Quantifying Pressing Effectiveness and Its Influence on Formations in Football

Quantifying Pressing Effectiveness and Its Influence on Formations in Football

by

Kenneth Ssekimpi

A Master's Mini-Dissertation

Submitted to the Department of Statistical Sciences

in partial fulfillment of requirements

for the Masters in Philosophy, Data Science Program

March 23, 2025

Table of Contents

Glossary

Abbreviations

BDP Buildup Disruption Percentage

DAxT Defensive Action expected Threat

EPL English Premier League

GABR Generalised Action-based Ball Recovery Model

PPDA Passes Per Defensive Action

VPEP Valuing Pressure Events by Estimating Probabilities

WSL Women's Super League

xA expected Assists

xG expected Goals

xT expected Threat

Parameters

These are for illustrative purposes for now…

BDP Buildup Disruption Percentage

DxAT Defensive Action expected Threat

PPDA Passes Allowed Per Defensive Action

PSR Pressing Success Rate

VPEP Valuing Pressure Events by Estimating Probabilities

xG expected Goals

xT expected Threat

Nomenclature

P_{win} *Probability of winning the ball*

$P_{goal/chance}$ *Probability of conceding a goal-scoring chance

t *Time variable used in pressing analysis (e.g., time to recover possession)*

x *Spatial location on the field (x-coordinate)*

y *Spatial location on the field (y-coordinate)*

w *Weight or significance of pressing action*

μ *Mean (average pressing intensity or event probability)*

σ *Variance (to represent variability in pressing effectiveness)*

Terminology

ball recovery the act of regaining possession of the ball, typically following a press or interception.

batch subset of training data used in one iteration.

compactness the degree to which a team stays close together, minimising space for opponents to exploit.

counter-attacking a playing philosophy focused on quickly attacking after regaining possession.

counter-press the act of pressing immediately after losing possession, often within a few seconds

defensive strategies these include overall approaches like deep-defending (maintaining a compact shape near the goal) and high-press (applying pressure high up the pitch).

defensive transition the phase in which a team shifts from attack to defence, often involving immediate pressing to regain possession

dropout optimise by randomly dropping out neurons during training

epoch one pass through the entire training dataset

expected Assists (xA) a measure of the likelihood that a pass will result in a goal

expected Goals (xG) a metric that quantifies the likelihood of a shot resulting in a goal, based on historical shot data

expected Threat (xT) a metric designed to quantify the danger posed by having possession of the ball in a specific location on the pitch (or resulting from a specific action).

formation tactical arrangement of players on the pitch (e.g. 4-4-2, 3-5-2)

gegenpressing a high-intensity pressing tactic that emphasises immediate pressure after losing possession to force errors from the opponent

** derivative of cost w.r.t. model parameters

line-breaking pass a pass that bypasses one or more defensive lines, putting the opposing team at a tactical disadvantage

marking defending players positioning themselves to restrict the movement and passing options of opponents

optimizer algorithm used to minimise the cost function

overfitting model is memorising the training data and not generalising well to new data

passing patterns the sequences and styles of passes between players that are considered part of offensive tactics

pressing defensive tactic where players apply pressure on opponents to regain possession quickly

regularisation optimisation by adding a penalty term to the loss function

spatial analysis analysis that takes into account player positions and movements on the pitch.

turnover gaining possession from the opponent, often as a result of successful pressing

underfitting model is not able to learn the underlying patterns in the data

zone-pressing pressing applied within a specific area or zone of the pitch

Chapter 1

Introduction

1.1 Background

Association football, also known as soccer, is a game played by two teams of eleven players each. Teams compete with the common goal of advancing a ball into their opponent's goal area, with the hope of scoring more goals than the opposing team. Teams would do so by adhering to established rules that govern gameplay, player conduct, and scoring (Memmert and Raabe 2018; **sumpter2016?**). This fundamental simplicity is a major reason for its global popularity. However, despite its simple premise, football possesses incredible complexity characterised by movement patterns, match plans, playing philosophies, and creativity. These qualities qualities are collectively referred to as football tactics (Memmert and Raabe 2018).

