THE CONTEXTUALISATION OF MATCH RUNNING PERFORMANCE IN ELITE FOOTBALL

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Abstract

The traditional approach to quantifying football (soccer) match physical demands in isolation from tactical and technical performances has been used over the last 45 years. An integrated approach for the contextualisation of match physical performance with key tactical actions has been devised. However, scientific examinations into match physical-tactical profiles are sparse.

The aim of Study 1 (Chapter 3) was to improve the original integrated approach to quantifying match physical-tactical performances (e.g., the lack of objectivity within the coding process and limited information regarding the actual tactical purpose of the action), and then verify the validity and reliability of the newly developed integrated approach. The new integrated approach demonstrated a high degree of validity and strong inter- (κ=0.81) and almost perfect intra-observer (κ=0.94) reliability. Hence, unique high-intensity profiles of elite players/teams in relation to key tactical actions can be validly and reliably generated.

Study 2 (Chapter 4) determined differences in match physical-tactical performances between various tactical roles to provide better insights into match performance in football. Physical-tactical profiles during match-play were position-specific. Analysing positions with specific tactical roles (e.g., central defensive and attacking midfielders) was found to be more sensitive in detecting match performance of players compared to a general positional analysis (e.g., central midfielders) that could over or underestimate physical-tactical demands. This suggests that coaches and practitioners should account for specific playing styles of their players within the team when designing position- or player-specific training programmes.

The Study 3 (Chapter 5) sought to establish the physical-tactical profiles of elite football teams and individual players with special reference to final league rankings alongside technical metrics to better understand associations between success in football and match performance. Higher-ranked teams not only performed more physical-tactical activities when in possession of the ball during a competitive match (e.g., ‘Move to Receive/Exploit Space’, ‘Run with Ball’, etc.) but also demonstrated better technical performances (e.g., greater number of shots on target, passes, etc.) compared to lower-ranked teams. The contextualised data can improve our understanding of a team’s playing style according to their competitive standard.

The Study 4 (Chapter 6) analysed the physical-tactical trends of elite players and teams during peak 1-, 3- and 5-min (i.e., the most 1-, 3- and 5-min intense period of play) and the following periods during matches to provide better insights into match peak physical demands of players in relation to tactical actions and transient decrements in high-intensity running after intensified periods of play. The contextualised data showed that during the most demanding passage of play, players/teams covered the largest high-intensity distance for 'Recovery Run' out of possession and 'Support Play' in possession. After peak periods players/teams covered less high-intensity distance compared to the match average, especially when out of possession performing less high-intensity 'Covering' and 'Recovery Run' distance. However, some physical-tactical actions showed inconsistency in different time durations of the next periods with these physical-tactical data being position-specific (e.g., central offensive players covered ~80-100% less 'Break into Box' high-intensity distance in the next 1- and 5-min periods compared to the match average with performing ~20% more during the next 3-min period). Such data can help practitioners prescribe position- or player-specific drills whilst replicating peak physical-tactical demands of play and better understand transient decrements in high-intensity running after intense periods.

This research programme provides novel data through investigating match physical-tactical profiles of players and teams. The studies reported above have demonstrated much clearer insights into match performance due to the fusion of physical metrics alongside their tactical context. Therefore, it is hoped that the contextualised data from the present research programme can help coaches and applied practitioners not only better understand match demands but also apply these into training sessions more effectively.

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Publications

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List of Abbreviations

AMP, Average Metabolic Power

B2BM, Box-to-Box Midfielders

CAM, Central Attacking Midfielders

CB, Centre Backs

CB^2, two Centre Backs

CB^3, three Centre Backs

CDM, Central Defensive Midfielders

CDP, Central Defensive Players

CF^1, one Centre Forward

CF^2, two Centre Forwards

CM, Central Midfielders

CMP, Central Midfield Players

COP, Central Offensive Players

CV, Coefficient of Variation

EPL, the English Premier League

EPTS, Electronic Performance and Tracking Systems

ES, Effect Size

FB, Full-Backs

FIFA, Federation Internationale de Football Association

FW, Forwards

GPS, Global Positioning System

HIMP, High-Intensity Movement Programme

HMLD, High Metabolic Load Distance

LPS, Local Positioning System

OTS, Optical Tracking Systems

PCr, Phosphocreatine

WB, Wing-Backs

WDP, Wide Defensive Players

WF, Wide Forwards

WM, Wide Midfielders

WOP, Wide Offensive Players

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 Background

Football (soccer) is the most popular sport in the world with approximately 265 million players actively involved in the game (Kunz, 2007). The popularity of football seems to be because the rules and equipment needed are simple (D'Orazio and Leo, 2010). Football requires ten outfield players and one goalkeeper for each team to invade an opponent's territory to score a goal when attacking and avoid conceding goals when defending with the intention of outscoring the opposition. Although the rules are that simple, the nature of football is highly complex in which the combination of physical, technical, tactical and psychological capabilities influence match performance (Mackenzie and Cushion, 2013; Bate and Jeffreys, 2015; Bradley and Ade, 2018). Football is characterised as an intermittent team sport since players repeatedly perform sub-maximal or maximal high-intensity actions interspaced by longer periods of low-intensity activity whilst not only simultaneously executing various technical and/or tactical skills but also interacting to both teammates and opponent players during a match (Bangsbo, Mohr and Krustrup, 2006; Rampinini et al., 2009; Bate and Jeffreys, 2015).

Time-motion analysis has been extensively used in the literature, especially for work-rate studies in elite football whereby quantifying match performance (Carling et al., 2008). For the first time in the scientific literature Reilly and Thomas (1976) conducted pioneering research to indirectly quantifying the physical demands of elite football players such as distances and intensities covered at different speeds (e.g., walking to sprinting) with the use of a manual technique (i.e., paper and pencil). Since then, this traditional methodology (e.g., simply reporting distance covered) has been adopted to provide some insights into match-play physical performance whilst the means of tracking a player's performance has evolved from manual to semiautomatic/automatic manner (Bangsbo, Nørregaard and Thorsoe, 1991; Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Paraskevas, Smilios and Hadjicharalambous, 2020; Riboli et al., 2021). An abundance of research has been conducted to understand not only physical but also technical and tactical performances using different technologies such as global positioning systems and optical tracking systems (Bradley et al., 2009; Rampinini et al., 2009; Ade, Fitzpatrick and Bradley, 2016; Yang et al., 2018; Oliva-Lozano et al., 2020). Existing studies have examined physical demands of elite senior as well as youth football players during a match irrespective of gender and how their performance is influenced by other factors such as playing positions, formations/playing style and opponent standard just to name a few (Rampinini et al., 2007; Di Salvo et al., 2009; Bradley et al., 2011; Bradley et al., 2014a; da Mota et al., 2016; Castellano, Martín-García and Casamichana, 2020). Over the last decade, high-intensity running activities undertaken during a match have been of great interest since they have increased by ~10-30% whilst only a 2-4% increase has been observed in the total distance covered (Barnes et al., 2014; Bradley and Scott, 2020; Zhou, Gomez and Lorenzo, 2020). Additionally, low-intensity running activities seem to have little to no impact on match outcome whereas high-intensity actions (e.g., sprinting) have greater impact on key moments of the game (Faude, Koch and Meyer, 2012; Martínez-Hernández, Quinn and Jones, 2022). More recently, greater attention has been paid to peak demands during matches (i.e., distance covered during the most intense period of play) as it helps practitioners to better prepare players for the physical requirements of modern match-play whilst replicating peak demands compared to average demands of play (Mernagh et al., 2021). Yet, issues exist when trying to directly translate physical metrics into specific training drills as the context of play (e.g., tactical activities) is completely omitted from any of the studies in the literature that have quantified the most intense period of a match (Carling et al., 2019). Moreover, running performance such as high-intensity running has been used as a fatigue indicator. The general consensus from previous findings is that the transient decrements in high-intensity running occur after intensified periods; however, why fatigue occurs temporarily after intense periods of play is still unclear due to numerous physiological (e.g., metabolic and ionic perturbations, depletion of phosphocreatine, etc.) and contextual factors influencing match performance such as pacing strategies adopted by players (Bradley and Noakes, 2013). Hence, more context is necessary to better understand the transient performance decrements.

Furthermore, technical performances have also been investigated although fewer studies have been conducted compared to those investigating physical demands of competition (Taylor et al., 2008; Rampinini et al., 2009; Bradley et al., 2011; Morgans et al., 2014; Yang et al., 2018). It has been reported that technical skills of players (e.g., number of shots on target) seem to be better indications to predict a team’s success and differentiate team standards and/or league rankings in elite football, rather than physical performance such as high-intensity running per se (Rampinini et al., 2009; Castellano, Casamichana and Lago, 2012; Konefał et al., 2019a). Indeed, physical activities do influence technical proficiency (Rampinini et al., 2008) whilst they are also modulated by tactical scenarios during competition (Schuth et al., 2016). Nevertheless, tactical analysis has been typically omitted from the scientific literature in the field of football, which appears to be due to the inherent complexity for measuring tactics and formations that are highly variable during match-play (Bradley et al., 2011). Despite such efforts to understand match performance, little progress has been made when it comes to optimising physical metrics used by coaches and applied practitioners within football teams (Bradley and Ade, 2018). This seems to be due to the reductionist and traditional method that previous researchers have adopted (e.g., analysing physical performance in isolation and just reporting distance covered). In fact, coaches sometimes have difficulty communicating with sports scientists regarding physical metrics (Nosek et al., 2021). Coaches appear to be more concerned about 'WHY' players do certain high-intensity actions during a match rather than 'WHAT' distance players have covered. Given the fact that physical activities during a match are constrained and modulated by tactical scenarios (Waldron and Highton, 2014; Schuth et al., 2016), adding tactical context into physical metrics would be beneficial to allow coaches to better understand data, thus translating them into training drills more effectively.

A novel approach that amalgamates high-intensity running metrics and tactical activities could be a solution since this can uncover unique high-intensity running profiles of various positions that exist due to distinct tactical roles (Ade, Fitzpatrick and Bradley, 2016; Bradley and Ade, 2018). For instance, full-backs cover ~10% of their high-intensity distance for 'Overlapping' during transition/attacking play whilst forwards perform ~10% of the total distance at high-intensity for 'Break into the Box' actions. This unveiled the components of the high-intensity distance covered by different playing positions, thus providing 'WHY' players perform high-intensity running during match-play. Therefore, using this innovative approach could help coaches not only understand physical metrics more clearly with tactical information but also give instructions to the players during a match more effectively. Moreover, it will allow practitioners to translate match data into training drills and programmes more successfully although this contextualises only high-intensity running efforts whilst not accounting for metabolically demanding actions (e.g., accelerations and directional changes). Regarding research wise, it seems to be achievable to provide much more informative data by integrating high-intensity running metrics with key tactical actions compared to the traditional methodology. For instance, physical-tactical differences between various tactical roles or team standards/league rankings could be determined. Also, the key physical-tactical movements of each position during the most demanding passage of play could be identified. Such data could ultimately help applied staff condition their players whilst meeting the optimal match physical-tactical demands according to a specific tactical role of players. In addition to this, it could also be possible to identify how players or teams modulate their physical performances whilst adjusting tactical behaviour in the period that follows the most intense period during a competitive match. This could provide greater insights regarding why transient physical decrements occur after intensified periods. However, existing methodological issues should be addressed before collecting and analysing data due to the integrated approach having been currently emerged as well as few studies having been conducted using this approach.

1.2 Aims and Objectives

The aims of the present thesis will be firstly to identify methodological problems within the integrated approach and develop it by modifying such issues and then verifying its validity and reliability, and secondly to investigate match performance in elite football by amalgamating physical metrics with tactical actions to improve the understanding of match performance in football as well as help not only coaches better understand data but also practitioners better prescribe training programmes.

To achieve these aims, the objectives are as follows:

1. To modify methodological issues and then verify the validity and reliability of the integrated approach.
2. To identify physical-tactical differences between various tactical roles.
3. To determine physical-tactical differences between teams based on their final league ranking (e.g., higher or lower rank).
4. To investigate physical-tactical performances during 1-, 3-, and 5-min peak periods during match-play (i.e., the most intensified period of play) and the subsequent periods.

