

# Quantifying Pressing Effectiveness and Its Influence on Formations in Football

# **Quantifying Pressing Effectiveness and Its Influence on Formations in Football**

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# 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

$\mu$  Mean (average pressing intensity or event probability)

$\sigma$  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 by advancing a ball into their opponent's goal, adhering to established rules that govern gameplay, player conduct, and scoring, with the aim to score more goals than their rivals (Memmert and Raabe 2018; Sumpter 2016). While the fundamental simplicity of football contributes significantly to its global popularity, the game simultaneously possesses incredible complexity characterised by movement patterns, match plans, playing philosophies, and creativity. These qualities are collectively referred to as football tactics (Memmert and Raabe 2018).

Football tactics involve strategically positioning players on the field and co-ordinating their movements to maximise the chances of winning matches. This encompasses both the formation a team adopts (i.e., the spatial arrangement of players on the pitch) and their overall style of play (Wilson 2010). Additionally, (Rein and Memmert 2016) describe 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.

A critical component of these tactical deployments, especially in modern football, is a defensive tactic known as pressing. Pressing requires co-ordinated teamwork aimed at swiftly regaining possession through targeted defensive pressure on opponents to limit their spatial options and disrupt their offensive play. Pressing involves players actively closing down opponents who have the ball and blocking potential passing lanes (Borbely et al. 2018).

Given the tactical importance of pressing, accurately measuring its effectiveness is essential. Recent advancements in data analytics and machine learning have

accelerated the development of sophisticated metrics to achieve this (Link 2018; Memmert and Raabe 2018; Rein and Memmert 2016; Rico-González, Markel et al. 2023). Data analytics has revolutionised the way football is understood today. While intuition and subjective observation once dominated, objective metrics and algorithms now offer deeper insights into performance, tactics, and outcomes (Memmert and Raabe 2018). Football analytics now rivals analytics in established sports like baseball, cricket, and basketball in sophistication and insight (Herold et al. 2019; Rico-González, Markel et al. 2023). This data-driven revolution has encouraged deeper exploration into pressing as a vital tactical strategy.

Pressing has emerged as a defining tactical element in modern football capable of transforming defence into attack and significantly influencing the flow and tempo of the game. Pressing disrupts opponents, forces turnovers, and creates goal-scoring opportunities, establishing itself as a cornerstone of contemporary football tactics (Robberechts 2019).

Effective pressing strategies, particularly high pressing styles, increase the likelihood of regaining possession 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 fulfils a dual tactical role, enhancing defensive solidity and creating attacking opportunities. Nonetheless, its effectiveness strongly depends players' physical capacities. Studies demonstrate that pressing demands 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 sustaining effective pressing throughout a match tend to achieve superior results, maintaining pressure on opponents and creating more scoring chances (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).

While the importance of pressing is established, its practical measurement faces challenges due to varying contextual factors, including opponent quality, tactical setups, 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 research 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 variations, 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 evaluations 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.

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