.

therefore possible that some OP instances that occurred on bordering zones were interpreted to have occurred in different zones by the coders. To limit the impact of this, all coders were advised to flag OP instances that were considered to have occurred on these bordering zones and then come to a unanimous agreement with regards to which zone to assign the OP occurrence. Furthermore, previous research has discovered that factors such as match status can impact ball recovery patterns (Vogelbein et al., 2014) and this data was absent from the data analysed in this study. Future research focusing on OP tactics and ball recovery patterns should explore a wider range of variables which may better account for the specific situational context. In addition, data on the exact distances players travelled to attempt a press was absent and this too could add value in future research. Finally, although BNs can uncover plausible causal links (e.g. "regain zone" -> "possession outcome"), this advantage rests mainly on the sufficiency assumption – that is, all relevant variables capable of influencing the outcome is represented and must be included in the model. Our parsimonious model left out several potential influencing variables, including, for example, match status as mentioned above. Future studies should add such factors to enrich the network structure reported here.

From a practical perspective, the findings of this study could inform recruitment strategies in elite women's football as wide players with good tackling attributes and central players with good anticipation and intercepting ability could be sought to help successfully implement an effective OP strategy. Furthermore, the results of this study could encourage more team managers to adopt and implement OP philosophies and

playing styles as they have been discovered to be an effective means of regaining and then maintaining possession of the ball, with regains further up the playing field more likely to result in progressive possession outcomes that lead to goal scoring opportunities.

5. Conclusion

The key findings of this revealed that organised pressing was revealed to be effective throughout the pitch but its pay-off mainly depends on where the ball is won. Successful pressing occurrences that resulted in the regaining of possession in the attacking right-hand size of the playing surface produced the highest likelihood of creating goal-scoring chances. Furthermore, the results of this study revealed that interceptions are the dominant recovery method, especially in central zones and tackling become more influential in wide areas of the pitch. In addition, this study revealed that team quality and recovery method both influenced outcomes, but only indirectly via their effect on regain location, while venue has no detectable impact on possession outcomes. Whilst this study did discover some similar trends in ball recovery patterns to those discovered previously in men's football, some unique findings specific to women's football were also discovered.

Disclosure statement

Funding

ORCID

Mikael Jamil http://orcid.org/0000-0001-6117-0546

Data availability statement

Due to commercial reasons (contractual agreement with Wyscout) supporting data is not available.

References

Almeida, C. H., Ferreira, A. P., & Volossovitch, A. (2014). Effects of match location, match status and quality of opposition on regaining possession in UEFA Champions League. *Journal of Human Kinetics*, *41*(1), 203–214. https://doi.org/10.2478/hukin-2014-0048

Barreira, D., Garganta, J., Guimarães, P., Machado, J., & Anguera, M. T. (2014). Ball recovery patterns as a performance indicator in elite soccer. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering & Technology*, *228*(1), 61–72. https://doi.org/10.1177/1754337113493083

Bradley, P. S., Dellal, A., Mohr, M., Castellano, J., & Wilkie, A. (2014). Gender differences in match performance characteristics of soccer players competing in the UEFA Champions League. *Human Movement Science*, *33*(1), 159–171. https://doi.org/10.1016/j.humov.2013.07.024

Casal, C. A., Losada, J. L., Maneiro, R., & Ardá, A. (2020). Gender differences in technical-tactical behaviour of La Liga Spanish football teams. *Journal of Human Sport & Exercise*, *16*(1), 1–16. https://doi.org/10.14198/JHSE.2021.161.04

Casal-Sanjurjo, C. A., Andujar, M. Á., Ardá, A., Maneiro, R., Rial, A., & Losada, J. L. (2020). Multivariate analysis of defensive phase in football: Identification of successful behavior patterns of 2014 Brazil FIFA World Cup. *Journal of Human Sport & Exercise*, *16*(3), 1–14. https://doi.org/10.14198/jhse.2021.163.03

Constantinou, A. C., Fenton, N. E., & Neil, M. (2012). Pi-football: A bayesian network model for forecasting association football match outcomes. *Knowledge-Based Systems*, *36*, 322–339. https://doi.org/10.1016/j.knosys.2012.07.008

Cooper, D., & Pulling, C. (2020). The impact of ball recovery type, location of ball recovery and duration of possession on the outcomes of possessions in the English Premier League and the Spanish La Liga. *Science and Medicine in Football*, 1–7. https://doi.org/10.1080/24733938.2020.1722319

Datson, N., Drust, B., Weston, M., & Gregson, W. (2019). Repeated high-speed running in elite female soccer players during international competition. *Science and Medicine in Football*, *3*(2), 150–156. https://doi.org/10.1080/24733938.2018.1508880

Ermidis, G., Randers, M. B., Krustrup, P., & Mohr, M. (2019). Technical demands across playing positions of the Asian Cup in male football. *International Journal of Performance Analysis in Sport*, *19*(4), 530–542. https://doi.org/10.1080/24748668.2019.1632571