CHAPTER TWO

REVIEW OF THE LITERATURE

2.1 Introduction

The quantification of match-play activities is useful to provide the requirements of match performance that could serve as a guide or benchmark when planning training sessions (Casamichana et al., 2019). The research conducted by Reilly and Thomas (1976) was pioneering with regard to the quantification of the physical demands in elite football (soccer) by manually recording distance covered and exercise intensities using a subjective assessment technique. Since then, this traditional approach has been adopted by researchers with different technologies to investigate the physical performance during match-play (Bangsbo, Nørregaard and Thorsoe, 1991; Mohr, Krustrup and Bangsbo, 2003; Rampinini et al., 2007; Bradley et al., 2009; Paraskevas, Smilios and Hadjicharalambous, 2020). Although many scientific studies have provided some valuable insights on intense physical activities such as high-intensity running and accelerations/decelerations during match-play (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2010; Varley and Aughey, 2013; Ingebrigtsen et al., 2015), the methods applied in the literature quantify only physical metrics without amalgamating other factors (e.g., tactical data). At the time of conducting this research, it was suggested to use an integrated approach that contextualises physical metrics with key tactical purposes in order to provide better insight into match performance (Bradley and Ade, 2018). This literature review will identify early to current methods to quantify the match physical performance of elite football players, along with technical metrics. And then discuss the match performance in relation to playing positions, team success and intensified periods of play with considerations of contextual factors that have an impact on match performances. The suggestion of using an integrated approach to quantifying match demands in elite football will then be discussed.

2.2 Time-Motion Analysis in Football

2.2.1 Manual Motion Analysis

Over the last four decades time-motion analysis has been widely applied in the literature, especially for work-rate studies in elite football (Reilly and Thomas, 1976; Bangsbo, Nørregaard and Thorsoe, 1991; Mohr, Krustrup and Bangsbo, 2003; Di Mascio and Bradley, 2013; Oliva-Lozano et al., 2020). This is a useful data-collection technique for indirectly quantifying the physical performance of elite football players for both training and match-play. Performance analysis using time-motion analysis can help the coaching process by providing accurate, objective, visual and effective information to coaches and practitioners. This information can be used to make decisions, plan training programmes with optimal workload whilst preventing injury risks, and give feedback to their players with the purpose of enhancing performance (Carling, Williams and Reilly, 2005; O'Donoghue, 2006; Buchheit and Simpson, 2017; Beato, Drust and Iacono, 2021). Early work in this area involved manual coding systems by using a coded map of the football pitch and visual cues along each touchline in order to manually estimate the distance covered or the time spent at different levels of speed (e.g., walking to sprinting). Reilly and Thomas (1976) for the first time quantified the match physical demand of elite football players whereby setting up several video cameras next to the side of the pitch to film each player. Followed by this classical work, Bangsbo, Nørregaard and Thorsoe (1991) progressed the earlier work by filming player movements with a camera and then applying a basic computer software to link this to the distance covered, time spent and frequency of occurrences according to intensity. Researchers then applied similar manual video-based motion analysis methods with some technical advancements for monitoring player work-rate in elite football (Mohr, Krustrup and Bangsbo, 2003; Krustrup et al., 2005; Impellizzeri et al., 2006). Although these studies provided some insightful information about the match physical demands, the manual-based method restricted the application of data within the applied setting due to the time consumption required for coding (e.g., allowing the analysis of one single player at a time) and the data collection process, to some extent, being prone to inaccuracies (Carling et al., 2008). Nonetheless, should analysts be experienced enough, they can generate appropriate and reliable data with manual-based analysis. In addition, it is challenging to accurately quantify rapidly changing movements such as acceleration and deceleration actions with the use of manual analysis techniques (Carling and Bloomfield, 2013).

2.2.2 Computerised Motion Analysis

In the late 1990s semi-automatic multiple-camera video technology such as AMISCO Pro® (Nice, France) and ProZone® (Leeds, UK) systems emerged, and this allowed the concurrent quantification of every player’s physical demand throughout a match (Carling et al., 2008). These systems used multiple cameras to capture the entire football pitch from various angles, and then the video footage captured was transferred through a software that could semi-automatically track the movements and speeds of all players. Such systems provided an effective and detailed means of analysing match demands in different aspects such as physical, technical and tactical performances. Such video-based tracking systems generally require teams to have several cameras installed permanently in their stadium at optimal positions to capture the entire field of play. Although most of the time these systems were automatically operated, some manual work was required, for instance, when crossover occurred between players or when numerous players became compacted in the penalty box during a corner kick (Barris and Button, 2008; Carling and Bloomfield, 2013). Therefore, data were only available within 12-36 hours after the match, which appeared to be acceptable for the teams who had adopted the systems (Carling et al., 2008). More recently, the state-of-the-art optical tracking systems (OTS) have been developed by some companies such as STATS (Chicago, US) and ChyronHego (New York, US). The sophisticated technological advancements in mathematical algorithms, particularly for player tracking, have allowed providing match-play data in real-time as opposed to previous systems (e.g., AMISCO Pro® and ProZone®). Thus, now coaches can not only use the data derived from real-time analysis for their team talk during half-time but also make quick and effective decisions on tactical modifications or substitutions during a match. In addition to this, these computerised tracking systems are non-intrusive for simultaneously tracking players and the ball without physical intervention (e.g., no technical equipment). Furthermore, there is no need to worry about data loss arose from sensor failure as data can be always restored from video footage. However, there are some drawbacks of computerised video-based tracking systems. First, the cost of numerous computerised tracking systems applied in elite football clubs is too expensive for all teams to use but for the richest clubs (Carling et al., 2008). Further limitations could be the lack of portability due to the installed cameras being fixed at the stadium and uncontrollable environmental factors such as changes in light and shadow, heavy rain or snow (Siegle, Stevens and Lames, 2013).

2.2.3 Wearable Microtechnology Devices

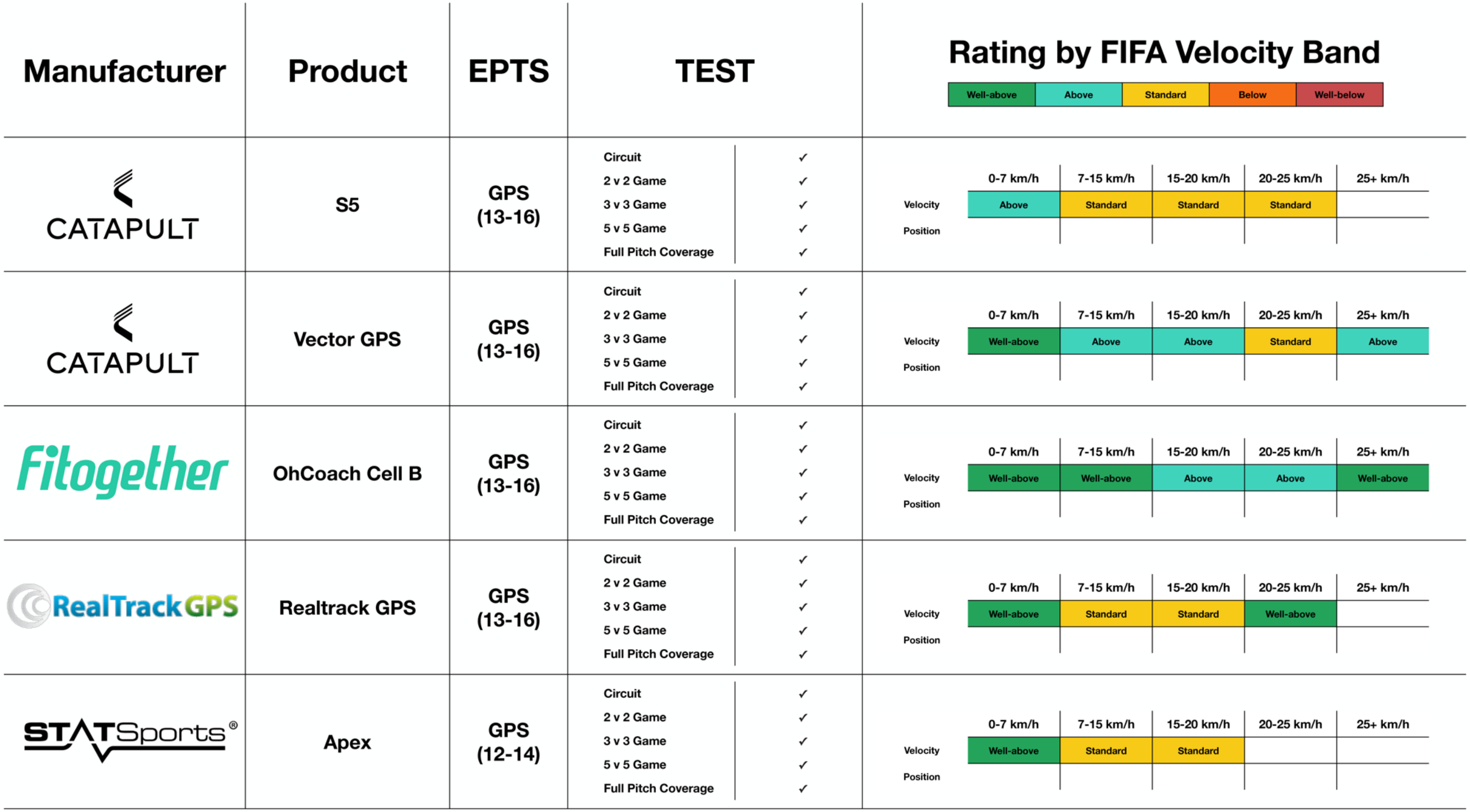
In addition to OTS aforementioned above, wearable microtechnology devices (e.g., global positioning system; GPS and radio-based local positioning system; LPS) provide much more detailed physical data, including not only locomotive (e.g., distance covered) but also mechanical demands such as acceleration, deceleration and change of direction (Scott, Scott and Kelly, 2016; Whitehead et al., 2018). In terms of GPS, satellites orbiting the earth transmit signals to GPS receivers, and then the receivers calculate their exact position and the speed at which the device is moving (Carling and Bloomfield, 2013). The units are placed in a vest on the player's back for capturing physical data (e.g., distances covered and speeds). This allows coaches and practitioners to analyse and evaluate player performance immediately or give feedback to their players during both training sessions and matches as they can receive live data to a laptop from the GPS through a wireless connection. Additionally, mechanical demands such as accelerations/decelerations can be measured by tri-axis accelerometers integrated in GPS. However, this device is limited to outdoor activities since GPS operates based on satellites although the data quality could be influenced by the number of satellite available and the structure of stadiums (e.g., high walls and curved roofs) due to the inability of GPS passing through most solid objects (Terrier and Schutz, 2005). LPS is an alternative device that uses radio signals to estimate the range between the receivers worn by the players and locally installed infrastructure nodes, thus this can be used either indoor or outdoor conditions depending on situations (Alt et al., 2020). Recently, Federation Internationale de Football Association (FIFA) updated their rules by accounting for the use of electronic performance and tracking systems (EPTS) during competitions, which now enables players to wear microtechnology devices (e.g., GPS and LPS) during official matches (Hennessy and Jeffreys, 2018). Elite football clubs now use different types of current technologies in isolation or in combination to monitor physical demands of players, typically using GPS and/or LPS during training sessions and optical tracking systems during matches (Akenhead and Nassis, 2016; Buchheit and Simpson, 2017). Although technology has advanced significantly over the last four decades, the way of quantifying physical demands (e.g., simply reporting distance covered and/or acceleration actions) has remained almost the same without fusing technical and tactical aspects.

2.2.4 Validity and Reliability of Electronic Performance and Tracking Systems

Match physical demands (e.g., distance covered in high-intensity running) can be quantified using various EPTS such as GPS, LPS and OTS. Consequently, it is imperative to check not only the validity and reliability of tracking systems before using data but also the interchangeability between various EPTS in order to interpret data properly and apply them into practice independently or interchangeably (Linke, Link and Lames, 2018). Validity refers to whether the test measures what it is supposed to measure. Many studies have verified the validity of various tracking systems from different technologies such as GPS (Beato et al., 2016; Scott, Scott and Kelly, 2016; Bastida Castillo et al., 2018), LPS (Frencken, Lemmink and Delleman, 2010; Ogris et al., 2012; Luteberget, Spencer and Gilgien, 2018) and OTS (Di Salvo et al., 2006; Redwood-Brown, Cranton and Sunderland, 2012; Felipe et al., 2019; Linke, Link and Lames, 2020) by comparing them with another measurement system. In addition to this, recently a variety of tracking systems from different technologies have been verified in terms of their validity by FIFA (Figure 2.1).