Football tactics can be understood as the intelligent deployment of players on the field and their co-ordinated movements within that structure, aiming to achieve success in the game. This encompasses both the formation a team adopts (i.e., the spatial arrangement of players on the pitch) and their overall style of play [(**wilson2020?**)]. Additionally, [Rein and Memmert (2016)] describes football tactics as the actions and strategies implemented by a team and its players during a match in order to achieve specific goals, primarily winning the game. These actions are typically adaptations to the dynamically changing situations of the match and the behaviour of the opposing team, managing space, time, and individual actions on the pitch.

Central to modern football strategy is a defensive tactic known as pressing. Pressing involves a co-ordinated attempt by a team to quickly regain possession of the ball by quickly applying immediate pressure on opponents to limit their spatial options and disrupt their offensive play. It involves players actively closing down opponents who have the ball and blocking potential passing lanes (**borbely2018?**).

The rise of data analytics has revolutionised the way football is understood and analysed today. While intuition and subjective observation once dominated, ob-

jective metrics and algorithms now offer deeper insights into performance, tactics, and outcomes (Memmert and Raabe 2018). Data analytics and machine learning in football have rapidly grown, rivalling analytics in sports like baseball, cricket, and basketball (Herold et al. 2019; Rico-González, Markel et al. 2023). This data-driven revolution has fuelled a deeper exploration into pressing as a critical aspect of football tactics.

Advanced pressing styles, such as high pressing, increase the likelihood of recovering the ball in advanced areas of the pitch, enabling teams to capitalise on their opponents' disorganisation following a turnover (Brîndescu, Datcu, and Buda 2021; Fernandez-Navarro et al. 2020; Modric, Gabrilo, and Sekulic 2023). Research indicates high-pressing tactics can effectively limit the opponent's time on the ball, forcing hurried decisions and mistakes (Forcher et al. 2023; Low et al. 2021). This can lead to a higher frequency of goal-scoring opportunities, as teams can exploit the spaces left by opponents who are caught out of position during pressing situations (Cooper and Pulling 2020; Fernandes et al. 2020).

Pressing has emerged as a defining tactical element. Modern tactics showcase how co-ordinated pressure can transform defence into attack, dictating the flow and tempo of matches. Pressing disrupts opponents, forces turnovers, and creates goal-scoring opportunities, making it a cornerstone of contemporary football tactics (Robberechts 2019).

Pressing serves a dual tactical purpose: it aids both defence and attack. However, its effectiveness is closely linked to the physical demands placed on players. Studies show that pressing requires high-intensity running and quick recovery periods, significantly impacting physiological performance (Bortnik, Burger, and Rhodes 2022; Ju et al. 2023). The ability to maintain high levels of intensity during pressing phases is crucial, as it not only impacts the immediate success of regaining possession but also influences overall match performance (Carr, Mullen, and Williams 2020; Fernandez-Navarro et al. 2019). Teams capable of sustaining effective pressing throughout matches tend to achieve better outcomes, maintaining pressure on opponents and generating more scoring opportunities (Liu 2023; Modric, Gabrilo, and Sekulic 2023). However, variability exists in physical demands, with some studies noting decreased exertion due to tactical efficiency, while others note intensive physical requirements for certain positions (Low et al. 2018; Carr, Mullen, and Williams 2020).

The execution of pressing is also influenced by various contextual factors, such as opponent quality, match situations, and formations. Research suggests that pressing effectiveness varies with these situational variables, underscoring the need for adaptable strategies (Toda et al. 2022; Ruan et al. 2022). For instance, teams may choose to implement a more aggressive pressing strategy against weaker opponents while adopting a more conservative approach against stronger teams (Bauer, Anzer, and Shaw 2023; Forcher et al. 2024). In addition, formations such as 4-3-3 and 3-5-2 offer structural advantages, including improved spatial coverage and compactness, enabling coordinated defensive actions. High pressing within these formations creates larger attacking zones and increased entries into the final third,

as demonstrated in league performances (Brîndescu, Datcu, and Buda 2021; Scotognella 2021).

1.2 Research Problem

Pressing is a fundamental tactical component in football, influencing defensive solidity and offensive transitions. Several metrics exist to quantify pressing effectiveness, such as Passes Allowed Per Defensive Action (PPDA), Buildup Disruption Percentage (BDP), Defensive Action Expected Threat (DAxT), and Valuing Pressure Decisions by Estimating Probabilities (VPEP). However, these metrics have limitations in accounting for contextual factors such as formation shifts, pressing traps and pressing triggers, and possession-based outcomes.

