Adaptability of performance to different contextual constraints as a predictor of development and success in competitive football: A systematic review

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Abstract—This systematic review organizes the literature regarding the influence of contextual constraints on football match action profiles, in order to inform better practice when utilized a data-informed approach towards identifying and predicting high performing football players. Furthermore, the validity of examining “on-ball” match actions in competitive matches as an indicator of performance was also investigated. Based on the studies reviewed, task and environmental constraints were highlighted to be significantly influential on match actions performed, which suggests that recruitment strategies may be more successful if there were a greater emphasis on identifying players that best fit the constraints unique to the team, rather than recruiting the “best” player in the position. Additionally, the ability to adapt and successfully produce goal-directed behaviour in a variety of contexts may therefore be indicative of future high performance. Results from existing studies suggest that match actions performed in competitive matches can significantly distinguish between higher and lower performing teams or individuals. However, given the largely retrospective study designs of existing studies, a shift towards prospective study designs utilizing machine learning or statistical modelling is proposed to increase the practical applicability of theoretical findings.

Key words: ecological dynamics, match actions, adaptability, performance environment, performance analysis

Résumé - L'adaptabilité des performances aux contextes de jeu comme prédicteur du développement et du succès au football: une revue systématique. L'évaluation des performances dans le football reste un défi auquel sont souvent confrontés les chercheurs et les praticiens du football, spécifiquement compte tenu de l'évolution constante des contraintes rencontrées dans le jeu à la fois au niveau individuel mais également au niveau collectif. Dans l'objectif de rendre l'analyse la plus objective et la plus complète possible, principalement lors de l'identification et la prédiction de la performance, l'utilisation des données de match se doit d'être basée sur des fondements théoriques de la performance sportive. La présente revue systématique se propose ainsi d'organiser la littérature qui s'intéresse à l'identification et la prédiction de la performance en football en fonction des diverses contraintes de tâches ou d'environnement qui les influencent. Plus précisément, l'utilité des données de match comme indicateur de performance est discutée. À partir des études identifiées dans la littérature, les contraintes de tâches et d'environnement qui influencent significativement le jeu sont discutées, suggérant que les stratégies de recrutement pourraient s'optimiser par l'identification des joueurs qui seraient les « plus adaptés » aux contraintes spécifiques d'une équipe plutôt que de recruter le « meilleurs » joueur de son poste. De plus, outre la production idéale d'un seul comportement précis, la capacité de s'adapter et de produire avec succès un large panel de comportements qui sont spécifiquement efficaces dans un contexte donné, autrement dit la capacité de montrer un haut niveau de flexibilité dans le jeu, peut s'avérer être révélatrice de performances élevées futures. Les résultats des études existantes suggèrent que les actions de match en compétition permettent effectivement de distinguer les joueurs les plus performants des joueurs moins performants. Cependant, les conceptions de ces études étant largement rétrospectives, le développement d'études prospectives utilisant des modélisations statistiques est proposé afin d'accroître l'utilisabilité des résultats observés dans ce domaine de recherche de la prédiction de la performance.

Mots clés : dynamique écologique, actions de match, adaptabilité, environnement de performance, analyse de performance

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1 Introduction

In the modern era of association football, the exponential increase in financial returns associated with succeeding at the highest performance level, has spurred football organizations to incorporate a more quantifiable, data-informed approach to guide strategic operations (Schildkamp & Kuiper, 2010). To increase their potential for success, football organizations seek to statistically evaluate, compare or predict the level of individual or team performance more proficiently than their competitors. In doing so, these organisations seek to gain advantages, especially in performance analytics-driven talent identification and recruitment. However, the process of scientifically comparing or predicting performance quality in football is less straightforward compared to sports with more stable performance environments, such as archery, weightlifting or long jumping. In these sports, formal definitions of quality are more easily identified (i.e., arrow placement accuracy, weight lifted, or distance jumped respectively) and a relational order between performances can be readily determined (Pappalardo et al., 2019).

Traditionally, to explain and evaluate performance, researchers tended to operationalise a set of “objective and universal” indicators of performance quality by deconstructing evaluation procedures into isolated, sport-specific performance measures such as general agility, speed endurance and sprinting power that are assessed outside of competitive matches (Höner, Votteler, Schmid, Schultz, & Roth, 2015; Lago-Peñas, Rey, Casáis, & Gómez-López, 2014; Rommers et al., 2019). Other such evaluations have focused on frequency analyses of sport specific actions such as dribbling, shooting at goal and number of completed passes (Höner et al., 2015; Rommers et al., 2019). However, such action-oriented approaches have shown limited accuracy in discriminating and predicting future competitive football performance, possibly because frequency analyses based on recording “context-free” actions do not consider performance in the highly dynamic and interactive demands of the competitive environment, as they only arise with the introduction of teammates, opposition and a competitive match setting (Correia, Araújo, Vilar, & Davids, 2013; Travassos et al., 2013). In response to limitations of this de-contextualised, behaviouristic approach, an ecological dynamics rationale postulates that “context is everything” in analysis and evaluation (Rothwell, Davids, Stone, Araújo, & Shuttleworth, 2020). A contextualised approach to performance analytics implies that a more precise evaluation of football performance is one that involves the continuous interactions that emerge between the performer(s) and their environment. In ecological dynamics, such an approach is required because of the deep interconnectedness between intentions, perceptions, and actions of sport performers needed when interacting with the emerging performance contexts (Davids, Araújo, Vilar, Renshaw, & Pinder, 2013; Travassos et al., 2013).

Building on the shift towards using theoretical principles of ecological dynamics as a framework for performance analytics, researchers in recent years have examined actions during competition to assess competitive performance (Gama, Dias, Passos, Couceiro, & Davids, 2020; Sarmento et al., 2018). Data on competitive match performance, have sought to describe and explain “on-ball” actions emerging from players during competitive matches (e.g., opportunities (affordances) for performing penetrative passes, shots, tackles, interceptions). Such data have been proposed as more reliable measures of footballing performance because they are emergent from a performer’s interactions with competitive contextual constraints, and are shaped by the key constraints of a sport context (Den Hartigh, Niessen, Frencken, & Meijer, 2018; Koopmann, Faber, Baker, & Schorer, 2020).

2 Ecological dynamics and performance analytics: Context is everything!

An ecological dynamics rationale suggests that, to meaningfully utilize frequency data on match actions as a valid performance measure, due consideration of contextual constraints is important (Den Hartigh et al., 2018). This proposition has been corroborated by previous research highlighting the importance of task and environmental constraints, such as the type of competition in which match actions were performed (Fernandez-Navarro, Fradua, Zubillaga, Ford, & McRobert, 2016) and/or effects of opposition quality (Castellano, Álvarez, Figueira, Coutinho, & Sampaio, 2013), and their significant influence on player behaviours and match actions.