Gómez, M. A., Gómez-Lopez, M., Lago, C., & Sampaio, J. (2012). Effects of game location and final outcome on game-related statistics in each zone of the pitch in professional football. *The European Journal of Sport Science*, *12*(5), 393–398. https://doi.org/10.1080/17461391.2011.566373

Griffin, J., Larsen, B., Horan, S., Keogh, J., Dodd, K., Andreatta, M., & Minahan, C. (2020). Women's football: An examination of factors that influence movement patterns. *The Journal of Strength and Conditioning Research*, *34*(8), 2384–2393. https://doi.org/10.1519/JSC.0000000000003638

Harkness-Armstrong, A., Till, K., Datson, N., Myhill, N., Emmonds, S., & Chenette, E. (2022). A systematic review of match-play characteristics in women's soccer. *PLOS ONE*, *17*(6), e0268334. https://doi.org/10.1371/journal.pone.0268334

Hughes, M., & Lovell, T. (2019). Transition to attack in elite soccer. *Journal of Human Sport & Exercise*, *14*(1), 236–253. https://doi.org/10.14198/jhse.2019.141.20

Iván-Baragaño, I., Maneiro, R., Losada, J. L., & Ardá, A. (2021). Multivariate analysis of the offensive phase in high-performance women's soccer: A mixed methods study. *Sustainability (Switzerland)*, *13*(11), 1–16. https://doi.org/10.3390/su13116379

Jamil, M. (2019). A case study assessing possession regain patterns in English Premier League football. *International Journal of Performance Analysis in Sport*, *19*(6), 1011–1025. https://doi.org/10.1080/24748668.2019.1689752

Jamil, M., Littman, P., & Beato, M. (2020). Investigating inter-league and inter-nation variations of key determinants for penalty success across European football. *International Journal of Performance Analysis in Sport*, *20*(5), 892–907. https://doi.org/10.1080/24748668.2020.1794720

Kubayi, A. (2022). The creation of goal-scoring opportunities at the 2019 FIFA Women's World Cup. *Journal of Human Kinetics*, *82*(1), 165–172. https://doi.org/10.2478/hukin-2022-0043

Kubayi, A., & Larkin, P. (2020). Technical performance of soccer teams according to match outcome at the 2019 FIFA Women's World Cup. *International Journal of Performance Analysis in Sport*, *20*(5), 908–916. https://doi.org/10.1080/24748668.2020.1809320

Liu, H., Hopkins, W., Gómez, A. M., & Molinuevo, S. J. (2013). Inter-operator reliability of live football match statistics from Opta Sportsdata. *International Journal of Performance Analysis in Sport*, *13*(3), 803–821. https://doi.org/10.1080/24748668.2013.11868690

Lopes, R., Yousefian, F., Gómez-Ruano, M. Á., Galvão, M., Brito, J., & Travassos, B. (2025). FIFA Women's World Cup 2019-2023. A PCA approach to the evolution of technical event performance data and key performance indicators. *International Journal of Performance Analysis in Sport*, 1–11. https://doi.org/10.1080/24748668.2025.2476845

Low, B., Boas, G. V., Meyer, L., Lizaso, E., Hoitz, F., Leite, N., & Gonçalves, B. (2018). Exploring the effects of deep-defending vs high-press on footballers' tactical behaviour, physical and physiological performance: A pilot study. *Motriz: Revista de Educacao Fisica*, *24*(2), 1–7. https://doi.org/10.1590/S1980-6574201800020009

Low, B., Rein, R., Raabe, D., Schwab, S., & Memmert, D. (2021). The porous high-press? An experimental approach investigating tactical behaviours from two pressing strategies in football. *Journal of Sports Sciences*, *39*(19), 2199–2210. https://doi.org/10.1080/02640414.2021.1925424

Maneiro, R., Casal, C. A., Álvarez, I., Moral, J. E., López, S., Ardá, A., & Losada, J. L. (2019). Offensive transitions in high-performance football: Differences between UEFA Euro 2008 and UEFA Euro 2016. *Frontiers in Psychology*, *10*(JUN), 1–10. https://doi.org/10.3389/fpsyg.2019.01230

Mara, J. K., Wheeler, K. W., & Lyons, K. (2012). Attacking strategies that lead to goal scoring opportunities in high level women's football. *International Journal of Sports Science and Coaching*, *7*(3), 565–577. https://doi.org/10.1260/1747-9541.7.3.565

McCormack, W. P., Hoffman, J. R., Pruna, G. J., Scanlon, T. C., Bohner, J. D., Townsend, J. R., Jajtner, A. R., Stout, J. R., Fragala, M. S., & Fukuda, D. H. (2015). Reduced high-intensity-running rate in college women's soccer when games are separated by 42 hours. *International Journal of Sports Physiology and Performance*, *10*(4), 436–439. https://doi.org/10.1123/ijspp.2014-0336