Most advanced pressing analyses require tracking data, which is not always freely available, making it difficult to evaluate pressing effectiveness comprehensively across different datasets. Given the availability of StatsBomb 360 data for select tournaments but only event data for others, this research seeks to develop new pressing evaluation models that work without tracking data, while still offering deep tactical insights into pressing effectiveness across different tactical formations and adjustments.

1.3 Research Aims and Objectives

This resarch aims to advance the analysis and understanding of pressing in football by developing robust metrics that integrate tactical context, spatial data, and offensive outcomes. Specifically, this study addresses three core objectives:

1. **Enhance existing pressing metrics** by systematically reviewing and expanding upon established measures such as Passes Allowed Per Defensive Action (PPDA), Ball Disruption Percentage (BDP), Defensive Action Expected Threat (DAxT), Generalised Ball Action Recovery (GABR), and Valuing Pressure Events by Estimating Probabilities (VPEP). This enhancement will incorporate tactical dimensions like formation drills, pressing traps, pressing triggers, and outcomes related to possession value.
2. **Develop novel pressing effectiveness metrics** capable of functioning effectively in the absence of detailed tracking data. Leveraging widely available event-based datasets (StatsBomb, FBRef, WySout, etc.), the metrics will be validated across multiple leagues and tournaments, including both men's and women's international and club competitions, ensuring their robustness and applicability in diverse contexts.
3. **Quantify the relationship between pressing effectiveness and offensive potential**, analysing how successful pressing translates into attacking opportunities through Expected Threat (xT) and Expected Goals (xG) chain analysis. This objective includes evaluating variations in pressing effectiveness across

tactical formations and examining pressing trends and intensity differences among different competitive contexts.

1.4 Research Questions

This dissertation aims to address the following research questions:

- How effectively do existing metrics (e.g., PPDA, BDP, GBAR, DAxT, VPEP) quantify pressing, and what contextual limitations do they have?
- How does pressing effectiveness vary across tactical formations, and what is the specific impact of pressing traps and triggers?
- What is the relationship between pressing success and offensive outputs (xT/xG chains), and how do these dynamics differ across men's and women's competitions, as well as between club and international tournaments?

1.5 Relevance and Contributions

This study quantifies pressing effectiveness in football, exploring its impact on tactical formations using event-based data (and some tracking data), machine learning, and performance metrics to optimise defensive transitions.

1.5.1 Academic Contributions

- Enhances existing pressing models by incorporating formation-based contextual factors and linking pressing actions to possession-based outcomes.
- Develops a pressing efficiency model that works without tracking data, enabling broader application in football analytics research.
- Bridges the gap between defensive pressing actions and offensive potential, integrating xT/xG chain analysis with pressing effectiveness.

1.5.2 Practical Contributions for Coaches, Analysts, and Scouts

- Provides a data-driven framework for evaluating pressing efficiency, which can be applied to tactical scouting and opponent analysis.
- Offers insights into how different formations impact pressing success, helping team optimise their defensive and transition strategies.
- Enables clubs to assess pressing effectiveness using widely available event data, making tactical evalutations more accessible even without high-cost tracking systems.
- Compares pressing trends across leagues and international tournaments, identifying macro-level tactical patterns that could inform team strategies.

1.6 Scope and Limitations

1.6.1 Scope

1.6.1.1 Data Sources

The study uses event-based as well StatsBomb 360 data for pressing analysis for the following tournaments:

- Cope America 2024, Euro 2020/1 & 2024, FAWSL 2020, Women's World Cup 2023, World Cup 2018 & 2022, and Bayer Leverkusen's unbeaten Bundesliga campaign in 2023/24.

Additionally, this study uses event-based data (without tracking data) from the EPL, La Liga, Serie A, Bundesliga, and Ligue 1, all from the 2015/16 season as test data.

This study considers the metrics: PPDA, DAx, VPEP, High-Intensity Pressing Sequences, and xT from Pressing.

Lastly, comparative analysis in the differences in pressing effectiveness across men's and women's football, club and international competitions, and top leagues and second-tier leagues is studied.