With this theoretical backdrop, this systematic review seeks to organize existing literature using a data-informed approach for identifying and predicting high performers in

<table>
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<tr>
<th>Highlights</th>
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<tr>
<td>• Task and environmental constraints critically influence the match actions demanded of football players, therefore data-informed systems of talent identification or recruitment should seek to identify the best-fitting player instead of seeking to identify the “best” player in the position.</td>
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<tr>
<td>• Due to the significant influence of task and environmental constraints that are constantly changing, existing evidence suggests that a player’s ability to adapt to a variety of contexts may potentially be a crucial indicator of performance.</td>
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<tr>
<td>• Match actions performed in competitive football matches are strong indicators of performance, but future research should utilize more prospective-oriented or predictive study designs in order to increase the practical implications of theoretical findings in this area of research.</td>
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football at present. To achieve our aim, we used an ecological dynamics framework to identify and theoretically organize the literature on: (1) the various environmental and task constraints found to significantly influence match action profiles, and (2), football match action data in relation to performance by profiling the purpose and key findings of the studies. We also identified common research methodologies and highlighted potential directions of future work. The following research questions were examined:

Are the technical actions observed during competitive football matches a significant indicator or predictor of performance?

In relation to these two research questions, considering the ecological dynamics theoretical framework highlighted in the introduction, we hypothesized that (1) environmental and task constraints have significant influence the frequency of match actions, and that (2) future performance can be significantly classified or predicted by examining actions performed during actual football matches.

3 Methods

3.1 Search and selection

Studies examined in this systematic review were gathered according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) by searching through three electronic databases, namely SPORTDiscus, ProQuest Sport Medicine & Education Index, and Web of Science. The following combinations of keywords were entered for each database: (a) football, OR soccer; AND (b) match actions, OR match analysis, OR game specific skills, OR technical skills, OR event data, OR game analysis, OR notational analysis, OR performance analysis.

The initial search was performed in June 2020, and a total of 31,819 articles were identified. The articles were screened, based on three inclusion criteria. First, the sport examined in the study must be association football, limited to studies of the full-sized 11-a-side format, when performed by males at the age group, amateur or professional level. This was done to limit the influence of match setup or player gender on resultant match actions. As age-related differences on match action profiles were meaningful for the intended purpose of the systematic review, studies that examined competitive performance data in age-group football up to adult, professional football, were included in the analysis. Second, the relationships between: (a) match actions and football performance, or (b), environmental or task constraints and match actions must have been explicitly investigated. Last, the studies must have been quantitative in nature, explicitly examining match action data as the primary variable of analysis.

After the automated screening for duplicate and ineligible articles filtered by topic and keywords, 1861 articles remained for the initial screening. The title and abstracts of these articles were then screened based on the inclusion criteria by one review author for a subsequent review of the full text. Altogether, 201 articles were selected for further examination of full texts. At this stage, articles that raised ambiguity in inclusion were highlighted for a review of the full text and discussed with two other reviewers. Where necessary, the eventual inclusion or exclusion of articles was determined through consensus. Finally, 45 articles were selected for analysis, based on their relevance in addressing our two main research questions. The references of the selected articles were subsequently screened to identify potentially relevant articles not identified by the original search, which yielded a further two studies meeting the inclusion criteria. The process for article collection, screening and selection is detailed in Figure 1. After a comprehensive analysis of the selected articles, it was determined that the most appropriate way to classify the articles would be to utilize a modified version of the classification system proposed by Sarmento et al. (2014). The articles were classified on two levels of analysis (Fig. 2): by type of analysis utilized in the article (comparative or predictive); and by type of performance being measured (individual or team level of performance).

4 Results

4.1 What are the environmental or task constraints that significantly influence the frequency of these match actions and what is the direction and magnitude of influence?

Based on the assumption that there are pronounced differences in the task demands on players in different playing positions, resulting in disparate match action profiles, 24% of the studies conducted separate analyses for each major position or sub-roles within each playing position. Studies in this category of analysis primarily examined how different environmental and task constraints varied in their influence on match action profiles and examined differences in direction and magnitude of their influence between playing positions. A summary of the study findings is provided in Table 1.

4.1.1 Playing position

Several studies examined effects of playing position (with respect to area of the field: e.g., central or wide) on match action profiles in isolation, regardless of interactions with other environmental and task constraints. For instance, researchers identified that differences in match action profiles were greatest between central defenders and forwards in the UEFA Champions League (UCL), with forwards performing more offensive match actions such as shots, shots on target, and key passes (Yi et al., 2018). Match actions also differed between the sub-roles within major playing positions. For example, central midfielders in the UCL performed more shots and shots on target compared to wide midfielders (Yi et al., 2018).
Sub-role differences in match action profiles were not league-specific and were evident in many competitions. For instance, central defenders in the Asian Cup performed fewer ground duels in comparison to wide defenders, while central midfielders performed more passes and successful passes than wide midfielders (Ermidis et al., 2019).

4.1.2 Team and opposition strength

Across multiple studies, match action profiles varied depending on the strength of the opposition – which were determined through their eventual position (i.e. placing) in the league (Liu, Yi, Giménez, Gómez, & Lago-Peñas, 2015) or club ranking point systems such as the UEFA season club coefficient (Liu, Gómez, Gonçalves, & Sampaio, 2016). These studies examined changes in match action profiles while only considering the strength of the opposition (Liu, Yi et al., 2015) or while considering the strength of one’s own team in relation to the opposition (Liu, Gómez et al., 2016). In both cases, significant variations in attacking match actions were highlighted. For example, match actions such as assists, total number of shots, shots on target, touches on the ball, through balls, key passes, fouls drawn, aerial duels won and number of offsides varied more widely when teams played against stronger opposition in the Spanish La Liga (Liu, Yi et al., 2015). Similarly, when accounting for strength of both teams, teams in the UCL varied significantly in frequency of shots, shots on target, shots from open play, passes, ball possession, aerial duels and fouls conceded (Liu, Gómez et al., 2016).

4.1.3 Seasons

Frequency of certain match actions varied significantly across different seasons of the Chinese Super League (Zhou et al., 2020), English Premier League (EPL) (Bush et al., 2015) and La Liga (Serrano et al., 2019). These changes were primarily specific to playing position – with the total number of passes and passing accuracy percentage of central defenders and midfielders increasing in the 2012–
2013 season of the EPL compared to 2006–2007 (Bush et al., 2015). Conversely, goalkeepers in La Liga exhibited a lower number of total saves in the 2016–2017 season compared to 2011–2012 (Serrano et al., 2019). These changes were also observed at the team level, with teams performing more crosses, shots, and offensive match actions leading to entry into the opposing penalty area in the 2017 season compared to the 2012 season of the Chinese Super League (Zhou et al., 2020).