Researchers have used various criterion methods for validation studies, incorporating predefined running circuits, timing gates and radar-based speed measurements in order to evaluate the accuracy of distance measurements, average speed and instantaneous running speed, respectively. However, each methodology has certain limitations. Firstly, the validation method using predefined movement circuits is prone to occurring errors introduced by the participants due to the failure for participants to accurately move through the predefined course (Frencken, Lemmink and Delleman, 2010). Secondly, timing gates can only be used to determine a speed reference due to this approach only being able to determine average velocity depending on limited sampling points (Malone et al., 2017). Finally, radar-based speed measurements can be used to measure the instantaneous speed of participants with high accuracy but are limited to validating linear running performances with no changes in direction (Siegle, Stevens and Lames, 2013). These limitations above led to conducting a comprehensive validation study by Linke, Link and Lames (2018) whereby comparing various EPTS (e.g., OTS, STATS SportVU, London, UK; GPS, GPSports, Canberra, Australia; and LPS, Inmotio, Amsterdam, Netherlands) with a reference motion capture system (VICON, Oxford, UK) in relation to the accuracy of position, instantaneous speed/acceleration and the combination of these as football-specific drills. The results demonstrated that higher accuracy was attained by LPS regarding the positional measurement with 23±7 cm of errors compared to OTS (56±16 cm) and GPS (96±49 cm). Regarding instantaneous speed measures, both GPS and LPS produced less errors (0.28±0.07 m·s^{-1} and 0.25±0.06 m·s^{-1}, respectively) than OTS (0.41±0.08 m·s^{-1}). Furthermore, instant acceleration values demonstrated comparable accuracies (OTS: 0.91±0.19 m·s^{-1}, GPS: 0.67±0.21 m·s^{-1} and LPS: 0.68±0.14 m·s^{-1}). During football-specific drills (e.g., small-sided games), the tracking systems revealed that all had a high quality to measure the total distance covered with <4% of errors (2.2% for GPS, 2.7% for OTS and 4.0% for LPS). However, all technologies had in common that the degree of the error increased as the speed of the player being tracked increased. This occurs particularly when distances covered at high-speed are measured, demonstrating >40% disparities from the reference system for each system. This trend has also been reported elsewhere (Buchheit et al., 2014; Rampinini et al., 2015). Since high-intensity running actions (e.g., speed at >19.8 km·h^{-1}) are commonly used when making decisions within the applied setting (Nosek et al., 2021), caution should be exercised when interpreting such data and before applying them into practice. Moreover, as large between-technology disparities in the validity of tracking data were observed, which suggests that sports scientists not to directly compare summated metrics obtained from various systems (Linke, Link and Lames, 2018), the team should develop their equations with their systems when using various tracking technologies interchangeably to integrate data in a meaningful way (Buchheit and Simpson, 2017). Instead, teams could use a software developed by an established company (e.g., Catapult Sports, Melbourne, Australia) to minimise the disparities between technologies (Ellens et al., 2022). For instance, if the team use a GPS such as Vector® (Catapult Sports, Melbourne, Australia) the team could feed physical tracking data obtained from optical tracking systems such as TRACAB (ChyronHego, New York, USA) into their GPS software to reduce errors, thus using such data interchangeably.

(A)

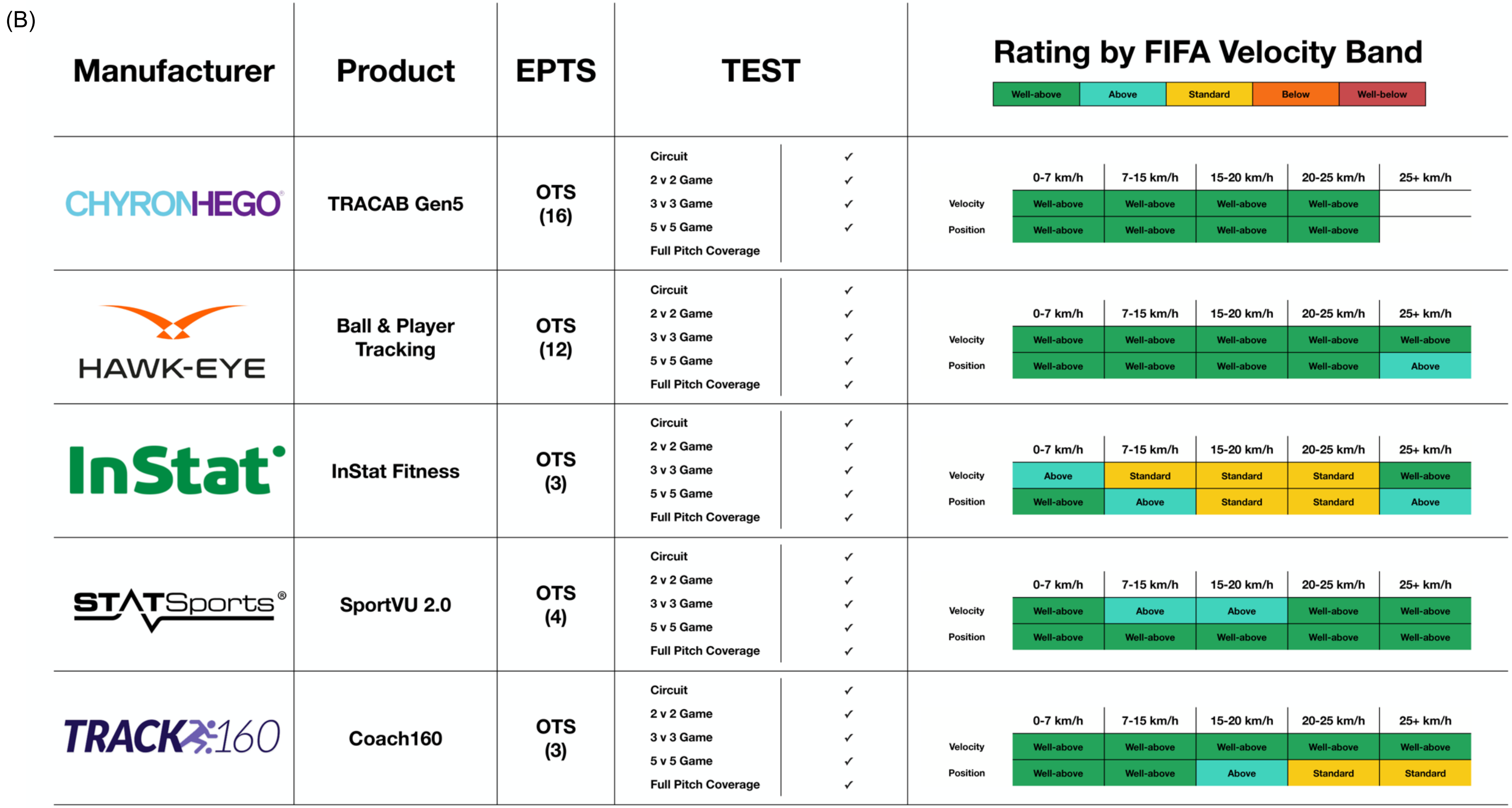


Rating by FIFA Velocity Band

Well-above | Above | Standard | Below | Well-below

Manufacturer	Product	EPTS	TEST		Rating by FIFA Velocity Band				
					0-7 km/h	7-15 km/h	15-20 km/h	20-25 km/h	25+ km/h
CATAPULT	S5	GPS (13-16)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Above	Standard	Standard	Standard	
				Position					
CATAPULT	Vector GPS	GPS (13-16)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Above	Above	Standard	Above
				Position					
Fitogether	OhCoach Cell B	GPS (13-16)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Well-above	Above	Above	Well-above
				Position					
RealTrackGPS	Realtrack GPS	GPS (13-16)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Standard	Standard	Well-above	
				Position					
STATSports®	Apex	GPS (12-14)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Standard	Standard		
				Position					

Figure 2.1. Various Electronic Performance and Tracking Systems (EPTS) verified from the FIFA Quality Programme; (A) Global Positioning System (GPS), (B) Optical Tracking System (OTS), and (C) Local Positioning System (LPS). Values in parentheses indicate the number of satellites, cameras and antennas used, respectively. Redrawn from FIFA Quality Performance Reports for EPTS.

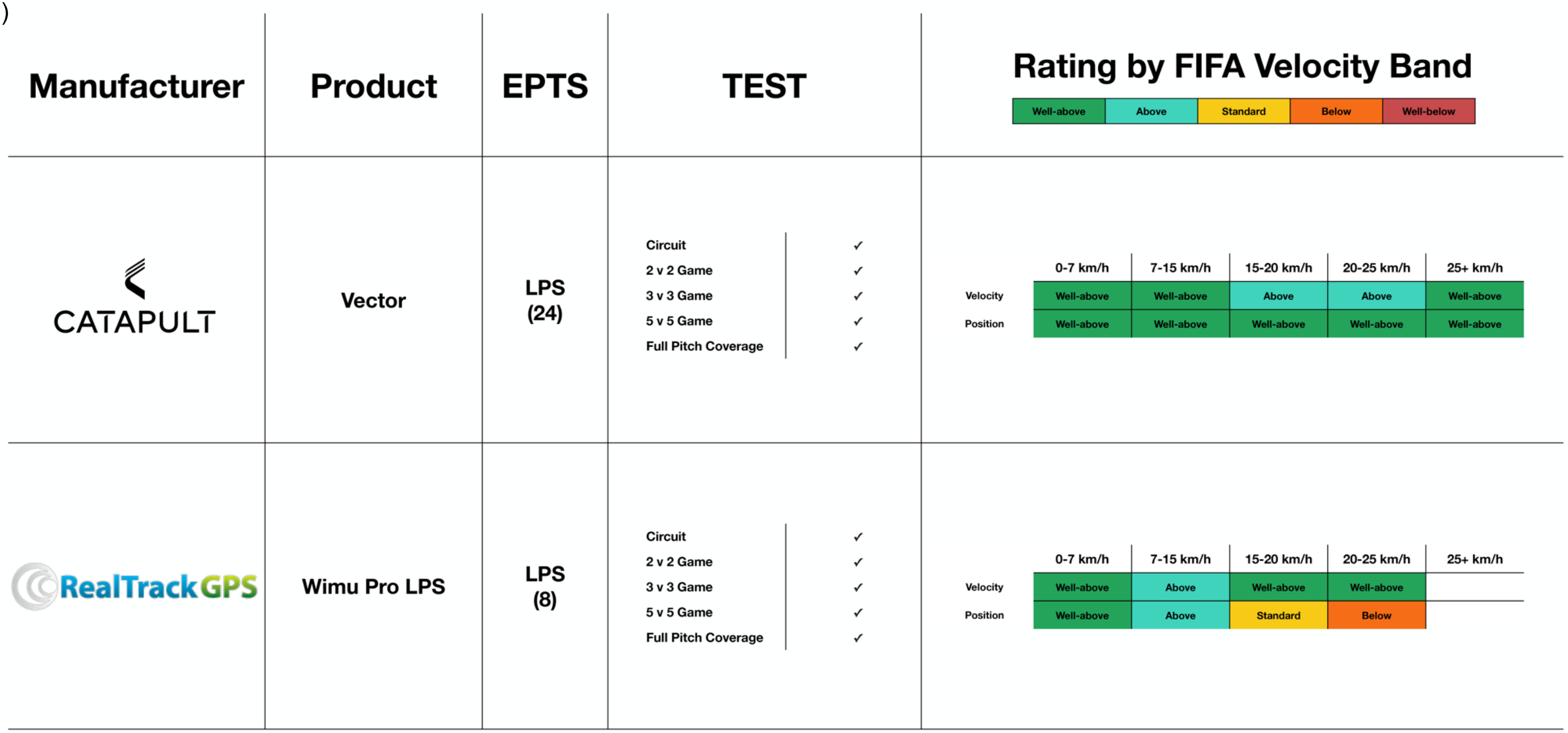


(B)

Manufacturer	Product	EPTS	TEST		Rating by FIFA Velocity Band				
					0-7 km/h	7-15 km/h	15-20 km/h	20-25 km/h	25+ km/h
CHYRONHEGO	TRACAB Gen5	OTS (16)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage	Velocity	Well-above	Well-above	Well-above	Well-above	
				Position	Well-above	Well-above	Well-above	Well-above	
HAWK-EYE	Ball & Player Tracking	OTS (12)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Well-above	Well-above	Well-above	Well-above
				Position	Well-above	Well-above	Well-above	Well-above	Above
InStat	InStat Fitness	OTS (3)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Above	Standard	Standard	Standard	Well-above
				Position	Well-above	Above	Standard	Standard	Above
STATSports®	SportVU 2.0	OTS (4)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Above	Above	Well-above	Well-above
				Position	Well-above	Well-above	Well-above	Well-above	Well-above
TRACK160	Coach160	OTS (3)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Well-above	Well-above	Well-above	Well-above
				Position	Well-above	Well-above	Above	Standard	Standard

Figure 2.1. Various Electronic Performance and Tracking Systems (EPTS) verified from the FIFA Quality Programme; (A) Global Positioning System (GPS), (B) Optical Tracking System (OTS), and (C) Local Positioning System (LPS). Values in parentheses indicate the number of the satellites, cameras and antennas used, respectively. Redrawn from FIFA Quality Performance Reports for EPTS.