1.6.2 Limitations

The study utilises publicly available datasets, including StatsBombR and worldfootballR packages, to analyse pressing metrics and their integration with team formations. While these datasets provide rich spatial and event data, limitations include a reliance on event-based metrics and a focus on selected leagues, tournaments, and formations.

The study will need to approximate player positioning and defensive shape using event-based data, which lacks full spatial tracking. The validation of the new pressing model using test data (without tracking) may introduce approximation errors.

Pressing success does not always translate to immediate attacking chances. The study aims to link pressing to xT/xG chains, but there may be lag effects where pressing creates advantages several passes later.

Differences in playing styles across competitions means that international tournaments may feature different pressing behaviours compared to league play, impacting comparability.

1.7 Conclusion: Advancing Pressing Analytics with a Novel Approach

By expanding existing pressing metrics and incorporating formation context, pressing triggers and traps, and pressing-to-attack transition analysis, this study aims to provide new tactical insights into pressing effectiveness.

Key takeaways include:

- Develop an alternative pressing metric that does not require tracking data.
- Assess pressing intensity across different formations and tournaments.
- Link pressing success to offensive potential using xT/xG chains.
- Provide a comparative analysis of pressing across multiple leagues and competitions.

This study bridges the gap between defensive analytics and offensive outcomes, offering practical and academic value in football analytics research.

Chapter 2

Literature Review

Football is a spectacle of precision and intensity.

Thinking about football and how to play it successfully is almost as old as the game itself, with the arrangement of players on the pitch recognised as making a significant difference, even as far back as the 1870s (Memmert and Raabe 2018; **wilson2010?**). What we now understand as football tactics goes back to the beginning of the sport (**memmert?**). In its earliest forms, football in medieval Britain was a violent, unruly, and anarchic "mob game" with rules varying by location (**wilson?**).

Modern football began to emerge in the early nineteenth century in English public school, where sport was seen as a tool for moral edification, necessitating the development of a coherent set of rules before tactics could evolve. Even by the end of the nineteenth century, formations were just beginning to emerge and were rarely subjected to much thought (**wilson2010?**).

2.1 The Importance of Pressing Effectiveness and its Relationship to Formations in Football

Pressing is a defensive strategy in football whereby the team without possession aggressively puts pressure on the opponent who is in possession of the ball [Brîndescu, Datcu, and Buda (2021). The objective is to limit the opponent's time to pass the ball and make plays, ideally forcing a mistake such as a bad pass or a turnover (Brîndescu, Datcu, and Buda 2021). Teams that are effective at pressing are able to win the ball back quickly and transition into attack (Brîndescu, Datcu, and Buda 2021; Low et al. 2018).

The concept of pressing has grown in importance in recent years as a tactical element of the game (Andrienko et al. 2017; Robberechts 2019). The successes of high-profile teams and coaches that employ a pressing style of play have made it

a popular focus of discussion among fans, commentators, and analysts (Andrienko et al. 2017; Robberechts 2019).

Understanding pressing effectiveness is crucial in football as it directly impacts team performance (Modric et al. 2022; Modric, Gabrilo, and Sekulic 2023). Research shows that successful team pressing influences team technical-tactical performance (TTP) significantly, leading to increased actions like shots on target, passes, key passes, crosses, dribbles, and entries into the final third and penalty area (Modric et al. 2022; Modric, Gabrilo, and Sekulic 2023). Moreover, the co-operative and well-organized interaction between players during pressing plays a more vital role in TTP than pure physical performance (Modric, Gabrilo, and Sekulic 2023). Individual actions, such as pressing, are fundamental in modern football, with higher praxeological parameters of these actions correlating with better sports results and team performance (Modric, Gabrilo, and Sekulic 2023).

Pressing has historically been difficult to analyse because it is a complex phenomenon involving multiple players and different objectives, which are hard to quantify (Merckx et al. 2021).

2.1.1 Pressing: From its Beginnings to Widespread Adoption

The evolution of pressing has been a continuous interplay between tactical innovation, player development, and advancements in sports science. From its early forms to the modern high-intensity approaches, pressing has become a fundamental tactic in modern football, highlighting the importance of proactive defending and quick transitions.