4.1.4 League type

Differences in match action profiles between different leagues were highlighted when comparing between leagues in similar (Dellal et al., 2011) or different tiers of competition (Elyakim et al., 2020). In particular, the number of aerial duels occurring, and number of ball touches taken during La Liga and EPL matches were significantly different, with players in La Liga competing in more aerial duels but having fewer touches on the ball per possession period compared to players in the EPL (Dellal et al., 2011). This observation suggests that, although teams may compete in similar competitive tiers (both compete for qualification into the UCL), there may be league-specific differences which contextualise playing styles, which then influence emergent match action profiles. Significant differences were also found between leagues of different competitive tiers, primarily in offensive match actions. For instance, teams in the Italian Serie A demonstrated greater frequency of passes into the penalty box, key passes, total shots, and offensive match actions leading to entry into the opposing penalty area compared to teams in a lower competitive tier such as the Israeli Premier League (Elyakim et al., 2020).

4.1.5 Age group

Evidence from the studies examined suggests that frequencies of certain match actions significantly differed across matches played in different age groups. Specifically, frequency of passes, ball touches, involvements with the ball, and successful pass percentage were positively
Table 1. Constraints of significant influence on match actions.

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Comparison</th>
<th>Procedures</th>
<th>Main results</th>
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<tbody>
<tr>
<td>Bradley et al. (2011)</td>
<td>20 matches played in the English Premier League during the 2006–2007 season</td>
<td>● Different team formations</td>
<td>Collected by Prozone Sports</td>
<td>● Greater pass frequency was observed for teams playing in a 4-4-2 and 4-3-3 formation compared to those in a 4-5-1 formation. ● Successful pass percentage was highest in a 4-4-2 formation.</td>
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<td>Carling (2011)</td>
<td>45 matches played in the French Ligue 1 over the 2007–2008 to 2009–2010 seasons.</td>
<td>● Different opposition team formations</td>
<td>Collected by AMISCO</td>
<td>● Frequency of passes played, one-touch passes, ground duels, aerial duels and touches per possession differed depending on the formation utilized by the opposing team.</td>
</tr>
<tr>
<td>Dellal et al. (2011)</td>
<td>5,938 match observations in 600 matches played in the Spanish La Liga and English Premier League for the 2006–2007 season</td>
<td>● Different competitions</td>
<td>Collected by AMISCO</td>
<td>● La Liga players won more heading duels, demonstrated similar number of successful passes, but had less touches per possession compared to EPL players.</td>
</tr>
<tr>
<td>Elyakim et al. (2020)</td>
<td>1,240 matches played in the Italian Serie A and Israeli Premier League</td>
<td>● Different competitions</td>
<td>Collected by InStat</td>
<td>● Frequency of match actions related to ball movement (passes into bRo, key passes) and attack efficiency (shots, attacks entering bRo) were significantly higher in the Italian Serie A.</td>
</tr>
<tr>
<td>Ermidis, Randers, Krstrup, &amp; Mohr (2019)</td>
<td>202 outfielders in 32 matches of the Asian Cup 2015</td>
<td>● Playing position</td>
<td>Collected by OPTA Sportsdata</td>
<td>● Frequency of attempts on goal, passes, successful passes, aerial duels and ground duels were different for players in different playing positions. ● Magnitude and direction of difference was unique for each playing position comparison.</td>
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</table>
| Gonzalez-Rodenas et al.     | 380 offensive sequences leading to goal in UEFA Champions League 2016–2017 | ● Playing style                 | Hand notation by researchers      | ● Most frequent penultimate match action in offensive sequences against an organized defence were crosses  
● Against disorganized/circumstantial defences, dribbles were most frequent                                                                                           |
| Goto & Saward (2020)        | 110 outfielders in 48 matches played in the Japanese professional age group league | ● Age groups                    | Hand notation by researchers      | ● Frequency of passes, touches, involvements, and pass accuracy percentage was associated with increase in age from U13 to U18                                                                               |
| Lago-Penas & Lago-Ballesteros (2011) | 20 teams in 380 matches played in the Spanish La Liga for the season 2008–2009 | ● Match location                | Collected by Gecasport            | ● Goals scored, shots, shots on target, attacking moves, bxox moves, crosses, offsides, assists, passes, successful passes, dribbles, successful dribbles, possession, gains of possession were more frequent for the home team  
● Away teams had more frequent losses of possession and yellow cards suffered  
● Home advantage influenced match actions differently for teams of different quality                                                                 |
| Palucci Vieira et al.       | 120 outfielders in 12 matches played in the Sao Paulo First Division Soccer Championship for the 2015–2016 season | ● Age groups                    | Hand notation by researchers      | ● Percentage of successful passes associated with increase in age up to PRO level, same for ball touches and touches per involvement but up to U15 level  
● Younger age groups characterized by higher number of duels but lower number of passes and involvements                                                                 |
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<tbody>
<tr>
<td>Rampinini, Impellizzeri, Castagna, Coutts, &amp; Wisløff (2009)</td>
<td>186 outfielders in 416 matches played in the Italian Serie A for the 2004–2005 season</td>
<td>● Time periods within match</td>
<td>Collected by SICS</td>
<td>● Frequency of match actions such as ball involvements, short passes and successful short passes dropped after half time</td>
</tr>
<tr>
<td>Rowlinson &amp; O’Donoghue (2008)</td>
<td>8 players in matches played in the UEFA Champions League 2005–2006 season and FIFA World Cup 2006</td>
<td>● Playing positions</td>
<td>Hand notation by researchers</td>
<td>● Across major playing positions (defender, midfielder, forward), offensive match actions were more frequently performed compared to defensive ones. ● Frequency of offensive and defensive match actions did not differ significantly across the two competitions</td>
</tr>
<tr>
<td>Russell, Rees, &amp; Kingsley (2013)</td>
<td>10 players in 23 matches played at home in the English Championship for the 2010–2011 season</td>
<td>● Time periods within match</td>
<td>Collected by AMISCO</td>
<td>● Possessions and ball distribution frequency dropped in the second half. ● Frequency of possessions dropped during the last 15 minutes of matches. ● Touches per possession, challenges, successful challenges percentage, length of forward distributions, and successful distribution percentage remained unchanged across halves and 15 minute intervals</td>
</tr>
<tr>
<td>Yang, Leicht, Lago, &amp; Gómez (2018)</td>
<td>3468 match observations in 240 matches played in Chinese Super League for the 2014–2015 season</td>
<td>● Nationality (Foreign vs. Domestic)</td>
<td>Collected by AMISCO</td>
<td>● Foreign players performed significantly more passes, shots, aerial duels and ground duels compared to domestic players</td>
</tr>
<tr>
<td>Yi, Gomez, Liu, &amp; Sampaio (2019)</td>
<td>59 matches in the FIFA World Cup 2018</td>
<td>● Playing style</td>
<td>Collected by OPTA Sportsdata</td>
<td>● Two playing styles emerged from analysis: possession and direct styles. ● Teams employing possession style demonstrated more goal scoring, attacking, and</td>
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</table>
associated with age, with elite U18 Japanese players performing significantly more of such actions compared to those at the U13 level (Goto & Saward, 2020). Similarly, Brazilian players in older age groups (U15) demonstrated greater pass accuracy, greater frequency of passes, ball touches, and ball touches per involvement, compared to their younger counterparts (U13 or U11) (Palucci Vieira et al., 2019).