O'Donoghue, P., & Beckley, S. (2023). Possession tactics in the UEFA Women's Euro, 2022 soccer tournament. *International Journal of Performance Analysis in Sport*, *23*(1), 48–64. https://doi.org/10.1080/24748668.2023.2206273

Oliva Lozano, J. M., Vidal, M., Yousefian, F., Cost, R., & Gabbett, T. (2025). Predicting the match outcome in the 2023 FIFA Women's World Cup and analysis of influential features. *Journal of Human Kinetics*, *98*, 169–182. https://doi.org/10.5114/jhk/195563

Olmedilla, A., Rubio, V. J., Fuster-Parra, P., Pujals, C., & García-Mas, A. (2018). A bayesian approach to sport injuries likelihood: Does Player's self-efficacy and environmental factors plays the main role? *Frontiers in Psychology*, *Volume*, 9–2018. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.01174

Pappalardo, L., Rossi, A., Natilli, M., & Cintia, P. (2021). Explaining the difference between men's and women's football. *PLOS ONE*, *16*(8), 1–17. https://doi.org/10.1371/journal.pone.0255407

Petty, K., & Pope, S. (2019). A new age for media coverage of women's sport? An analysis of English media coverage of the 2015 FIFA Women's World Cup. *Sociology*, *53*(3), 486–502. https://doi.org/10.1177/0038038518797505

Plakias, S., Moustakidis, S., Kokkotis, C., Papalexi, M., Tsatalas, T., Giakas, G., & Tsaopoulos, D. (2023). Identifying soccer players' playing styles: A systematic review. *Journal of Functional Morphology and Kinesiology*, *8*(3), 104. https://doi.org/10.3390/jfmk8030104

Pourret, O., Naim, P., & Marcot, B. (Eds.). (2008). *Bayesian networks: A practical guide to applications*. John Wiley & Sons.

R Core Team. (2024). *R: A language and environment for statistical computing (version 4.4.2)*. Computer software. R Foundation for Statistical Computing. http://www.R-project.org

Ruiz-Pérez, I., Ayala, F., Puerta, J. M., Elvira, J. L. L., De Ste Croix, M., Hernández-Sánchez, S., & Vera-Garcia, F. J. (2019). A Bayesian network approach to study the relationships between several neuromuscular performance measures and dynamic postural control in futsal players. *PLOS ONE*, *14*(7), e0220065. https://doi.org/10.1371/journal.pone.0220065

Russell, S. J., & Norvig, P. (2021). *Artificial intelligence: a modern approach* (4th ed.). Pearson.

Santos, P., Lago-Peñas, C., & García-García, O. (2017). The influence of situational variables on defensive positioning in professional soccer. *International Journal of Performance Analysis in Sport*, *17*(3), 212–219. https://doi.org/10.1080/24748668.2017.1331571

Sarmento, H., Anguera, M. T., Pereira, A., Marques, A., Campaniço, J., & Leitão, J. (2014). Patterns of play in the counterattack of elite football teams - a mixed method approach. *International Journal of Performance Analysis in Sport*, *14*(2), 411–427. https://doi.org/10.1080/24748668. 2014.11868731

Scanlan, M., Harms, C., Cochrane Wilkie, J., & Ma'ayah, F. (2020). The creation of goal scoring opportunities at the 2015 Women's World Cup. *International Journal of Sports Science and Coaching*, *15*(5–6), 803–808. https://doi.org/10.1177/1747954120942051

Scutari, M., & Denis, J.-B. (2021). *Bayesian networks: With examples in R* (2nd ed.). Chapman and Hall/CRC. https://doi.org/10.1201/9780429347436

Vescovi, J. D., & Falenchuk, O. (2019). Contextual factors on physical demands in professional women's soccer: Female athletes in motion study. *The European Journal of Sport Science*, *19*(2), 141–146. https://doi.org/10.1080/17461391.2018.1491628

Vogelbein, M., Nopp, S., & Hökelmann, A. (2014). Defensive transition in soccer - are prompt possession regains a measure of success? A quantitative analysis of German fußball-bundesliga 2010/2011. *Journal of Sports Sciences*, *32*(11), 1076–1083. https://doi.org/10.1080/02640414. 2013.879671

Wang, S. H., & Qin, Y. (2020). Differences in the match performance of Asian women's football teams. *Journal of Physical Education & Sport*, *20*(3), 2231–2238. https://doi.org/10.7752/jpes. 2020.s3299

Wright, C., Atkins, S., Polman, R., Jones, B., & Sargeson, L. (2011). Factors associated with goals and goal scoring opportunities in professional soccer. *International Journal of Performance Analysis in Sport*, *11*(3), 439–449. https://doi.org/10.1080/24748668.2011.11868563