While the idea of pressing can be traced back to the early days of football, its implementation and effectiveness have evolved significantly alongside the sport itself. Early instances of pressing, like the "Volga Clip" used by Krylya Sovetov Kuibyshev in the 1940, involved one half-back dropping deep, enabling the center-half to sweep behind the full-backs. This system, similar to the Swiss *verrou*, aimed to limit space for opponents (Wilson 2013). The development of pressing was accelerated by the rise of zonal defending and a focus on regaining possession quickly (Cox 2019).

The development of pressing was accelerated by the rise of zonal defending and a focus on regaining possession quickly (Cox 2019).

The Dynamo Kyiv team in the 1960s is credited with being one of the first to utilise pressing effectively. Their system involved players hunting in packs, closing down opponents, and winning the ball in unexpected areas of the pitch (Wilson 2013).

The effectiveness of pressing was also boosted by advancements in sports science and nutrition, allowing players to maintain the required intensity for longer durations (Wilson 2013).

Total Football, pioneered by Ajax in the 1970s, heavily featured pressing. Their aggressive man-marking of opposing playmakers, combined with their high defensive

line aimed at catching opponents offside, became hallmarks of the Dutch approach (Cox 2019; Wilson 2013).

While other teams, such as Dynamo Kyiv, adopted pressing tactics, its adoption wasn't universal (Wilson 2013). The spread of pressing was "curiously patchy" due to factors like the physical demands it placed on players and the differing tactical philosophies across different regions (Wilson 2013).

AC Milan, inspired by Total Football, further revolutionised pressing in the late 1980s. Their system was highly organised and focused on controlling space (Cox 2019; Wilson 2013).

FC Barcelona revitalised pressing in the late 2000s and early 2010s, emphasising winning the ball back quickly in the opponent's half (Cox 2017).

Borussia Dortmund and later Liverpool popularised the concept of gegenpressing, which focuses on immediately winning the ball back after losing possession. This approach challenged the traditional understanding of phases of play and demonstrated the effectiveness of a high-energy, coordinated press (Cox 2017, 2019).

Pressing became increasingly common in the Bundesliga and eventually spread to spread the Premier League, notably influenced by foreign managers entering the league (Cox 2017, 2019).

2.1.2 Key Themes and Areas of Focus

2.2 Pressing Analysis in Football

2.2.1 How is Pressing Analysed in Football?

Pressing in football is currently analysed through various methods. Studies have shown that successful defensive plays exhibit higher defensive pressure, especially towards the end of a defensive sequence and closer to the ball (Forcher et al. 2022). Automated detection of pressing strategies, like counterpressing, has been achieved using machine learning models, saving time and standardising the analysis process (Bauer and Anzer 2021). Computational approaches have been proposed to estimate pressure relationships during a game, visualising defending players' pressure on the ball and opponents, aiding in detailed analysis of team tactics (Andrienko et al. 2017; Andrienko et al. 2018). Research also indicates that successful team pressing positively influences team technical-tactical performance, emphasizing the importance of co-ordinated player interaction in pressing strategies (Modric et al. 2022). These findings collectively highlight the significance of defensive pressure analysis in understanding and optimising team performance in football.

2.3 Different Types of Pressing Strategies

2.3.1 High Press

In football, two primary pressing strategies are commonly employed: high-press defending and deep-defending. Research by (**low2021?**) compared these strategies. High-press defending involves players pressing the opposition closer to their goal, aiming to win the ball back quickly and disrupt the opponent's build-up play. On the other hand, deep-defending sees players defending deeper on the field, often closer to their own goal, focusing on maintaining defensive shape and limiting space for the opposition to exploit. The study (**low2021?**) found that high-press defending can lead to closer centroid distances, more regular movement patterns, decreased synchronisation patterns of effective playing space, lower physical demands in terms of distance covered, and player velocity, as well as reduced heart rates compared to deep defending.

2.3.2 Low-Block Defence

Low-block defence in football impacts the opponent's strategy by creating challenges in breaking through the defensive line efficiently. The use of low block defence can restrict the opponent's ability to penetrate the defence due to the compact structure and reduced space available for attacking manoeuvres.

2.3.3 Midfield Press

The midfield press in football significantly influences the opponent's strategy by applying pressure and disrupting their build-up play. Overall, the midfield press serves as a tactical tool to unsettle opponents, control play, and create scoring opportunities.