(C)



Well-above | Above | Standard | Below | Well-below

Manufacturer	Product	EPTS	TEST	Rating by FIFA Velocity Band					
					0-7 km/h	7-15 km/h	15-20 km/h	20-25 km/h	25+ km/h
CATAPULT	Vector	LPS (24)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Well-above	Above	Above	Well-above
				Position	Well-above	Well-above	Well-above	Well-above	Well-above
RealTrackGPS	Wimu Pro LPS	LPS (8)	Circuit ✓ 2 v 2 Game ✓ 3 v 3 Game ✓ 5 v 5 Game ✓ Full Pitch Coverage ✓	Velocity	Well-above	Above	Well-above	Well-above	
				Position	Well-above	Above	Standard	Below	

Figure 2.1. Various Electronic Performance and Tracking Systems (EPTS) verified from the FIFA Quality Programme; (A) Global Positioning System (GPS), (B) Optical Tracking System (OTS), and (C) Local Positioning System (LPS). Values in parentheses indicate the number of the satellites, cameras and antennas used, respectively. Redrawn from FIFA Quality Performance Reports for EPTS.

Reliability refers to how consistently a method measures a characteristic, thus indicating the objectivity of the method (Cooper et al., 2007). This can be assessed on two levels: intra- and inter-rater reliability. The former measures the agreement between two or more trials performed by one observer whilst the latter assesses the agreement between two observers. Both intra- and inter-rater reliability tests are fundamental for a new analytical method since they assess the ability of the observers to understand the operational definitions of the system (O'Donoghue, 2007). Additionally, intra-rater reliability test alone cannot guarantee the objectivity of a system as the operator’s understanding of the definitions to code events may vary from other potential operators. This methodological approach in performance analysis has been used for categorical data such as tactical movements (Bloomfield, Polman and O'Donoghue, 2004; Ade, Fitzpatrick and Bradley, 2016) and technical events (Bradley et al., 2007; Liu et al., 2013) with the Kappa statistic. By contrast, regarding the assessment of the reliability of GPS units, data are obtained over multiple occasions where test setups are identical, and then the disparities between tests are identified typically using the coefficient of variation (Portas et al., 2010; Varley, Fairweather and Aughey, 2012). Although different types of GPS units and their frequency rate (5 or 10 Hz) can impact the accuracy, 10 Hz units seem to be optimum when evaluating high-intensity short distance running compared to 5 and 15 Hz (Scott, Scott and Kelly, 2016).

2.3 Match Performance

2.3.1 General Physical Demands

The physical demands of football during match-play have been extensively investigated but the majority of research has used computerised multiple-camera optical tracking systems to quantify this due to its prevalent use in elite teams (Bangsbo, Nørregaard and Thorsoe, 1991; Mohr, Krustrup and Bangsbo, 2003; Rampinini et al., 2007; Bradley et al., 2009; Di Salvo et al., 2009; Akenhead et al., 2013; Di Mascio and Bradley, 2013; Barnes et al., 2014). It has been reported that elite male football players cover the total distance of 9-14 km during a 90-min game with high-intensity running accounting for ~5-15% of the distance (Mohr, Krustrup and Bangsbo, 2003; Di Mascio and Bradley, 2013; Sarmento et al., 2014). In addition, players perform up to 250 brief intense actions such as sprinting, jumping, or shooting during a match, which could elevate individual blood lactate concentrations up to 14 mmol·L^{-1} (Mohr, Krustrup and Bangsbo, 2003; Bangsbo, Mohr and Krustrup, 2006; Krustrup et al., 2006), indicating the high anaerobic demands of football. Players execute brief high-intensity actions interspaced between longer periods of low-intensity activities; thus, football is characterised as an intermittent sport (Bangsbo, Mohr and Krustrup, 2006). Over the last decade, the distance covered at high-intensity has increased by ~10-30% with only a 2-4% increase in the total distance covered (Barnes et al., 2014; Bradley and Scott, 2020; Zhou, Gomez and Lorenzo, 2020). Thus, the measurement of the distance covered in high-intensity running seems to be more sensitive in identifying modern physical requirements compared to that of the total distance covered. In addition, findings have suggested that low-intensity running actions have little to no impact on match results whilst high-intensity actions (e.g., high-speed running and sprinting) have greater impact on match outcome (Faude, Koch and Meyer, 2012; Martínez-Hernández, Quinn and Jones, 2022). Consequently, greater attention has been paid to high-intensity actions as it helps practitioners to prepare players for the physical requirements of modern match-play through benchmarking contemporary requirements while trying to minimise the risk of injuries (Beato, Drust and Iacono, 2021). Yet, researchers have not only used different terminologies of high-intensity actions (e.g., high-intensity running vs very high-intensity running vs sub-maximal intensities etc.) but also assigned an array of speed thresholds to various physical activities (Table 2.1). For instance, some studies classified high-intensity as the speed threshold of >14.4 km·h^{-1}, which includes moderate running, high-speed running and sprinting (Mohr, Krustrup and Bangsbo, 2003; Rampinini et al., 2007; Bradley et al., 2009; Bradley et al., 2011; Carling and Dupont, 2011; Bradley and Noakes, 2013). However, others used the high-intensity running threshold at >19.8 km·h^{-1} (Di Salvo et al., 2009; Di Mascio and Bradley, 2013; Barnes et al., 2014; Bush et al., 2015b; Bradley et al., 2016). To further complicate matters, different systems/technologies use various filtering algorithms as well as dwell times to classify high-intensity running actions (Mackenzie and Cushion, 2013), which significantly influences the measurement of physical activities (Varley et al., 2017). These differences undoubtedly limit comparability between various studies although the discrepancies between some of the speed thresholds used by studies are minor. Furthermore, if the pre-defined value (>19.8 km·h^{-1}) is applied, the distance players cover in high-intensity running can be underestimated as the speed at which players reach high-intensity differs, thus the high-intensity running speed thresholds should be individualised (Abt and Lovell, 2009). The individualised approach could reduce match-to-match variability of players (reported as the coefficient of variation, CV) by 20% when comparing ‘individualised >100% maximal aerobic speed’ (CV: 17%) to ‘sprinting’ (CV: 37%). Despite this, this proposed individualised method has not been widely adopted by researchers due to the required time, complexity and difficulty to have access to ventilatory threshold data of players (Carling et al., 2014). Thus, it seems to be practically beneficial that researchers use common pre-defined speed thresholds of high-intensity running (>19.8 $km \cdot h^{-1}$) to make it more straightforward to compare results between studies although the application of the individualised technique is more sensitive in estimating individual physical demands.

In addition to the distance covered in high-intensity running, mechanical demands such as accelerations/decelerations have gained greater attention since obtaining the profiles of accelerations and decelerations seems to be a key factor in identifying and reducing injury risks (Harper, Carling and Kiely, 2019). Accelerations and decelerations can cause not only internal physiological but also mechanical loading stress on players (Vanrenterghem et al., 2017). For instance, the former produces a higher metabolic cost (Hader et al., 2016) whilst the latter generates a higher mechanical load likely occurring from eccentric contractions experienced within muscle groups when decelerating rapidly (Dalen et al., 2016). Accelerations are frequently performed during a match with players executing these nearly 100 times per match (Ingebrigtsen et al., 2015), which could be up to an eightfold greater number compared to the number of sprinting (Varley and Aughey, 2013). Additionally, a large proportion of accelerations does not reach speeds at high-intensity (Varley and Aughey, 2013). This may indicate that measuring only the distance covered in high-intensity running limits the understanding of the true match-play physical demands. Thus, it seems imperative to incorporate not only high-intensity running metrics but also metabolically taxing activities (e.g., accelerations, decelerations and etc.) produced by players during matches when profiling match physical performances. This would ultimately allow coaches and applied practitioners to prepare their players for the real physical demands of match-play through benchmarking contemporary requirements as a team and/or individually.

Table 2.1. Summary of findings in physical performance during match-play.

Source	Standard	Sample	Method	TD (m)	HSRD (m)	SD (m)	HIRD (m)	Speed Thresholds
Andrzejewski et al. (2015)	Europa League 2008/09 to 2010/11	147 Players 10 Games	VID (Amisco Pro®, Nice, France, 25 Hz)	10,336-11,760	–	167-346	–	SP >24 km·h^{-1}
Akenhead et al. (2013)	English Premier League 2010/11	36 Players 18 Games	GPS (MinimaxX, Catapult Innovations, Canberra, ACT, Australia, 10 Hz)	10,451±760	505±209	194±101	699	HSR >21 km·h^{-1} SP >24 km·h^{-1}
Barnes et al. (2014)	English Premier League 2006/07 to 2012/13	14,700 Observations	VID (Prozone Sports Ltd®, Leeds, UK)	10,679-10,881	–	232-350	890-1,151	HSR 19.8-25.1 km·h^{-1} SP >25.1 km·h^{-1} HIR >19.8 km·h^{-1}
Bradley et al. (2009)	English Premier League 2005/06	370 Players 28 Games	VID (Prozone Sports Ltd®, Leeds, UK, 10 Hz)	9,885-11,535	–	152-346	603-1,214	HSR 19.8-25.1 km·h^{-1} SP >25.1 km·h^{-1} VHIR >19.8 km·h^{-1}
Bradley et al. (2013a)	English Premier League	190 Players 947 Observations	VID (Prozone Sports Ltd®, Leeds, UK)	10,722-11,607	681-881	248-360	929-1,242	HSR >19.8 km·h^{-1} SP >25.1 km·h^{-1} HIR >19.8 km·h^{-1}
	Championship	155 Players 261 Observations						
	League 1	366 Players 867 Observations						
Bradley et al. (2011)	English Premier League 2006/07	153 Players 20 Games	VID (Prozone Sports Ltd®, Leeds, UK)	10,613-10,786	–	–	901-956	HSR 19.8-25.1 km·h^{-1} SP >25.1 km·h^{-1} VHIR >19.8 km·h^{-1}
Carling (2011)	French League 1 2007/08 to 2009/10	21 Players 297 Observations 45 Games	VID (AMISCO Pro®, Sport-Universal Process, Nice, France, 10 Hz)	10,594-10,808	–	–	704-741	VHIR >19.8 km·h^{-1}
Di Salvo et al. (2007)	Spanish La Liga Champions League 2002/03 to 2003/04	300 Players 30 Games	VID (AMISCO Pro®, Sport-Universal Process, Nice, France)	11,393±1016	397-738	215-446	612-1,184	HSR 19.1-23 km·h^{-1} SP >23 km·h^{-1}
Di Salvo et al. (2013)	English Premier League	1,241 Players 13,991 Observations	VID (Prozone Sports Ltd®, Leeds, UK)	10,746-11,102	693-750	258-273	951-1,023	HSR 19.9-25.2 km·h^{-1} SP >25.2 km·h^{-1}
	Championship	1,494 Players 12,458 Observations						

TD: Total distance; HSRD: high-speed running distance; SD: sprinting distance; HIRD: high-intensity running distance. VID: computerised multiple-camera video tracking systems; GPS: global positioning systems; LPS: radio-based local positioning systems. HSR: high-speed running (range from 18 km·h^{-1} to 25.2 km·h^{-1}, depending on studies); SMI: sub-maximal intensity (equal to high-speed running); SP: sprinting (range from >22.7 km·h^{-1} to >30 km·h^{-1}, depending on studies); MI: maximal intensity (equal to sprinting). HIR: high-intensity running (range from >18 km·h^{-1} to >19.8 km·h^{-1}; the combination of high-speed running and sprinting); VHIR: very high-intensity running (equal to high-intensity running). Values are presented as mean ± standard deviation or a range.