4.1.6 Team playing style

Differing playing styles were also highlighted as a significant influence on match actions collectively performed by teams. Specifically, teams competing in the FIFA World Cup 2018 were found to exhibit either a possession- or direct-play oriented playing style (Yi et al., 2019). Possession-oriented teams executed more goal scoring, offensive and passing related match actions compared to direct-play teams. Similarly, in the Chinese Super League there were four distinct playing styles (e.g., focus on possession, set piece attacks, counterattacking, or transitional play) characterized by significantly different match action profiles (Lago-Peñas et al., 2017).

<table>
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<tbody>
<tr>
<td>Yi, Jia, Liu, &amp; Gómez (2018)</td>
<td>1990 outfields in 1000 matches of the UEFA Champions League from 2009–2010 to 2016–2017 seasons</td>
<td>● Playing position</td>
<td>Collected by OPTA Sportsdata</td>
<td>● Greatest difference in match action profiles were central defenders and forwards. Smallest differences were between central defenders and full backs. ● Forward demonstrated greatest frequency of shots and shots on target. ● Among midfielders, those playing in central positions demonstrated higher shots and shots on target compared to wide midfielders. ● Match actions related to passing and organizing were lower than expected for midfielders, with midfielders playing in wide positions demonstrating relatively better performance.</td>
</tr>
<tr>
<td>Zhou, Gómez, &amp; Lorenzo (2020)</td>
<td>1032 players in 1429 matches in the Chinese Super League from the 2012 to 2017 season</td>
<td>● Different seasons</td>
<td>Collected by AMISCO</td>
<td>● Frequency of crosses, shots, and offensive sequences entering opponent penalty area increased from 2012 to 2017.</td>
</tr>
</tbody>
</table>
Additionally, defensive playing styles utilized by the opposition also significantly influenced the match actions performed. For instance, against a well-organized defensive playing style (i.e., where the defending team has a coordinated and balanced structure, with players in their specific positions), attacking teams in the UCL were more reliant on crosses as the penultimate match action in offensive sequences leading to goals (González-Ródenas et al., 2019). In contrast, against a disorganized defensive playing style (i.e., certain players are not in their specific positions, and the defending team seeks to urgently stop their numerical or positional disadvantage), attacking teams relied more frequently on dribbling as the penultimate action before scoring.

4.1.7 Team formation

Evidence from the studies examined also highlight playing formation of the team and that of the opponent as a significant influence on the frequency of match actions performed. Specifically, teams that played in a 4-4-2 (i.e., four defenders, four midfielders, and two forwards) or 4-3-3 formation played a significantly higher number of passes compared to those playing in a 4-5-1 formation (Bradley et al., 2011). However, the formation that the opposition team utilized also played a crucial role, as teams performed a significantly greater number of passes when facing a 4-4-2 formation as compared to when they faced a 4-2-3-1 formation (Carling, 2011).

4.1.8 Period of match

Certain match actions also varied in their frequency across different time periods within matches. For example, passing frequency and number of involvements by players in the English Championship dropped significantly in the second half of matches compared to the first (Russell et al., 2013). In the same study, frequency of ball involvements also dropped significantly in the last 15 minutes compared to the first 15 minutes of each match. Similarly, players in the Italian Serie A also experienced significantly fewer ball involvements, total short passes and successful short passes in the second half compared to the first (Rampinini et al., 2009).

4.1.9 Nationality

In the modern globalized era of football, there is a significantly larger talent pool bolstered by foreign players that teams can recruit from to improve their squad. In the Chinese Super League, these foreign players demonstrated significantly different match action profiles compared to their domestic counterparts (Yang et al., 2018). Specifically, foreign-born central defenders performed more aerial duels, ground duels and fewer crosses while foreign-born wide defenders performed more passes compared to their domestic counterparts. Significant differences were also found in offensive positions, for instance, foreign-born forwards performed significantly more shots and demonstrated greater shot accuracy.

4.1.10 Match score

The current match score, which is indicative of whether a team was currently in a favourable or non-favourable position, emerged as a significant influence on match action profiles. Specifically, when their team was not in the lead during the match, players competing in the UEFA European Championships 2016 had more possession and performed more passes, short passes, and crosses when trying to tie the match or gain the lead (Konefal et al., 2018).

4.2 Are the technical actions observed during competitive football matches a significant indicator or predictor of performance?

There were multiple approaches undertaken to construct a measure of football performance across the selected studies, which suggests that interpretation of high performance in football needs theoretical guidance. At the team level, indicators of high performance included successful match outcomes, team ranking derived from points earned at the end of season, or qualification for later stages of a competition. Conversely, high performers at the individual level were categorized based on membership of higher performing teams (e.g., representing teams in higher competitive tiers, higher ranked teams in the same tier or qualification into later stages of competition) or individual ranking indexes. A summary of the studies examined at the comparative level of analysis and predictive level of analysis is provided in Tables 2 and 3, respectively. Studies were classified as comparative if the primary purpose was to examine the differences between high and low performers. Conversely, studies were classified as predictive if the primary purpose was to highlight the match actions associated with level of performance achieved.