2.3.4 Counter-pressing

Counter-pressing in football significantly influences the opponent's strategy by disrupting their transition play and creating immediate offensive opportunities (Bauer and Anzer 2021). This strategic approach involves quickly regaining possession after losing the ball, pressuring the opponent to make hasty decisions, and potentially leading to turnovers. By automatically identifying and analysing counter-pressing situations through machine learning techniques, teams can assess the effectiveness of this tactic in terms of winning the ball back swiftly, generating scoring chances, and determining key success factors. The ability to adjust the counter pressure exerted on the opponent based on the forward pressure applied by the pressing team enhances the effectiveness of this strategy, creating a dynamic and adaptive defensive approach. Additionally, utilising counter-pressing can have defensive and offensive consequences for both teams, impacting the flow and outcome of the game.

2.4 Formation Analysis and Gameplay Influence

2.4.1 How are Formations Currently Analysed?

Traditionally, notational analysis, based on average statistics and tallies, was used to analyse tactics

2.4.2 Influence of Formations on Attacking and Defensive Strategies in Football

Tactical situations and playing styles are crucial performance indicators in soccer, influencing team strategies and outcomes. Research has shown significant differences in attack styles between European and South American teams, with European teams excelling in fast and positional attacks, while South American teams focus more on shots from outside the box and off-target shots . Additionally, a study comparing different age groups in football found that First teams demonstrate more final third entries, passes, crosses, and build-up play in wide areas compared to younger teams, highlighting the evolution of playing styles with age and experience (**dayusjacob2021?**). Moreover, the impact of external factors like the COVID-19 pandemic has led to changes in performance indicators over the years, resulting in a more passive game with tighter results, emphasizing the need for teams to adapt their playing styles accordingly

2.5 How Formations Impact Player Roles, Defensive Shape, Pressing Strategies. and Overall Gameplay

2.5.1 Commonly Used Formations in Football

2.6 Machine Learning and Automated Analysis

2.6.1 The Role of Data Analysis in Football Performance Evaluation

Data analytics in football has revolutionised the way the sport is played, managed, and analysed. By leveraging vast amount of data, teams can gain insights into player performance, match strategies, and even financial decisions (Memmert and Raabe 2018).

Football is an inherently dynamic and unpredictable sport, requiring complex and multifaceted strategies for success (Herold et al. 2019). Traditionally, performance analysis in football has relied on statistics derived from manual notational analysis based on observational match events such as team possession, shots on targets, successful passes (Herold et al. 2019; Plakias, et al. 2024; Rein and Memmert 2016). Match event data is typically collected from video footage and assists coaches and

analysts evaluate past football matches and prepare for future games (Herold et al. 2019). However, these methods and metrics, while insighful, were time-consuming, often subjective often discard critical contextual information necessary for comprehensive tactical analysis (Rein and Memmert 2016).

The dearth of knowledge on how various factors such as technical skill, individual physiology, and team formations hampers our understanding of how these factors affect tactical decision-making (Rein and Memmert 2016).

2.6.2 The Use of Statistical Methods, Machine Learning Techniques, and Data Visualisation Tools in Football Analysis

Machine learning applications in men's professional football have been instrumental in enhancing attacking play. Studies have shown that expected goals (xG) models developed using machine learning techniques like Logistic Regression and Gradient Boosting can accurately predict xG probability values for players based on shots taken during matches (**hewitt2023?**). Additionally, the analysis of key performance indicators related to attacking play in football has been a common practice among coaches and analysts, emphasizing the importance of leveraging data-driven insights to improve offensive strategies in professional football (Herold et al. 2019).

2.6.3 Recent Advances in Data-Driven Approaches to Studying Pressing Effectiveness and Formation Dynamics

2.7 Gap in Existing Literature: Pressing and Formations

2.8 Conclusion and Proposal Contribution

References

Andrienko, Gennady, Natalia Andrienko, Guido Budziak, Jason Dykes, Georg Fuchs, Tatiana von Landesberger, and Hendrik Weber. 2017. "Visual Analysis of Pressure in Football." *Data Mining and Knowledge Discovery* 31 (6): 1793–1839. https://doi.org/10.1007/s10618-017-0513-2.