Table 2.1. (continued)

Source	Standard	Sample	Method	TD (m)	HSRD (m)	SD (m)	HIRD (m)	Speed Thresholds
Hoppe et al. (2015)	German Bundesliga 2012/13	306 Games	VID (Viz.Track, Ismaning, Germany)	11,124-11,954	–	150-185	518-618	SP >22.7 km·h^{-1} HIR >18 km·h^{-1}
Ingebrigtsen et al. (2015)	Norwegian Eliteserien League	15 Players 101 Observations	LPS (ZXY Sport Tracking, Trondheim, Norway, 40 Hz)	11,230±992	542-1168	213±111	845±332	HSR 19.8-25.2 km·h^{-1} SP >25.2 km·h^{-1} HIR >19.8 km·h^{-1}
Lago et al. (2010)	Spanish La Liga 2005/06	19 Players 182 Observations 27 Games	VID (Amisco Pro®, Nice, France)	10,491-11,425	388-609	179-344	576-946	SMI 19.1-23 km·h^{-1} MI >23 km·h^{-1}
Lago-Peñas et al. (2009)	Spanish La Liga 2005/06	127 Players 18 Games	VID (AMISCO Pro®, Sport-Universal Process, Nice, France)	10,943±935	333-682	184-490	517-1,172	HSR 19.1-23 km·h^{-1} SP >23 km·h^{-1}
Mohr, Krustrup and Bangsbo (2003)	Italian Serie A	18 Players	VID	10,330-10,860	–	410-650	–	HSR >18 km·h^{-1} SP >30 km·h^{-1}
	Danish Superliga	24 Players						
Morgans et al. (2015)	English Premier League & Championship	6 Players 42 Games	VID (AMISCO Pro®, Sport-Universal Process, Nice, France, 25 Hz)	10,911-11,232	–	306-317	601-613	SP >23 km·h^{-1} HIR >19.1 km·h^{-1}
Rampinini et al. (2007)	European National League	14 Players 34 Games	VID (Prozone Sports Ltd®, Leeds, UK)	10,827-11,097	–	–	605-997	HSR 19.8-25.2km·h^{-1} SP >25.2 km·h^{-1} VHIR >19.8 km·h^{-1}

TD: Total distance; HSRD: high-speed running distance; SD: sprinting distance; HIRD: high-intensity running distance. VID: computerised multiple-camera video tracking systems; GPS: global positioning systems; LPS: radio-based local positioning systems. HSR: high-speed running (range from 18 km·h^{-1} to 25.2 km·h^{-1}, depending on studies); SMI: sub-maximal intensity (equal to high-speed running); SP: sprinting (range from >22.7 km·h^{-1} to >30 km·h^{-1}, depending on studies); MI: maximal intensity (equal to sprinting). HIR: high-intensity running (range from >18 km·h^{-1} to >19.8 km·h^{-1}; the combination of high-speed running and sprinting); VHIR: very high-intensity running (equal to high-intensity running). Values are presented as mean ± standard deviation or a range.

2.3.2 Position-Specific Demands

2.3.2.1 High-intensity Running Demands Across Positions

A plethora of research has quantified the match physical demands of football (Di Salvo et al., 2007; Bradley et al., 2013a; Barnes et al., 2014; Ingebrigtsen et al., 2015) reporting distances covered using pre-defined speed thresholds such as high-speed running (19.8-25.2 km·h^{-1}), sprinting (>25.2 km·h^{-1}) and high-intensity running (>19.8 km·h^{-1}). Since professional football players have been reported to reach ~30 km·h^{-1} for their maximal running velocities during sprint tests (Ferro et al., 2014; Djaoui et al., 2017), such pre-defined speed thresholds are roughly equivalent to 65-80% of maximal speed for high-speed running, >80% for sprinting and >65% for high-intensity running, indicating that high-intensity running efforts are physically demanding over the course of a match. Moreover, the distance covered at high-intensity is associated with physical capacity of players (Krustrup et al., 2005; Bradley et al., 2013a), and this can differentiate positions/tactical roles of players (Di Salvo et al., 2007; Bradley et al., 2009; Ade, Fitzpatrick and Bradley, 2016). Coaches and practitioners use these metrics to benchmark modern football requirements of match-play by ensuring training sessions are specific to playing positions or even individual players (Bradley et al., 2019; Martín-García et al., 2019).

The physical demands during match-play are very position-specific. The largest distance in high-intensity running (~800-1500 m) is covered by wide midfielders (WM) compared to other positions such as centre backs (CB), full-backs (FB), central midfielders (CM) and forwards (FW) during a match (Di Salvo et al., 2007; Bradley et al., 2009; Di Salvo et al., 2009; Andrzejewski et al., 2016; Carling et al., 2016). However, other studies reported that WM run less distance in sprinting than FB and execute fewer number of sprints than FB (Varley and Aughey, 2013; Dalen et al., 2016). This variation could be due to various technologies used (Linke, Link and Lames, 2018), different filtering techniques and dwell times (Varley et al., 2017), the increased match physical demands of FB, especially in high-intensity running (Bush et al., 2015b) and different playing styles/formations (Bradley et al., 2011; Aquino et al., 2020). There have been some consistent findings from previous research, demonstrating that wide players (WM or FB) cover the greatest high-intensity distance with CB the lowest. That said, numerous factors such as formations/playing styles, locations

(Home or Away), score-line and opponent levels influence match performance, especially in high-intensity running (Trewin et al., 2017). This could be further supported by the match-to-match variability produced by players. Irrespective of playing position, the percentages of CV for the distances covered in high-intensity running (>19.8 km·h^{-1}), high-speed running (19.8-25.2 km·h^{-1}) and sprinting (>25.2 km·h^{-1}) are 20%, 19% and 37%, respectively (Gregson et al., 2010; Bush et al., 2015a; Carling et al., 2016). Nonetheless, this varies depending on playing positions with WM and FW producing more consistent performance across matches compared to other positions.

Previous studies in the literature have adopted a generalist approach to positional analysis such as CB, FB, CM, WM and FW (Bradley et al., 2009; Di Mascio and Bradley, 2013; Bush et al., 2015b; Ade, Fitzpatrick and Bradley, 2016), which limits our understanding of the genuine demands of players with more specialised tactical roles. When the position of CM has been divided into defensive (central defensive midfielders, CDM) or attacking (central attacking midfielders, CAM) roles, great disparities have been evident with CAM covering more distance in high-intensity running compared to CDM regardless of gender (Dellal et al., 2011; Scott, Haigh and Lovell, 2020). Similarly, when wide defensive players have been categorised into FB and wing-backs (WB), greater high-intensity distance is covered by WB than FB (Baptista et al., 2019; Modric, Versic and Sekulic, 2020). Additionally, the numbers of CB and FW seem to influence their locomotive demands with three CB at the defensive line covering greater high-intensity distance than two CB (Modric, Versic and Sekulic, 2020) whilst one player up front as a centre forward covered ~40-70% more high-intensity distances when out of possession compared to two players up front as two centre forwards (Bradley et al., 2011). Therefore, it seems that using a generalist position analysis may not be sensitive enough to estimate the true physical demands of players in accordance with a specialised tactical role during match-play, which may lead to the under or overestimation of their match physical demands. No research has conducted to examine the differences between general and specialised tactical roles to determine whether disparities exist; thus, research that investigates the comparison between the two different positional analyses is warranted.

2.3.2.2 Technical Performance and Movement Patterns Across Positions

Technical skills are regarded as actions performed when the ball is involved such as dribbles, crosses, shots and passes when in possession of the ball, tackles when out of possession, and headers for both in and out of possession (Hughes et al., 2012). Recently, due to the development of technological methodologies, more accurate and detailed technical performance data can be automatically produced. Technical metrics have been used to not only differentiate competitive standards of players (Bradley et al., 2013a), but also investigate the influence of contextual variables such as formations (Bradley et al., 2011; Carling, 2011; Arjol-Serrano et al., 2021), match status (Taylor et al., 2008) and ball possession (Bradley et al., 2013b; Bradley et al., 2014b; da Mota et al., 2016). Moreover, studies have compared technical demands of elite players across positions (Taylor, Mellalieu and James, 2004; Bloomfield, Polman and O'Donoghue, 2007; Dellal et al., 2010; Ermidis et al., 2019). For instance, CM have been reported to produce more passes compared to other positions, which could be due to teams building their attack via the midfield, thus CM being more likely involved in transition phases from defence to attack more often (Ermidis et al., 2019). Furthermore, the frequency of crosses was reported to be the highest for FB (Ermidis et al., 2019), which may indicate the modern playing style of FB (Konefał et al., 2015). However, as the match-to-match variability of technical performances of individual players has been reported to be very high, ranging from 27 to 154% of CV (Bush et al., 2015a), caution should be taken when applying technical data to assess and interpret match performance of players.

Existing studies have provided some information regarding movement patterns such as changing directions at specific angles, swerving, or arc runs when running at higher velocities (Bloomfield, Polman and O'Donoghue, 2007; Ade, Fitzpatrick and Bradley, 2016; Baptista et al., 2018; Morgan et al., 2021). Generally, players could change their directions 305 times per game with ~20 s of recovery between such actions and the majority of them (77%) being performed at ≤ 90° (Morgan et al., 2021). Moreover, these movement data can be used to devise unique training drills to improve the movement qualities of individual players that are required for each position. For example, FW have been reported to perform more arc runs before, during and after high-intensity running (>21 $km \cdot h^{-1}$) when out of possession compared to CB and FB; however, CB executed more 0-90° turns before and after high-intensity actions compared to FB and CM (Ade, Fitzpatrick and Bradley, 2016). Moreover, Baptista et al. (2018) demonstrated that FB and WM executed more >90° and 181-270° turns than CB whilst CB and FB performed more 271-360° turns than FW. Regarding actions moving lateral and backwards, defenders (e.g., CB and FB) have been reported to execute such movements more often than MF and FW during match-play (Bloomfield, Polman and O'Donoghue, 2007). Although these data seem to be practical, it should be acknowledged that large variations (CV: >11%) have been reported for the movement patterns analysed (Ade, Fitzpatrick and Bradley, 2016). This indicates that it could be challenging to detect the meaningful change (smallest worthwhile change) since the change must exceed the noise (%CV) to confirm the meaningfulness of the signal between different time points (e.g., between matches) on a certain variable (French and Ronda, 2021).

2.3.3 Match Performance and Team Success

2.3.3.1 Physical Performance in relation to Team Success

In order to understand associations between team success in football and physical capacity or match running performance, especially high-intensity running, many researchers have linked such variables to the standard of teams or team rankings at the end of the season (Mohr, Krustrup and Bangsbo, 2003; Di Salvo et al., 2009; Rampinini et al., 2009; Bradley et al., 2013a; Di Salvo et al., 2013; Bradley et al., 2016). Mohr, Krustrup and Bangsbo (2003) revealed that there was a link between physical performances and standards, demonstrating that top-class players covered more high-intensity distance during a match with having better capabilities to perform the Yo-Yo intermittent recovery test (level 1) compared to moderate professional counterparts. That said, when comparing players in the English Premier League (EPL) to those in lower-standards (e.g., Championship and League 1) the players in the lower-standards covered greater total distance and high-intensity running distance with their physical capacities being comparable to those in the EPL (Bradley et al., 2013a). In Norwegian football League, however, ~20-25% and ~50-60% greater physical demands of high-speed running (P>0.05) and sprinting (P<0.05), respectively, were observed in Level 1 teams (the highest competitive level) compared to those in Level 2 and Level 4 (Sæterbakken et al., 2019). Such disparities between studies could be due to the training status of players (e.g., part-time or full-time training) since the high-intensity distance covered during a game is closely related to physical capacity of players (Krustrup et al., 2005). Based on these findings, after players attain a certain physical capacity, determinants of team success seem not necessarily related to physical performance but could be more associated with their technical or tactical abilities (Bradley et al., 2013a). Additionally, studies investigating relationships between physical data and final league rankings have demonstrated that lower-ranked clubs covered greater total distance in high-speed running than higher-ranked counterparts whilst the latter performed more high-intensity distance when in possession of the ball (Di Salvo et al., 2009; Rampinini et al., 2009; Bradley et al., 2016; Brito Souza et al., 2020). Thus, success in football might be more likely linked to greater high-intensity in-possession activities whilst maintaining the possession of the ball to create more space and attacking threats. Nonetheless, it is still unclear 'HOW' high-standard teams tactically perform whilst covering greater high-intensity running distance when in possession (e.g., why high-ranked teams execute more high-intensity efforts in relation to tactical actions). Moreover, the quality of opposition teams has a significant influence on physical output during match-play in which teams playing against a stronger opponent perform greater high-intensity activities like high-intensity running with different speed thresholds of >14.4 km·h^{-1} (Rampinini et al., 2007) and 17.1-24 km·h^{-1} (Castellano, Blanco-Villasenor and Alvarez, 2011), and accelerations and decelerations (Rago et al., 2018) compared to against a weaker opponent. Thus, it is important to appropriately control and balance data in relation to contextual factors before analysing individual and team trends for interpreting data in a more generalised manner (Barnes et al., 2014). Collectively, there is still limited evidence to determine associations between success and physical performance data. This lack of evidence is possibly due to the methodological approaches that previous researchers have used (Bradley et al., 2013a; Bradley et al., 2016). For instance, previous studies incorporated solely individual samples (e.g., those who completed the entire match playing in the same position). As this only indicates the activity profiles of individual players, this limits the understanding of a team's collective performance during match-play. As football is a team sport where physical, technical and tactical performances of players are influenced by both opponent and teammate activities (Bush et al., 2015a; Bradley, 2020), team performance characteristics (e.g., the summation of individual player performances for each match) could be a potential approach to gain insights into team performances, possibly determining team success more effectively. That said, it seems to be more likely due to a lack of context (e.g., tactical movements) since the context of the match and team playing styles/formations are the major factors influencing physical movement activities of players during a match (Paul, Bradley and Nassis, 2015).