4.2.1 Team level—Comparative

Offensive match actions related to a greater quantity, higher quality (location of shot, type of shot) and efficiency of shooting (shots on target, goals to shots ratio), were consistently revealed as indicators of higher team ranking or more positive match outcomes (Del Coso et al., 2020; Delgado-Bordonau et al., 2013; Evangelos et al., 2014; Konefal et al., 2018; Liu, Yi et al., 2015; Liu, Gómez et al., 2016; Rampinini et al., 2009; Varley et al., 2017; Yue et al., 2014). Furthermore, greater quantity of passes and successful passing percentage were also consistently indicative of higher performance (Evangelos et al., 2014; Liu, Yi et al., 2015; Liu, Gómez et al., 2016; Rampinini et al., 2009; Yi et al., 2019). Similarly, passes that created goal scoring opportunities in the offensive third of the pitch or the opposition penalty area, significantly differentiate between teams of different performance levels (Yang et al., 2018). Conversely, defensive match actions, such as the number of successful 50-50 challenges (situation where both players have an equal chance of
<table>
<thead>
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<tbody>
<tr>
<td>Del Coso, Brito Souza, Campo, Blanco-Pita, &amp; Resta (2020)</td>
<td>592 match observations of 2 teams in the Spanish La Liga for the 2010–2011 to 2017–2018 seasons</td>
<td>● Team performance: Team ranking</td>
<td>Collected by Media Coach</td>
<td>● Greater shooting accuracy, lower conceded number of shots and corners best differentiated the best from second best team in the season</td>
</tr>
<tr>
<td>Delgado-Bondonau, Domenech Monforte, Guzmán Luján, &amp; Méndez Villanueva (2013)</td>
<td>54 matches in the FIFA World Cup 2010</td>
<td>● Team performance: Team ranking</td>
<td>Collected by FIFA</td>
<td>● Across group and knockout stages, shots on goal and shot conversion rates were consistent indicators of team success</td>
</tr>
<tr>
<td>Evangelos, Aristotelis, Ioannis, Stergios, &amp; Foteini (2014)</td>
<td>64 matches in the EPL, Bundesliga, La Liga, and Ligue 1 for the 2013–2014 season</td>
<td>● Team performance: Match outcome</td>
<td>Hand notation by researchers</td>
<td>● In games with clear result (&gt;3 goals difference), winning teams demonstrated a greater frequency of aerial duels, overall duels, ball possession, overall passes, opponent-half passing accuracy, overall shots, shot accuracy, on-target shots, short distance, long distance shots and corners</td>
</tr>
<tr>
<td>Konefal et al. (2018)</td>
<td>24 teams in 36 matches played in the European Championships 2016 group stage</td>
<td>● Team performance: Match outcome</td>
<td>Collected by OPTA Sportsdata</td>
<td>● Shots on target and shots from inside penalty area were closely related to outcome of the match ● Greater possession, crosses, passes, and short pass frequency when team is trying to overcome an unfavourable score (losing or drawing)</td>
</tr>
<tr>
<td>Liu, Gómez et al. (2016)</td>
<td>409 outfielders in 380 matches of the Spanish La Liga for the 2012–2013 season</td>
<td>● Team performance: Team ranking</td>
<td>Collected by OPTA Sportsdata</td>
<td>● Significantly higher frequencies of assists, passes, pass accuracy, through balls, shots on target, touches, dribbles by players from Top 3 teams in league ● Profiles differed across playing position, and also differed between players from strong or weak teams for the same playing position ● Contextual variables such as strength of own team and opposition influenced match action profiles, and had a</td>
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<tr>
<td>Study</td>
<td>Sample</td>
<td>Comparison</td>
<td>Procedures</td>
<td>Main results</td>
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| Liu, Yi et al. (2015)       | 992 match observations in 496 matches played in the UEFA Champions League from the 2009–2010 to 2012–2013 season | ● Team performance: Team ranking                                          | Collected by OPTA Sportsdata    | ● Match actions related to scoring, attacking and defending could significantly distinguish teams of different strengths  
● Team match action profiles varied when facing different levels of opposition, specifically match actions such as shots, shots on target, open play shots, possession, aerial success and fouls  
● Across teams of different strengths, match actions profiles differed in relation to match outcome and match location |
| Oberstone (2010)            | 37 goalkeepers in 380 matches played in the English Premier League for the 2007–2008 season | ● Individual performance: Player ranking                                   | Collected by Opta Sportsdata    | ● Frequency of shots conceded inside and outside the box, punches, short passes, clean sheets, and goals allowed were match actions statistically significant in predicting a goalkeeper’s performance |
| Rampinini et al. (2009)     | 186 outfielders in 416 matches played in the Italian Serie A for the 2004–2005 season | ● Team performance: Team ranking                                          | Collected by SICS               | ● Top ranked teams performed more ball involvements, short passes, successful short passes, tackles, dribbling, shots, and shots on target |
| Seaton & Campos (2011)      | 4 goalkeepers in 40 matches played in various division of Spanish football | ● Individual performance: Membership to team of different strengths        | Hand notation by researchers    | ● Type of distribution, intended area of distribution, and distribution success differed significantly across goalkeepers of different playing levels |
| Serrano et al. (2019)       | 127 goalkeepers in 3874 matches in the Spanish La Liga for the 2011–2012 to 2016–2017 seasons | ● Individual performance: Membership to team of different strengths        | Collected by Media Coach        | ● Goalkeepers from lower ranked teams performed more passes and saves but had lower percentage of successful passes |
winning the ball) (Yang et al., 2018), aerial and ground duels (Evangelos et al., 2014), also significantly differed between teams of varying performance levels.

The variance of these actions performed across matches also differentiated between teams of differing performance levels. Lower performing teams exhibited match action profiles with less variability in frequency of defensive match actions observed, such as interceptions and defensive clearances. In contrast, higher performing teams showed less variability in offensive match actions such as assists, shots, shots on target, ball touches, passes, through balls, key passes, successful dribbles and pass accuracy (Liu, Yi et al., 2015).

### 4.2.2 Individual level—Comparative

Here, we sought to identify differences in match actions performed between individuals of differing performance levels. Studies in this category of analysis exclusively examined players in the goalkeeper position. Evidence