Andrienko, Gennady, Natalia Andrienko, Guido Budziak, Tatiana von Landesberger, and Hendrik Weber. 2018. "Exploring Pressure in Football." In, 13. AVI '18. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/3206505.3206558.

Bauer, Pascal, and Gabriel Anzer. 2021. "Data-Driven Detection of Counterpressing in Professional Football." *Data Mining and Knowledge Discovery* 35 (5): 2009–49. https://doi.org/10.1007/s10618-021-00763-7.

Bauer, Pascal, Gabriel Anzer, and Laurie Shaw. 2023. "Putting Team Formations in Association Football into Context." *Journal of Sports Analytics* 9 (1): 39–59. https://doi.org/10.3233/JSA-220620.

Bortnik, Lukasz, Joost Burger, and David Rhodes. 2022. "The Mean and Peak Physical Demands During Transitional Play and High Pressure Activities in Elite Football." *Biology of Sport* 39 (4): 1055–64.

Brîndescu, Sorin, Francisc-Remus Datcu, and Ionu -Alexadru Buda. 2021. "Study on the Efficiency of Advanced Pressing in the Premier League." *Baltic Journal of Health and Physical Activity* 13 (6): 11.

Carr, Rhys, Rich Mullen, and Morgan Williams. 2020. "Differences in High Intensity Running When Playing a 4-4-2 Formation with a High Press Strategy: A Case Study from the English Championship." *International Sports Studies* 42 (2).

Cooper, Daniel, and Craig Pulling. 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* 4 (3): 196–202.

Cox, Michael W. 2017. *The Mixer: The Story of Premier League Tactics, from Route One to False Nine*. HarperCollins.

———. 2019. *Zonal Marking: The Making of Modern European Football*. 1st ed. HarperCollins.

Fernandes, Tiago, Oleguer Camerino, Júlio Garganta, Raúl Hileno, and Daniel Barreira. 2020. "How do Elite Soccer Teams Perform to Ball Recovery? Effects of

Tactical Modelling and Contextual Variables on the Defensive Patterns of Play." *Journal of Human Kinetics* 73 (July): 165–79. https://doi.org/10.2478/hukin-2019-0141.

Fernandez-Navarro, Javier, Luis Fradua, Asier Zubillaga, and Allistair P McRobert. 2019. "Evaluating the Effectiveness of Styles of Play in Elite Soccer." *International Journal of Sports Science & Coaching* 14 (4): 514–27. https://doi.org/10.1177/1747954119855361.

Fernandez-Navarro, Javier, Carlos Ruiz-Ruiz, Asier Zubillaga, and Luis Fradua. 2020. "Tactical Variables Related to Gaining the Ball in Advanced Zones of the Soccer Pitch: Analysis of Differences Among Elite Teams and the Effect of Contextual Variables." *Frontiers in Psychology* 10 (January). https://doi.org/10.3389/fpsyg.2019.03040.

Forcher, Leander, Leon Forcher, Stefan Altmann, Darko Jekauc, and Matthias Kempe. 2022. "The Keys of Pressing to Gain the Ball – Characteristics of Defensive Pressure in Elite Soccer Using Tracking Data." *Science and Medicine in Football* 0 (0): 1–9. https://doi.org/10.1080/24733938.2022.2158213.

———. 2023. "The Success Factors of Rest Defense in Soccer – a Mixed-Methods Approach of Expert Interviews, Tracking Data, and Machine Learning." *Journal of Sports Science & Medicine* 22 (4): 707–25. https://doi.org/10.52082/jssm.2023.707.

———. 2024. "Is a Compact Organization Important for Defensive Success in Elite Soccer?–Analysis Based on Player Tracking Data." *International Journal of Sports Science & Coaching* 19 (2): 757–68.

Herold, Mat, Floris Goes, Stephan Nopp, Pascal Bauer, Chris Thompson, and Tim Meyer. 2019. "Machine Learning in Men's Professional Football: Current Applications and Future Directions for Improving Attacking Play." *International Journal of Sports Science & Coaching* 14 (6): 798–817. https://doi.org/10.1177/1747954119879350.