2.3.3.2 Technical Performance in relation to Team Success

Generally, it is well established in the literature that other factors such as technical and tactical performances, rather than physical performance per se (e.g., high-intensity running distance), have a greater influence on achieving success (Carling, 2013). For example, high-ranked teams tend to have a greater number of shots on target, ball touches and passes, as well as a higher pass accuracy compared to low-ranked counterparts (Rampinini et al., 2009; Castellano, Casamichana and Lago, 2012; Liu et al., 2016; Konefał et al., 2019a). This technical inferiority of low-ranked teams may be a direct consequence of covering greater high-intensity distance when out of possession to regain ball possession (Di Salvo et al., 2009). However, different game styles such as having a higher or lower percentage of ball possession can impact both technical and physical performance during match-play (Bradley et al., 2013b; da Mota et al., 2016; Lorenzo-Martinez et al., 2021). Previous studies demonstrated that teams with a high percentage of ball possession are technically superior compared to those with a low percentage of ball possession (Rampinini et al., 2009; Bradley et al., 2013b; da Mota et al., 2016). This technical superiority may explain strong relationships between success and percentage of ball possession (Jones, James and Mellalieu, 2004; Lago-Peñas et al., 2010); however, conflicting findings exist (da Mota et al., 2016). This indicates that such relationship is highly complex with other factors possibly having an impact such as the efficiency of passing (e.g., greater passes to shots on goal ratio), type of offensive playing styles (e.g., counterattack or direct), match status (e.g., winning, drawing, or losing) and opponent levels (Lago-Peñas and Dellal, 2010; Collet, 2013). Furthermore, ball possession has been reported to influence the distance covered by players, especially at high-intensity, with teams having a higher rate of ball possession running more high-intensity distance while in possession compared to those having a lower percentage of ball possession (Bradley et al., 2013b; da Mota et al., 2016) and vice versa (e.g., the latter covering more distance out of possession). Having said that, current research has revealed contrasting findings, demonstrating that the teams with lower possession of the ball covered more high-intensity distance (>21 km·h^{-1}) per minute when in possession whilst those with higher possession of the ball ran more distance per minute when out of possession (Castellano et al., 2022). Additionally, teams with a high percentage of ball possession appear to generally require a less conditional response compared to those with a less percentage of ball possession since lower physical demands (e.g., total distance covered and that covered at high-intensity) were evident when analysing distances covered per minute (Lorenzo-Martinez et al., 2021; Castellano et al., 2022). These differences seem to be due to methodological reasons since the demarcations between high (51-66%) and low (34-50%) percentages of ball possession used in these studies (Bradley et al., 2013b; da Mota et al., 2016) lacked sensitivity required to determine disparities in match physical performance. Taken together, reductionist approach such as using technical or physical metrics in isolation to determine team success and demarcate between team standards and/or league rankings in elite football is simplistic considering the complex nature of football. Therefore, a more holistic approach to quantifying match performance with fusing physical, technical and tactical performances is necessitated due to technical skills (Rampinini et al., 2008) and tactical scenarios (Schuth et al., 2016) impacting physical activities.

2.3.4 The Most Intense Period of Match-Play

2.3.4.1 Physical Demands During the Most Intense Period

The activity profiles of players derived from match-play can be used for designing training drills such as position-specific team circuits and speed endurance programmes (Bradley et al., 2019; Martín-García et al., 2019; Ade et al., 2021). Previous studies in the literature have mainly analysed general physical demands during matches (Rampinini et al., 2007; Di Salvo et al., 2009; Bradley et al., 2013a; Ade, Fitzpatrick and Bradley, 2016); however, this could lead to the underestimation of locomotive demands of players (Mernagh et al., 2021). Considering this, a greater interest has emerged in the past few years in relation to evaluating peak match running demands that players face in selected periods during competition. Yet, various terminologies to indicate such periods have been used such as the most intense period (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Di Mascio and Bradley, 2013), peak periods (Baptista et al., 2020; Dalen et al., 2021), the most demanding passages of play (Martín-García et al., 2018; Casamichana et al., 2019; Martín-García et al., 2019; Castellano, Martín-García and Casamichana, 2020; Oliva-Lozano, Fortes and Muyor, 2021; Riboli et al., 2021) and the worst-case scenarios (Oliva-Lozano et al., 2020; Novak et al., 2021). These periods are generally defined as the most demanding period of a match and can be set at various durations (e.g., 1-, 3-, 5-, 10- and 15-min) whilst measuring a number of variables such as running distance, average metabolic power (AMP; $W{\cdot}kg^{-1}$), high metabolic load distance (HMLD; $m{\cdot}min^{-1}$) and the number of high-intensity accelerations/decelerations (Martín-García et al., 2018; Casamichana et al., 2019; Fereday et al., 2020; Oliva-Lozano et al., 2020; Riboli et al., 2021). Match running distance includes total distance covered, high-speed running and sprinting distance covered where metabolically taxing movements such as acceleration and deceleration are excluded. This can be reported as absolute (m) or relative values ($m{\cdot}min^{-1}$). AMP is the combination of the energy expenditure by the player in relation to constant speed activities as well as acceleration/deceleration actions (>2 or >3 $m{\cdot}s^{-2}$), which estimates the metabolic running demands only (e.g., not jumping or kicking). HMLD (i.e., the distance covered by the player when their metabolic power is >20 or >25.5 $W{\cdot}kg^{-1}$) sums up the distance covered in high-speed running and also incorporates the distance covered when the player is involved in high-intensity acceleration/deceleration movements. AMP and HMLD are the metrics that are calculated by a software algorithm developed by STATSports (Newry, UK). Using these metrics seems to be more advantageous as they can provide more detailed external loads of players compared to solely analysing high-intensity running demands. Elite male football players tend to run the total distance of ~190 m per minute given a peak 1-min period whilst covering up to ~55 m and ~25 m per min for high-speed running and sprinting, respectively (Figure 2.2), as well as performing ~30 acceleration/deceleration actions per minute regardless of playing position. But the total distance covered decreases to ~120 m per minute in peak 10-min periods, and also the distances covered in high-speed running and sprinting decline to ~15 m and ~5 m per minute, respectively, whilst performing a smaller number of accelerations and decelerations (~10 actions per minute). Moreover, greater values of HMLD and AMP are observed in shorter epochs (e.g., peak 1-min period; ~65-95 $m \cdot min^{-1}$ and ~20 $W \cdot kg^{-1}$, respectively) compared to longer epochs (e.g., peak 10-min period; ~25-40 $m \cdot min^{-1}$ and ~12 $W \cdot kg^{-1}$, respectively). Hence, in order to appropriately facilitate players to be physically conditioned for the peak demands of play, 1-min periods must be examined as these serve as the most intensified in-game locomotor demands (Rico-González et al., 2022). Furthermore, the distance covered during the most intense period during match-play is highly dependent on playing positions of players (Table 2.2). Central defensive players or forwards typically exhibited the lowest physical demands during intensified periods of play (e.g., 1-, 3-, 5-, 10-min) whereas central midfielders, wide midfielders or full-backs displayed the largest (Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017; Martín-García et al., 2018; Riboli et al., 2021).

Regarding methodological quantification, the most intense period of match-play can be measured using predefined periods (e.g., 0-4.59”, 5-9.59”, 10-14.59” …until the end of the match) or a rolling average method (distance covered from every time point). However, it has been reported that using the fixed periods can underestimate the total (7-10%) and high-speed running (12-25%) distance covered during peak periods compared to the rolling average technique (Varley, Elias and Aughey, 2012; Fereday et al., 2020; Oliva-Lozano et al., 2021). Application of the rolling average technique seems to produce a more accurate estimation of player locomotive demands of match-play peak periods than the predefined method. Although peak performance data have been practically used as a reference to develop football-specific drills such as small-sided games and position-specific speed endurance exercises (Bradley et al., 2019; Martín-García et al., 2019), issues still exist when trying to directly translate these physical data into specific drills since the context of play is completely omitted from any of the studies that have quantified the most demanding passages of competition (Carling et al., 2019). It would be practically more advantageous to amalgamate peak physical data of each tactical role of players with tactical context, which will eventually help with translating such data into practice more effectively (Figure 2.5).

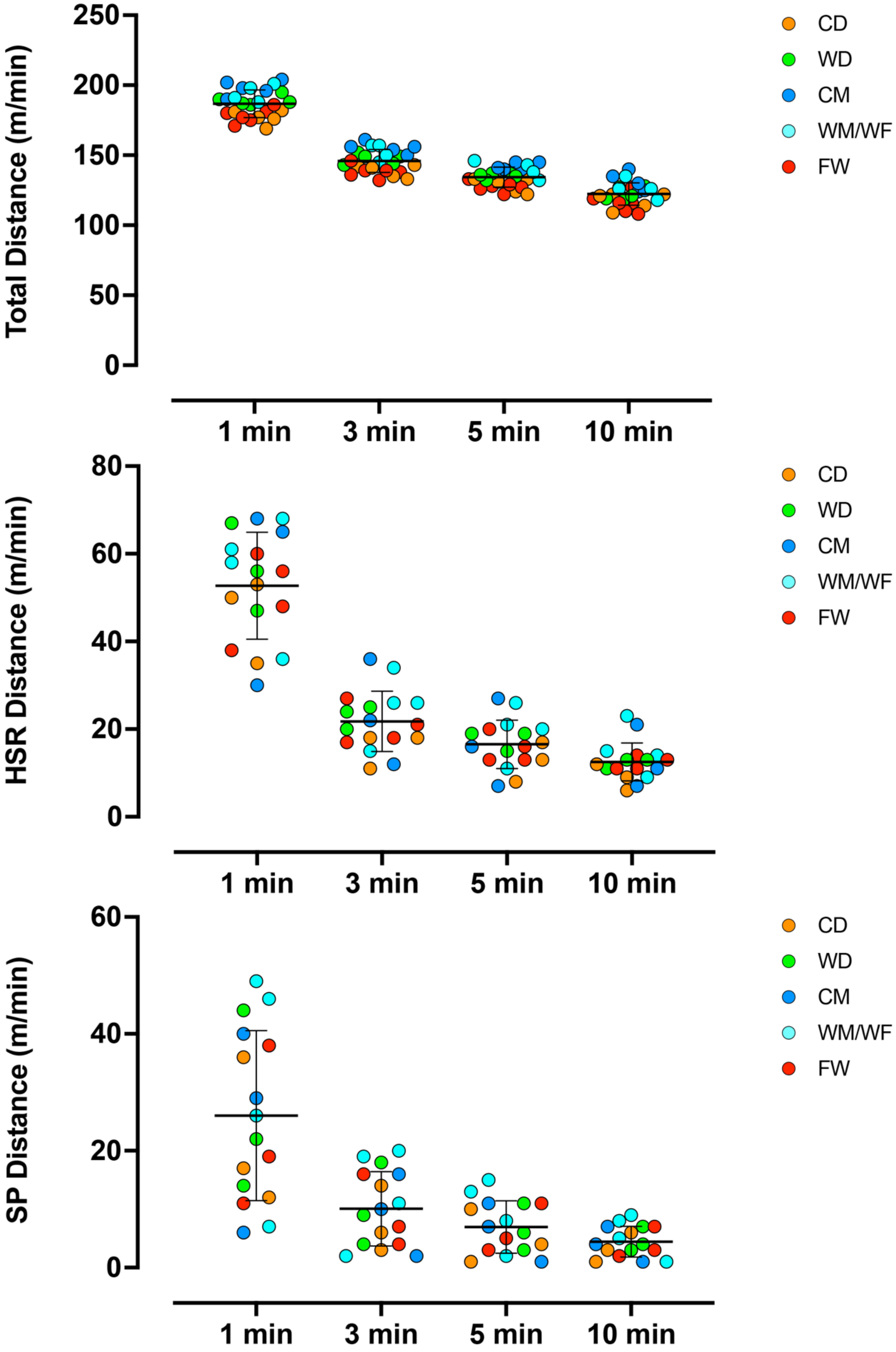


Figure 2.2. A synthesis of mean (±standard deviations) values for total, high-speed running (HSR) and sprinting (SP) distances covered by various playing positions from different studies investigating peak periods of play in elite football players (Martín-García et al., 2018; Casamichana et al., 2019; Fereday et al., 2020; Oliva-Lozano et al., 2020; Riboli et al., 2021). Central Defenders (CD), Wide Defenders (WD), Central Midfielders (CM), Wide Midfielders (WD), Wide Forwards (WF) and Forwards (FW).