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Comparison</th>
<th>Procedures</th>
<th>Main results</th>
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<tbody>
<tr>
<td>Varley et al. (2017)</td>
<td>380 players in 52 matches played in Al Kass International Cup 2015 and 2015</td>
<td>● Team performance: Team ranking</td>
<td>Collected by Prozone Sports</td>
<td>● Top ranked teams demonstrated greater absolute and relative number of shots and shots on target, and greater relative number of tackles compared to bottom ranked teams. Absolute number of shots, shots on target, shot conversion, and passing accuracy was lowest when middle and bottom ranked teams played top ranked teams.</td>
</tr>
<tr>
<td>Yang et al. (2018)</td>
<td>240 matches in the Chinese Super League for the 2014 season</td>
<td>● Team performance: Team ranking</td>
<td>Collected by AMISCO</td>
<td>● Percentage of possession, possession in opponent’s half, entries into final third and penalty area, 50-50 challenges and fouls committed differentiated teams of different ranking. ● Time of possession was associated with likelihood of winning.</td>
</tr>
<tr>
<td>Yi et al. (2019)</td>
<td>1536 match observations in 768 matches of the UEFA Champions League from the 2009–2010 to 2016–2017 season</td>
<td>● Team performance: Qualification</td>
<td>Collected by OPTA Sportsdata</td>
<td>● Teams that qualified past group stage demonstrated more stable match action profile related to goal scoring, attacking, and passing match actions. ● Teams that failed to qualify demonstrated more stable match action profile related to defensive match actions.</td>
</tr>
<tr>
<td>Yue, Broich, &amp; Mester (2014)</td>
<td>50 matches in the Bundesliga for the 2011–2012 season</td>
<td>● Team performance: Match outcome</td>
<td>Collected by Opta Sportsdata</td>
<td>● Greater goal efficiency (goals to opportunity ratio) best differentiated winning teams, followed by total shots, passes and touches.</td>
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<tr>
<td>Study</td>
<td>Sample</td>
<td>Predicted variable</td>
<td>Procedures</td>
<td>Main results</td>
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| Adams, Morgans, Sacramento, Morgan, & Williams (2013) | 10369 individual match observations in the English Premier League for the 2011–2012 season | ● Individual performance: Membership to team of different strengths | Collected by Opta Sportsdata | ● For defenders, frequency of successful short passes followed by unsuccessful passes in opposition half were the best predictors  
   ● For midfielders, frequency of successful passes in opposition half were the best predictors |
| Barron, Ball, Robins, & Sunderland (2020) | 966 players in the English Championship for the 2008–2009 and 2009–2010 seasons | ● Individual performance: Membership to team of different strengths | Collected by STATS         | ● Match actions associated with passing, shooting and regaining possession were significant factors in predicting the level of competition an individual would compete at in the following season |
| Brito Souza, López-Del Campo, Blanco-Pita, Resta, & Del Coso (2019) | 3040 matches played in the Spanish La Liga for the 2010–2011 to 2017–2018 seasons | ● Team performance: Points earned in season           | Collected by Media Coach    | ● Greater frequencies of shots, corners, recoveries and better ratio of shots conceded to goals conceded were positively associated with points earned  
   ● Match actions of shot accuracy and preventing shots conceded were positively associated with points earned |
| Elyakim et al. (2020)                      | 1240 matches played in the Italian Serie A and Israeli Premier League | ● Team performance: Match outcome                     | Collected by InStat         | ● Match actions associated with possession (passes, time in possession), key actions (shots, key passes, actions up the pitch) and performance quality (shot accuracy percentage, pass accuracy percentage) positively influenced match outcome |
| Harrop & Nevill (2014)                     | 46 matches in the English League One for the 2012–2013 season          | ● Team performance: Match outcome                     | Collected by Prozone       | ● Successful passes and shots were predictive of successful match outcomes  
   ● Total passes and dribbles were predictive of negative match outcomes |
| Lago-Peñas & Dellal (2010)                 | 380 matches played in the Spanish La Liga for the 2008–2009 season      | ● Team performance: Match outcome                     | Collected by Gecasport      | ● Greater frequency of shots (total, on target, to goal ratio), assists, |
Table 3. (continued).

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<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Predicted variable</th>
<th>Procedures</th>
<th>Main results</th>
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  ● Defensive errors, shots to goal ratio, shots (counter attack, on target, total) greatest positive influence on match outcome  
  ● Crossing frequency negatively influenced match outcome  
  ● Certain match actions influenced by contextual variables of opponent strength and home advantage |
| Liu, Gómez, Lago-Peñas, & Sampaio (2015) | 48 matches in FIFA World Cup 2014 group stage              | ● Team performance: Match outcome | Collected by Opta Sportsdata | ● Shots (total, on target, counter attack, inside area), possession, short pass, average pass streak, aerial advantage and tackles had clear positive effects on the team’s probability of winning  
  ● Shots blocked, crosses, dribbles and red cards had clear negative effects on winning |
| Liu, Hopkins, & Gómez (2016)   | 320 matches in Spanish La Liga for the 2012–2013 season            | ● Team performance: Match outcome | Collected by Opta Sportsdata | ● Shots on target, total shots and possession had a positive effect on likelihood of winning |
| Mao, Peng, Liu, & Gómez (2016) | 480 matches played in the Chinese Super League for the 2014 and 2015 season | ● Team performance: Match outcome | Collected by Opta Sportsdata | ● Match outcome was positively influenced by shots on target, shot accuracy, cross accuracy, tackles and yellow cards received |
| Moura, Martins, & Cunha (2014) | 96 match observations in the FIFA World Cup 2006 group stage         | ● Team performance: Match outcome | Collected by FIFA       | ● Shots (total, on target) and fouls (conceded, committed) were significant match actions that discriminated between winning, drawing and losing teams |
from these studies suggested that individual players with distinct levels of performance differed significantly in their match action profiles. Goalkeepers competing in different competitive tiers significantly differed in the type of distribution method chosen, intended area of distribution, and distribution success (Seaton & Campos, 2011). High performance goalkeepers competing in the first division of La Liga, for example, distributed the ball more frequently into areas that provided a greater tactical advantage for the team when attacking (e.g., central zone of the attacking third), compared to goalkeepers from the second division, third division or under-19 years old youth teams. Furthermore, goalkeepers that represented lower ranked teams within La Liga performed more passes and were also required to perform more saves (Serrano et al., 2019).

### 4.2.3 Team level—Predictive

The studies in this category sought to highlight match actions significantly associated with level of performance achieved. Similar to the results of the comparative research articles, a greater quantity, higher quality