Ju, Wonwoo, Dominic Doran, Richard Hawkins, Mark Evans, Andy Laws, and Paul Bradley. 2023. "Contextualised High-Intensity Running Profiles of Elite Football Players with Reference to General and Specialised Tactical Roles." *Biology of Sport* 40 (1): 291–301.

Liu, Yun. 2023. "Characterization of Immediate Pressing Tactics in Soccer in the Age of Artificial Intelligence." *Applied Mathematics and Nonlinear Sciences*.

Low, Benedict, Gabriel Vilas Boas, Lars Meyer, Eneritz Lizaso, Fabian Hoitz, Nuno Leite, and Bruno Gonçalves. 2018. "Exploring the Effects of Deep-Defending Vs High-Press on Footballers' Tactical Behaviour, Physical and Physiological Performance: A Pilot Study." *Motriz: Revista de Educação Física* 24 (May): e1018171. https://doi.org/10.1590/S1980-6574201800020009.

Low, Benedict, Robert Rein, Dominik Raabe, Sebastian Schwab, and Daniel Memmert. 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.

Memmert, Daniel, and Dominik Raabe. 2018. *Data Analytics in Football: Positional Data Collection, Modelling and Analysis*. 1st ed. Routledge.

Merckx, Simon, Pieter Robberechts, Yannick Euvrard, and Jesse Davis. 2021. "Mea-

suring the Effectiveness of Pressing in Soccer." In *Workshop on Machine Learning and Data Mining for Sports Analytics*.

Modric, Toni, Goran Gabrilo, and Damir Sekulic. 2023. "Influence of Team Pressing on Match Performance in Highest-Level Soccer; Preliminary Report." *Kinesiologia Slovenica* 29 (1): 138. https://doi.org/10.52165/kinsi.29.1.138-148.

Modric, Toni, James J. Malone, Sime Versic, Marcin Andrzejewski, Paweł Chmura, Marek Konefał, Patrik Drid, and Damir Sekulic. 2022. "The Influence of Physical Performance on Technical and Tactical Outcomes in the UEFA Champions League." *BMC Sports Science, Medicine and Rehabilitation* 14 (1): 179. https://doi.org/10.1186/s13102-022-00573-4.

Plakias, Spyridon, Tsatalas, Themistoklis, Armatas, Vasileios, Tsaopoulos, Dimitris, and Giakas, Giannis. 2024. "Tactical Situations and Playing Styles as Key Performance Indicators in SoccerTactical Situations and Playing Styles as Key Performance Indicators in Soccer." *Journal of Functional Morphology and Kinesiology* 9 (2): 88. https://doi.org/https://doi.org/10.3390/jfmk9020088.

Rein, Robert, and Daniel Memmert. 2016. "Big Data and Tactical Analysis in Elite Soccer: Future Challenges and Opportunities for Sports Science." *SpringerPlus* 5 (1): 1410. https://doi.org/10.1186/s40064-016-3108-2.

Rico-González, Markel, Pino-Ortega, José, Méndez, Amaia, Clemente, Filipe Manuel, and Baca, Arnold. 2023. "Machine Learning Application in Soccer: A Systematic Review." *Biology of Sport* 40 (1): 249–63. https://www.termedia.pl/Machine-learning-application-in-soccer-a-systematic-review,78,46287,0,1.html.

Robberechts, Pieter. 2019. "Valuing the Art of Pressing." In *StatsBomb Innovation in Football Conference*. Vol. 11.

Ruan, Lingfeng, Huanmin Ge, Yanfei Shen, Zhiqiang Pu, Shouxin Zong, and Yixiong Cui. 2022. "Quantifying the Effectiveness of Defensive Playing Styles in the Chinese Football Super League." *Frontiers in Psychology* 13: 899199.

Scotognella, Francesco. 2021. "Simulations of Nearest Teammate-Based Soccer Match-Plays with Different Formations."

Toda, Kosuke, Masakiyo Teranishi, Keisuke Kushiro, and Keisuke Fujii. 2022. "Evaluation of Soccer Team Defense Based on Prediction Models of Ball Recovery and Being Attacked: A Pilot Study." *Plos One* 17 (1): e0263051.

Wilson, Jonathan. 2013. *Inverting the Pyramid: The History of Soccer Tactics*. 2nd ed. Orion Books Ltd,.