Table 2.2. Physical performance metrics during the most demanding passages of play in professional male football players.

Source	Method	Level	Sample	Half	Position	Variables	Period										Thresholds
							1-min	**2-min**	**3-min**	**4-min**	**5-min**	**6-min**	**7-min**	**8-min**	**9-min**	**10-min**	
Di Mascio and Bradley (2013)	VID (ProZone Sports Ltd, Leeds, UK)	English Premier League, 2006/07	100 Players; 20 Games	Full	Central Defenders	TD (m)					574±77						HIR ≥19.8 km·h^{-1}
						HIRD (m)					87±17						
						IP HIR (m)					16±17						
						OOP HIR (m)					71±13						
						Time HIR (s)					13±2						
						HIR (n)					14±5						
					Wide Defenders	TD (m)					639±75						
						HIRD (m)					119±23						
						IP HIR (m)					51±30						
						OOP HIR (m)					67±30						
						Time HIR (s)					18±3						
						HIR (n)					20±6						
					Central Midfielders	TD (m)					675±65						
						HIRD (m)					107±29						
						IP HIR (m)					43±37						
						OOP HIR (m)					58±39						
						Time HIR (s)					16±6						
						HIR (n)					17±5						
					Wide Midfielders	TD (m)					692±75						
						HIRD (m)					129±25						
						IP HIR (m)					75±36						
						OOP HIR (m)					55±39						
						Time HIR (s)					18±6						
						HIR (n)					21±6						
					Forwards	TD (m)					638±75						
						HIRD (m)					112±25						
						IP HIR (m)					74±30						
						OOP HIR (m)					38±25						
						Time HIR (s)					17±4						
						HIR (n)					16±5						
					Overall	TD (m)					644±83						
						HIRD (m)					111±28						
						IP HIR (m)					52±37						
						OOP HIR (m)					58±32						
						Time HIR (s)					16±5						
						HIR (n)					18±6						

Table 2.2. (continued)

Source	Method	Level	Sample	Half	Position	Variables	Period										Thresholds
							1-min	2-min	3-min	4-min	5-min	6-min	7-min	8-min	9-min	10-min	
Martín-García et al. (2018)	GPS (Viper Pod, STATsports Viper, Northern Ireland, UK)	Spanish La Liga 2, 2015/16	23 Players; 37 Games; 605 observations	Full	Central Defenders	TD (m·min^{-1})	182±16		143±10		133±8					122±7	HSR >19.8 km·h^{-1} SP >25.2 km·h^{-1} Acc/Dec >3 m·s^{-2} HMP >25.5 W·kg^{-1}
						HSRD (m·min^{-1})	35±24		11±9		8±5					6±3	
						SD (m·min^{-1})	12±19		3±5		1±2					1±1	
						HMLD (m·min^{-1})	59±17		31±8		25±5					22±4	
						AMP (W·kg^{-1})	17±2		13±1		12±1					11±1	
						Acc (n·min^{-1})	3±1		2±1		2±1					2±0	
						Dec (n·min^{-1})	3±2		3±1		2±1					2±1	
					Wide Defenders	TD (m·min^{-1})	195±16		152±9		139±8					128±8	
						HSRD (m·min^{-1})	47±24		20±9		15±6					11±4	
						SD (m·min^{-1})	14±17		4±5		3±3					3±2	
						HMLD (m·min^{-1})	70±18		40±9		33±6					28±5	
						AMP (W·kg^{-1})	19±2		14±1		13±1					12±1	
						Acc (n·min^{-1})	3±1		2±1		2±1					2±1	
						Dec (n·min^{-1})	4±1		3±1		3±1					2±1	
					Central Midfielders	TD (m·min^{-1})	204±15		161±8		140±8					140±7	
						HSRD (m·min^{-1})	30±22		12±7		7±3					7±3	
						SD (m·min^{-1})	6±11		2±3		1±1					1±1	
						HMLD (m·min^{-1})	66±16		38±7		32±5					27±5	
						AMP (W·kg^{-1})	19±1		15±1		14±1					13±1	
						Acc (n·min^{-1})	3±1		3±1		3±1					3±1	
						Dec (n·min^{-1})	3±1		3±1		3±1					3±1	
					Wide Midfielders	TD (m·min^{-1})	201±20		157±16		146±16					135±16	
						HSRD (m·min^{-1})	36±20		15±8		11±5					9±4	
						SD (m·min^{-1})	7±12		2±3		2±2					1±2	
						HMLD (m·min^{-1})	70±16		39±10		34±9					29±8	
						AMP (W·kg^{-1})	19±2		15±1		14±1					13±1	
						Acc (n·min^{-1})	3±2		3±1		3±1					2±1	
						Dec (n·min^{-1})	4±2		3±1		3±1					3±1	
					Forwards	TD (m·min^{-1})	181±20		138±16		128±14					127±13	
						HSRD (m·min^{-1})	38±22		17±9		13±6					11±4	
						SD (m·min^{-1})	11±14		4±4		3±3					2±2	
						HMLD (m·min^{-1})	62±18		36±10		29±8					25±6	
						AMP (W·kg^{-1})	18±2		13±2		12±1					11±1	
						Acc (n·min^{-1})	3±2		2±1		2±1					2±1	
						Dec (n·min^{-1})	3±2		3±1		2±1					2±1	
					Overall	TD (m·min^{-1})	192±20		149±15		138±14					127±13	
						HSRD (m·min^{-1})	38±23		16±9		12±6					9±4	
						SD (m·min^{-1})	11±16		3±4		2±3					2±2	
						HMLD (m·min^{-1})	65±18		37±9		31±7					26±6	
						AMP (W·kg^{-1})	18±2		14±1		13±1					12±1	
						Acc (n·min^{-1})	3±2		2±1		2±1					2±1	
						Dec (n·min^{-1})	3±2		3±1		3±1					2±1	

Table 2.2. (continued)

Source	Method	Level	Sample	Half	Position	Variables	Period										Thresholds
							1-min	2-min	3-min	4-min	5-min	6-min	7-min	8-min	9-min	10-min	
Casamichana et al. (2019)	GPS (Viper Pod, Statsports Viper, Northern Ireland, UK)	Spanish La Liga, 2016/17	23 Players; 37 Games; 265 observations (each half)	1st	Central Defenders	TD (m/min^{-1})	177±14		142±9		131±8					122±7	HSR >14.4 km·h^{-1} Acc/Dec >2 m·s^{-2} HMP >25.5 W·kg^{-1}
						HMLD (m/min^{-1})	62±12		36±7		29±4					24±3	
						AMP (W·kg^{-1})	18±1		13±1		12±1					11±1	
					Wide Defenders	TD (m/min^{-1})	190±16		149±11		137±9					127±10	
						HMLD (m/min^{-1})	74±17		42±7		35±6					29±5	
						AMP (W·kg^{-1})	19±2		14±1		13±1					12±1	
					Midfielders	TD (m/min^{-1})	196±22		156±17		145±15					135±15	
						HMLD (m/min^{-1})	70±15		39±8		32±7					27±6	
						AMP (W·kg^{-1})	19±2		15±2		14±1					13±1	
					Offensive Midfielders	TD (m/min^{-1})	195±26		157±13		146±12					137±12	
						HMLD (m/min^{-1})	74±15		45±9		37±8					32±7	
						AMP (W·kg^{-1})	19±2		15±1		14±1					13±1	
					Forwards	TD (m/min^{-1})	175±23		136±17		126±15					116±14	
						HMLD (m/min^{-1})	67±17		39±8		32±7					26±6	
						AMP (W·kg^{-1})	18±2		13±2		12±2					11±1	
					Overall	TD (m/min^{-1})	186±22		147±16		136±11					126±14	
						HMLD (m/min^{-1})	70±16		40±8		33±7					27±5	
						AMP (W·kg^{-1})	18±2		14±2		13±1					12±1	
				2nd	Central Defenders	TD (m/min^{-1})	176±12		135±9		124±8					114±7	
						HMLD (m/min^{-1})	65±12		34±6		28±4					22±3	
						AMP (W·kg^{-1})	17±1		13±1		12±1					11±1	
					Wide Defenders	TD (m/min^{-1})	186±21		143±10		132±9					119±8	
						HMLD (m/min^{-1})	73±16		40±8		33±6					27±5	
						AMP (W·kg^{-1})	19±2		14±1		13±1					11±1	
					Midfielders	TD (m/min^{-1})	190±20		150±15		140±14					127±14	
						HMLD (m/min^{-1})	66±15		37±8		31±6					25±5	
						AMP (W·kg^{-1})	18±2		14±2		13±1					12±1	
					Offensive Midfielders	TD (m/min^{-1})	192±23		151±14		141±12					127±11	
						HMLD (m/min^{-1})	74±14		42±7		35±7					28±5	
						AMP (W·kg^{-1})	19±2		14±1		13±1					12±1	
					Forwards	TD (m/min^{-1})	171±25		132±17		122±14					110±14	
						HMLD (m/min^{-1})	65±15		36±9		30±7					24±6	
						AMP (W·kg^{-1})	17±2		13±2		12±2					10±1	
					Overall	TD (m/min^{-1})	182±23		141±15		131±14					119±13	
						HMLD (m/min^{-1})	68±15		38±8		31±7					25±5	
						AMP (W·kg^{-1})	18±2		13±2		12±1					11±1	

Table 2.2. (continued)

Source	Method	Level	Sample	Half	Position	Variables	Period										Thresholds
							1-min	2-min	3-min	4-min	5-min	6-min	7-min	8-min	9-min	10-min	
Fereday et al. (2020)	GPS (Optimeye S5, Catapult Sports, Melbourne, Australia, 10 Hz)	English Championship, 2018/19	23 Players; 28 Games; 347 Observations	Full	Defenders	TD (m/min^{-1})	188±19	155±14	143±12	136±11	131±11	128±10	125±10	122±10	120±10	119±10	HSR >19.8 km·h^{-1}
						HSRD (m/min^{-1})	60±21	34±16	27±13	23±12	20±10	18±9	16±8	15±7	14±7	14±6	
					Midfielders	TD (m/min^{-1})	197±20	163±17	150±15	143±14	138±14	134±14	131±14	129±13	127±13	125±13	
						HSRD (m/min^{-1})	61±26	38±21	30±16	25±14	22±13	20±11	18±10	17±9	16±8	15±7	
					Forwards	TD (m/min^{-1})	180±19	149±15	139±15	131±15	127±15	124±15	122±15	119±14	117±15	116±14	
						HSRD (m/min^{-1})	56±19	34±13	27±11	22±10	20±8	18±7	16±6	15±6	15±5	14±5	
					Overall	TD (m/min^{-1})	190±20	157±17	145±15	138±14	133±14	130±14	127±13	125±13	123±13	121±13	
						HSRD (m/min^{-1})	60±23	36±18	28±14	24±12	21±12	19±10	17±9	16±8	15±7	14±7	
Oliva-Lozano et al. (2020)	GPS (WIMU Pro, RealTrack Systems, Almeria, Spain, 10 Hz)	Spanish La Liga 2, 2018/19	23 Players; 13 Games; 1205 Observations	Full	Central Defenders	TD (m/min^{-1})	169±32		133±21		122±17					109±15	HSR >19.8 km·h^{-1} SP >25.2 km·h^{-1}
						HSRD (m/min^{-1})	53±34		18±11		13±8					9±6	
						SD (m/min^{-1})	17±11		6±5		4±3					3±2	
					Wide Defenders	TD (m/min^{-1})	188±32		149±22		135±19					119±15	
						HSRD (m/min^{-1})	67±137		25±11		19±9					13±6	
						SD (m/min^{-1})	22±13		9±7		6±5					4±3	
					Central Midfielders	TD (m/min^{-1})	202±142		154±60		141±39					125±25	
						HSRD (m/min^{-1})	65±159		22±43		16±26					11±14	
						SD (m/min^{-1})	29±14		10±5		7±3					4±1	
					Wide Midfielders	TD (m/min^{-1})	188±42		145±21		132±119					118±16	
						HSRD (m/min^{-1})	61±96		26±10		20±8					14±6	
						SD (m/min^{-1})	26±16		11±7		8±5					5±3	
					Forwards	TD (m/min^{-1})	186±61		146±26		133±20					119±17	
						HSRD (m/min^{-1})	60±128		21±10		16±8					11±6	
						SD (m/min^{-1})	19±14		7±5		5±4					3±2	
					Overall	TD (m/min^{-1})	187±12		145±8		133±7					118±6	
						HSRD (m/min^{-1})	61±5		22±3		17±3					12±2	
						SD (m/min^{-1})	23±5		9±		6±2					4±1	