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Predicted variable</th>
<th>Procedures</th>
<th>Main results</th>
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<tbody>
<tr>
<td>Pappalardo &amp; Cintia (2017)</td>
<td>6396 matches in Premier League, Serie A, La Liga, Bundesliga, Eredivisie, and Ligue 1</td>
<td>● Team performance: Match outcome</td>
<td>Collected by Wyscout</td>
<td>● Possession and shots were positively associated with match outcome Goalkeeper interventions, fouls conceded and clearances were negatively associated with match outcome Relative performance of match actions better descriptor than absolute performance</td>
</tr>
<tr>
<td>Pappalardo et al. (2019)</td>
<td>21,361 players in 19,619 matches across 18 professional domestic and international competitions</td>
<td>● Individual performance: Player ranking</td>
<td>Collected by Wyscout</td>
<td>● Different variations of match actions creating assists (simple pass, cross, head) and shots or free kicks on target were significant predictors in match outcome ● Predictors across competitions were small, with the exception of international tournaments such as the European Championships and FIFA World Cup</td>
</tr>
<tr>
<td>Sgrò, Barresi, &amp; Lipoma (2015)</td>
<td>24 matches in the European Championships 2012</td>
<td>● Team performance: Match outcome</td>
<td>Hand notation by researchers</td>
<td>● Offensive actions related to goal scoring—total goals, total shots, shot efficiency and assists were best predictors of match outcome</td>
</tr>
<tr>
<td>Waldron &amp; Worsfold (2010)</td>
<td>53 sub-elite and 18 elite English youth football players</td>
<td>● Individual performance: Membership to team of different strengths</td>
<td>Hand notation by researchers</td>
<td>● Significantly higher frequencies of 9 match actions in domains of successful shooting, passing, dribbling by elite players compared to sub-elite ones</td>
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(location of shot, type of shot) or efficiency of shots (shots on target, goals to shots ratio) were identified as significant predictors of positive match outcome. Additionally, greater amount of time in possession was identified to be significantly correlated with positive match outcomes (Elyakim et al., 2020; Liu, Gómez et al., 2015; Liu, Hopkins et al., 2016). Also, more shots and ball recoveries, combined with greater shot accuracy and fewer shots allowed, were positively associated with points earned in the season (Brito Souza et al., 2019).

Interestingly, although successfully executed offensive pass-related actions (such as accurate passes, crosses, and key passes) were positively associated with match outcomes, the absolute quantity of match action frequencies did not have the same association with match outcomes. For instance, a high number of passes, crosses or dribbles attempted (Harrop & Nevill, 2014; Liu, Gómez et al., 2015) were not significantly associated with team performance and were sometimes associated with negative match outcomes. Similarly, although a greater frequency of tackles (Liu, Gómez et al., 2015; Mao et al., 2016) and aerial duels won (Liu, Gómez et al., 2015) were positively associated with match outcomes, a greater frequency of shots blocked (Liu, Gómez et al., 2015), fouls conceded (Moura et al., 2014; Pappalardo & Cintia, 2017), clearances and goalkeeper interventions (Pappalardo & Cintia, 2017) were negatively associated with match outcomes.

4.2.4 Individual level – Predictive

The articles within this level of predictive analysis primarily examined match actions crucial in predicting individual performance. To quantify individual performance, a top-down approach was commonly utilized whereby researchers pre-classified individuals into different levels of performance based on a proprietary performance index (Oberstone, 2010); membership of teams (1) that finished in the top or bottom half of the same league (Adams et al., 2013), (2) in leagues of different competitive tiers (Barron et al., 2020), or (3) in football academies of different competitive tiers (Waldron & Worsfold, 2010). After which, researchers examined individual match action profiles to derive the match actions significantly associated with level of individual performance.

Across the major outfield playing positions, higher frequency in offensive match actions, such as successfully executed passes, was significantly associated with membership of higher performing teams (Adams et al., 2013; Barron et al., 2020). Akin to earlier sections, successful shooting was significantly associated with greater individual performance. Specifically, individuals that executed more successful shooting attempts were likelier to compete in a league of higher competitive tier in the following season, such as progressing from the English Championship to the EPL (Barron et al., 2020). Similarly, successful shooting was significantly associated with likelihood of recruitment into an elite EPL academy (Waldron & Worsfold, 2010). For goalkeepers, shots conceded in and outside the box, punches, short passes, clean sheets, and goals allowed were significantly associated with individual performance indicated by scores on the Opta Index (a consolidated performance metric built from the weighted frequencies of different key match actions for each playing position) (Oberstone, 2010).

In contrast to this top-down approach, one study utilized a bottom-up approach which involved first identifying the critical match actions for each playing position (Pappalardo et al., 2019). This was achieved by using a machine learning approach to identify match actions that best contributed to a positive performance outcome. Individual performance level was then constructed by combining the frequency and derived importance of these critical match actions. Using this approach, the match actions highlighted to be critical in predicting individual performance were assists, key passes (i.e., pass leading to shooting opportunity, but no goal scored), and shot accuracy. Interestingly, the critical match actions identified from the bottom-up approach were similar to those identified from the top-down approach.

5 Discussion

Building on an ecological dynamics approach, this systematic review sought to highlight the environmental and task constraints of significant influence in contextualising competitive performance in football (Araújo, Couceiro, Seifert, Sarmento, & Davids, 2021). We sought to identify the direction and magnitude of their influence, and to establish the processes in which quantitative indicators of football performance can be meaningfully interpreted. Furthermore, existing evidence on the validity of frequency of match actions as a performance indicator in football was also examined.

5.1 High performance as best fit rather than best player

The significant influence of the multitude of key constraints on emergent match action profiles highlighted in this systematic review presents several contributions to the assessment of performance in football. Most notably, these results highlight the importance of contextualizing performance and accounting for key constraints when assessing performance in football. More specifically, because the key constraints acting on each individual are unique, even between players in similar positions, indicators of high performance cannot be universal. They largely depend on the unique task and environmental constraints demanded of the individual in particular environments. For instance, forward players from lower ranked teams were required to perform more defensive actions (e.g., aerial duels, clearances) while those from higher performing teams executed more possession and offensive actions (e.g., ball touches, passes, shots on targets and assists) (Liu, Gómez et al., 2016). Therefore, during recruitment, teams should closely consider the unique constraints that would be exacted on their
potential recruit (and consequently, the match actions that they would be required to perform regularly) as part of their selection process. From a practical perspective, this may be exemplified by lower ranked teams understanding that they would not have the bulk of possession during matches, and therefore looking to recruit forward players that “fit” their team constraints (e.g., proficiency in winning aerial duels, defensive awareness) rather than those with traditionally-valued abilities (e.g., dribbling proficiency).

Building on this concept of the “best-fit” player, the current approach of approximating level of individual performance based on membership of high or low performing teams (Adams et al., 2013; Barron et al., 2020; Waldron & Worsfold, 2010) may have limited validity as it disregards the contexts of competitive performances. To illustrate, defenders with low capabilities in defensive match actions may not have their weaknesses highlighted if they represent high performing teams, as they are rarely required to perform these actions (Liu, Gómez et al., 2016; Yi et al., 2019). Conversely, defenders with high capabilities in both offensive and defensive match actions may not be identified as a high performer if they represent lower performing teams, due to the lack of opportunities to demonstrate offensive match actions.

Accordingly, future research should consider building on the bottom-up approach proposed by (Pappalardo et al., 2019) that was described in the earlier section. For example, by first identifying the match actions critical for competing successfully under specific local constraints, lower resourced or lower performing teams can build a prediction model to identify candidate high performers. Conversely, higher resourced or higher performing teams could identify candidate high performers using a disparate model accounting for their own specific constraints. In this way, a more contextualized measure of individual performance may be developed, whereby individual performance is defined as the likelihood of improving match outcomes based on unique task and environmental constraints experienced by the team, instead of the performer biased approach of recruiting the best player in the position. Such a system might be instrumental in reducing likelihood of false positives (i.e., low performers getting by in high performing teams) or false negatives (i.e., high performers not recognized due to representation of low performing teams) in assessing individual player performance.

To this end, it is important to consider that contextual demands faced by the players are constantly changing. For example, professional football teams face different opponents every week, in a variety of settings (e.g., type of competition, match location) and these demands significantly alter task and environmental constraints at the individual and team level. Therefore, from an ecological perspective, the ability to successfully adapt to perennial changes in contextual constraints could be most indicative of high performance (David, Araújo, & Shuttleworth, 2005; Davids, Araújo, Seifert, & Orth, 2015). The importance of this performer adaptability in skill acquisition has been widely highlighted in sports coaching and practice design (Woods, McKeown, Shuttleworth, Davids, & Robertson, 2019). Taken together with the results of the current study, it is justifiable to hypothesize that adaptability may be a crucial indicator of athletic performance or imperative to athlete development. In this case, a hallmark of an elite performer amongst professional players could be “behavioural flexibility”, or the ability to repeatedly adapt one’s match actions to dynamically changing contextual constraints (Ranganathan, Lee, & Newell, 2020). Therefore, more than assessing which match actions are linked to higher performance, a potentially crucial question relates to if the ability to generate a variety of necessitated goal-directed behaviour is indicative of high performance. Indeed, a key consideration from an ecological dynamics approach is whether multiple sets of match actions can lead to a similar outcome within a similar context, also known as degeneracy (Seifert, Konar, Araújo, & Davids, 2016). In this perspective, a higher level of degeneracy (i.e., possessing a greater number of coordinative patterns or behavioural responses to achieve similar goal-directed outcomes) is a key signature of individual and collective expertise. Diversity of match actions both within a similar context and between different contexts therefore may provide information on expertise level of players and teams.

5.2 Match actions as an indicator of performance in football

The results of the present review suggest that frequency data on match actions, performed by individuals or collectively as a team, have some value in differentiating between individuals or teams of contrasting levels of performance. However, the present findings also reveal the need for advances in current theoretical approaches to improve the practical viability of utilizing match actions frequency data as a performance indicator in football.

5.2.1 Shift towards prospective study designs

Across the studies examined, all the studies utilized a retrospective study design with the exceptions of Pappalardo et al., (2019) and Serrano et al., (2019). These retrospective study designs focused solely on examining key differences between individuals or teams of high or low performance in a certain context. Most crucially, the retrospective approach does not apply its findings towards a set of participants outside of the sample from which the findings were derived. Therefore, it remains unknown whether findings from these studies are limited to the participants studied or if they remain true when applied to other samples or different contexts. Furthermore, these studies may be limited in their practical value as football organizations are more likely to edge out their competition
if they can predict the likelihood that a player would be a high performer instead of merely knowing the characteristics of previously high performing players.

In response, a prospective-oriented approach that seeks to shift the focus towards forecasting likelihood of high performance in the future, could provide more value to practitioners. Such an approach should closely examine knowledge from existing retrospective studies, to guide the construction of prediction models using machine learning and statistical modelling techniques. Moreover, to further bolster the validity of these models, the prospective approach should be grounded in the ecological dynamics framework and should account for task and environmental constraints unique to the context of the team or individual (Araújo et al., 2021). Specifically, prediction models in this prospective approach should seek to forecast likelihood of high performance in a specific context (i.e., in a certain team with specific task and contextual constraints, see earlier section on high performance as best fit). Such an approach would provide greater practical value for football organizations as they serve as an empirical, data-informed means of player evaluation grounded by existing knowledge. Consequently, such an approach also allows for the forecasting of future performance in different potential environments. Specifically, players who show high potential in adapting to multiple and varied contexts could, therefore, be considered more valuable than players with limited adaptability.

5.3 Limitations

As briefly discussed in previous sections, the inconsistency in operational definitions of performance (e.g., team performance was categorized as ranking within the league, match outcome, or qualification towards next stage of competition) and match actions (multiple definitions between sports data companies, and hand notations done by researchers) make it difficult to conduct a meta-analysis or use another systematic statistical approach in the current systematic review. Therefore, although evidence from the reviewed studies suggests that “on-ball” match actions are a significant indicator and predictor of performance, we are unable to statistically conclude the strength or extent to which they can be used to differentiate and predict performance. It is possible that other indicators, such as match actions that occur “off-the-ball” (e.g., ball recovery actions, compactness of team shape) may also need to be considered in order to more comprehensively assess performance (Memmert, Lemmink, & Sampaio, 2017). Future research may consider addressing this inconsistency in operational definitions by conducting meta-analyses only using studies from a single sports data company with consistent operational definitions.

6 Conclusion

Given the dynamic nature of the sport, researchers and practitioners in football have long struggled with establishing an objective, universal definition of footballing performance. And perhaps more importantly, establishing processes in which performances can be meaningfully analysed to generate practical insights and inform decision-making. The results of this review further reinforce the need to transition towards an ecological dynamics approach when utilizing a data-informed approach towards identifying and predicting high performing football players. Specifically, use of match action data as a performance indicator, which more closely accounts for interactions between a performer and contextual constraints, certainly appears to be a more reliable performance indicator compared to those measured in abstract, “context-free” environments. In addition, the significant influence of environmental and task constraints on the match actions performed suggest that behavioural flexibility and adaptability to varied contexts should be considered as a key factor for expert performance, at both the individual and team level.

Pertaining to study designs in this area of research, there is an overwhelming use of a retrospective, top-down approach to classify performance. Given the potential applications of this performance analysis oriented, data-informed approach in player recruitment, performance forecasting and contract decisions, it seems reasonable to propose that future work should transition towards a prospective research design that places greater emphasis on utilizing the knowledge derived from retrospective studies towards forecasting future performance. Lastly, future research should examine the prospective power of critical match actions in the short- and long-term using mathematical modelling and simulation techniques and explore the influence of multiple environmental and task constraints on the likelihood of future high performance. This approach would, therefore, emphasize the need to consider behavioural flexibility and adaptability as key indicators to be considered in talent identification.

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Conflicts of interest

The authors declare no conflicts of interest in relation to this article.

Ethics approval

Ethical approval was not required.

Informed consent

This article does not contain any studies involving human subjects.
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