Table 2.2. (continued)

Source	Method	Level	Sample	Half	Position	Variables	Period										Thresholds
							1-min	2-min	3-min	4-min	5-min	6-min	7-min	8-min	9-min	10-min	
Riboli et al. (2021)	VID (Stats Perform, Chicago, Illinois, USA)	Spanish La Liga 2	223 Players; 18 Games; 305 Observations	Full	Central Defenders	TD (m/min^{-1})	181±30	151±28	141±23	136±26	133±23					121±28	HSR 15-20 km·h^{-1} VHSR 20-24 km·h^{-1} SP >24 km·h^{-1} Acc/Dec >3 m·s^{-2} HMP >20 W·kg^{-1}
						HSRD (m/min^{-1})	50±22	23±11	18±14	18±12	17±7					12±3	
						VHSRD (m/min^{-1})	34±11	19±7	15±5	13±4	11±4					8±3	
						SD (m/min^{-1})	36±15	19±9	14±6	11±5	10±4					6±3	
						Acc/Dec (n·min^{-1})	31±4	18±3	15±2	12±2	11±2					7±1	
						HMLD (m/min^{-1})	88±20	60±13	52±11	46±10	42±12					36±9	
						AMP (W·kg^{-1})	19±4	16±3	14±2	14±2	13±3					12±2	
					Wide Defenders	TD (m/min^{-1})	187±27	157±27	144±21	140±23	136±21					121±30	
						HSRD (m/min^{-1})	56±19	26±14	24±19	21±14	19±6					13±3	
						VHSRD (m/min^{-1})	37±13	22±8	17±6	14±5	12±4					9±4	
						SD (m/min^{-1})	44±15	23±9	18±7	14±6	11±5					7±3	
						Acc/Dec (n·min^{-1})	33±5	20±3	15±2	13±2	11±2					8±1	
						HMLD (m/min^{-1})	92±24	65±17	54±13	49±13	43±16					38±13	
						AMP (W·kg^{-1})	20±3	16±3	14±2	14±3	12±4					12±3	
					Central Midfielders	TD (m/min^{-1})	198±27	168±28	156±24	150±26	145±24					130±33	
						HSRD (m/min^{-1})	68±19	36±12	36±16	32±12	27±5					21±4	
						VHSRD (m/min^{-1})	39±12	24±8	19±5	16±5	14±4					10±3	
						SD (m/min^{-1})	40±17	23±10	16±7	13±6	11±5					7±3	
						Acc/Dec (n·min^{-1})	31±4	18±2	15±2	12±2	11±2					8±1	
						HMLD (m/min^{-1})	103±17	75±14	64±10	59±11	50±18					46±11	
						AMP (W·kg^{-1})	21±4	17±2	16±2	15±2	13±5					13±3	
					Wide Midfielders	TD (m/min^{-1})	198±19	167±18	157±14	148±23	143±19					126±37	
						HSRD (m/min^{-1})	68±20	35±13	34±17	32±14	26±6					23±5	
						VHSRD (m/min^{-1})	41±14	25±9	20±6	17±6	15±5					11±4	
						SD (m/min^{-1})	49±17	27±10	20±8	16±6	15±6					9±4	
						Acc/Dec (n·min^{-1})	35±4	21±3	17±2	14±2	13±1					9±2	
						HMLD (m/min^{-1})	103±21	75±16	64±13	57±13	50±18					45±12	
						AMP (W·kg^{-1})	22±8	17±5	16±3	15±3	13±4					13±3	
					Centre Forwards	TD (m/min^{-1})	177±38	148±34	139±30	132±31	129±30					108±43	
						HSRD (m/min^{-1})	48±21	23±13	18±17	20±13	13±6					13±3	
						VHSRD (m/min^{-1})	34±13	22±8	16±6	14±5	12±5					9±4	
						SD (m/min^{-1})	38±19	21±11	16±8	13±8	11±6					7±4	
						Acc/Dec (n·min^{-1})	29±5	17±3	14±2	12±2	11±2					7±2	
						HMLD (m/min^{-1})	86±23	60±17	52±13	46±13	36±20					35±13	
						AMP (W·kg^{-1})	19±4	16±3	14±3	13±3	11±6					11±3	

Table 2.2. (continued)

Source	Method	Level	Sample	Half	Position	Variables	Period										Thresholds
							1-min	2-min	3-min	4-min	5-min	6-min	7-min	8-min	9-min	10-min	
Continued – Riboli et al. (2021)				Full	Wide Forwards	TD (m/min^{-1})	191±19	160±13	150±12	143±12	138±10					126±15	HSR 15-20 $km{\cdot}h^{-1}$ VHSR 20-24 $km{\cdot}h^{-1}$ SP >24 $km{\cdot}h^{-1}$ Acc/Dec >3 $m{\cdot}s^{-2}$ HMP >20 $W{\cdot}kg^{-1}$
						HSRD (m/min^{-1})	58±19	29±10	26±14	24±11	21±5					15±3	
						VHSRD (m/min^{-1})	39±8	22±6	18±4	14±4	13±3					10±3	
						SD (m/min^{-1})	46±14	27±9	19±7	16±6	13±5					8±3	
						Acc/Dec ($n{\cdot}min^{-1}$)	33±4	21±2	16±2	14±1	12±1					8±1	
						HMLD (m/min^{-1})	94±17	66±12	56±9	51±9	44±13					39±8	
						AMP ($W{\cdot}kg^{-1}$)	20±2	16±2	15±1	14±1	13±3					12±2	
					Overall	TD (m/min^{-1})	188±26	159±24	148±20	142±23	138±43					122±29	
						HSRD (m/min^{-1})	58±18	29±12	26±17	25±13	21±6					16±3	
						VHSRD (m/min^{-1})	37±12	22±7	17±5	15±5	13±5					9±3	
						SD (m/min^{-1})	42±16	23±9	17±7	14±6	12±6					7±3	
						Acc/Dec ($n{\cdot}min^{-1}$)	32±7	19±4	15±3	13±2	12±3					8±2	
						HMLD (m/min^{-1})	94±20	67±15	57±12	51±11	44±16					40±11	
						AMP ($W{\cdot}kg^{-1}$)	20±4	16±3	15±2	14±2	13±4					12±3	

Abbreviations for method: VID: computerised multiple-camera video tracking systems; GPS: global positioning systems.

Abbreviations for variables: TD: Total distance; HIRD: high-intensity running distance; HSRD: high-speed running distance; VHSRD: very high-speed running distance; SD: sprinting distance; HMLD: high metabolic load distance; AMP: average metabolic load; IP: in possession; OOP; out of possession.

Abbreviations for thresholds: HIR: high-intensity running; HSR: high-speed running; VHSR: very high-speed running; SP: sprinting; Acc: acceleration; Dec: deceleration; HMP: high metabolic power; HI: high-intensity. Data are presented as mean ± standard deviation (decimals were rounded up when more than 0.5). Adapted from Rico-González et al. (2022).

2.3.4.2 Fatigue and Transient Running Decrements During Competition

Football players are repeatedly exposed to mechanical and metabolic stress during competitive match-play, which may provoke physiological changes and ultimately lead to fatigue. Fatigue can be described as any activity-induced decline in the ability to exert a required exercise intensity or an expected power output during prolonged exercise. The reduction in muscle function while exercising could be induced by 'central' (e.g., due to impaired motor neuron activity) and/or 'peripheral' (e.g., due to the depletion of muscle glycogen or the accumulation of metabolites at the muscle) fatigue (Meeusen et al., 2006; Westerblad, Bruton and Katz, 2010). This may also be induced by exercise-induced muscle damage during a match due to mechanical stresses likely occurring from eccentric contractions experienced when decelerating rapidly (Dalen et al., 2016). Thus, fatigue during and/or following a football match is multifaceted.

Time-motion studies have used running performance as a fatigue indicator, demonstrating that fatigue occurs not only toward the end of a match but also temporarily, especially in the periods that follow the most demanding passage of play (Mohr, Krustrup and Bangsbo, 2003; Rampinini et al., 2007; Bradley et al., 2009; Bradley and Noakes, 2013; Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017). Findings from existing studies demonstrate that irrespective of playing level and position, the high-intensity distance covered (≥ 14.4 km·h^{-1}) in the last 15 min of a match can decline by ~10-20% compared to the first 15 min period, which indicates that players are fatigued at the end of a match (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Bradley et al., 2010). Although this simple comparison (e.g., the opening period vs the last period of a match) seems to be inappropriate due to the playing tempo in the initial few minutes of play being at its most intense (Lovell et al., 2013), this reduction in high-intensity running toward the end of a match seems to be due to the glycogen depletion of individual muscle fibres (Mohr, Krustrup and Bangsbo, 2005) and/or exercise-induced muscle damage during a match (Thorpe and Sunderland, 2012), which is typically caused by mechanical stress such as decelerations (i.e., eccentric muscle contractions). This could be supported by other studies that used physical performance measurements such as sprinting and jumping, demonstrating that players were fatigued after a match as evidenced by a decline of sprint (-3%) and jump (-4.4%) performance (Krustrup et al., 2006; Andersson et al., 2008; Rampinini et al., 2011). Although a player's physical performance decreases toward the end of a match, it appears that players seem to be able to maintain their technical abilities despite fatigue, which may signify players could modulate their physical activities as a pacing strategy to keep performing a high level of technical skills until the end of a competition (Carling and Dupont, 2011). In addition, players tend to cover less high-intensity running distance in the initial period of the second half than the opening period of the first half (Mohr, Krustrup and Bangsbo, 2003; Bradley and Noakes, 2013). This appears to be due to the drop in muscle temperature during the half-time since a decrease in muscle temperature (e.g., 2°C) after the half-time demonstrated a more evident decline in sprinting performance than when performing low-intensity activities as a re-warm up before the second half to preserve muscle temperature (Mohr et al., 2004). However, it could be due to a pacing strategy since the players who performed more physical activities in the first half showed reductions in high-intensity running in the initial 10 min of the second half; however, those who were moderately or less involved in physical activities in the first half did not exhibit decreases in high-intensity running in the same period of the second half (Bradley and Noakes, 2013).

Numerous studies have also investigated the 5-min periods after the most intense period during competitive match-play to evaluate transient decrements in high-intensity running compared to the match average along with peak periods of play (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Bradley et al., 2010; Carling and Dupont, 2011; Di Mascio and Bradley, 2013; Bradley et al., 2014a; Fransson, Krustrup and Mohr, 2017). Yet, most of the aforementioned studies used the predefined periods, which can overestimate the distance covered in the following period after the most intense period of match-play by up to ~30% (Varley, Elias and Aughey, 2012). Despite this, findings demonstrate that the amount of the high-intensity distance covered by elite male football players in the 5-min period after the most intense 5-min period can decline by 6-16% compared to the match average (Figure 2.3) although research used different speed thresholds for high-intensity running (range: ≥14.4 to 19.8 $km \cdot h^{-1}$). This could indicate that players experience fatigue temporarily after performing intense actions for a certain period during a competition. This phenomenon can be supported by a study by Krustrup et al. (2006), which demonstrated that although the sprinting performance of players was significantly lowered after an intensified period in the first half, the ability to execute repeated sprints was fully recovered at the end of the first half. It has been suggested that temporary fatigue following intensified activities during a match seems to be caused by a consequence of metabolic and ionic perturbations whereby excitation-contraction coupling of muscles are impaired resulting in reduced muscle force (Mohr, Krustrup and Bangsbo, 2005; McKenna, Bangsbo and Renaud, 2008). Additionally, such transient reductions could be ascribed to the depletion of phosphocreatine (PCr) stored in the muscle since the muscular store of PCr is almost entirely depleted after exhaustive activities although it is rapidly replenished (Baker, McCormick and Robergs, 2010). However, transient decrements in high-intensity running during the following periods after intensified periods are not necessarily due to physiological fatigue, but could be associated with other factors such as mental fatigue (Smith, Marcora and Coutts, 2015), pacing strategies/tactical adjustment by players/teams (Bradley and Noakes, 2013) and/or fewer playing opportunities (Carling and Dupont, 2011). Limited evidence exists to understand transient physical decrements during the subsequent periods after the most demanding passage of play. Since physical involvements during a match could be modulated by tactical scenarios such as pacing strategies (Paul, Bradley and Nassis, 2015), providing ‘HOW’ players and teams modify physical performances in relation to tactical actions would aid our understanding of transient decrements in physical performance during the period that follows the most intense period of play.

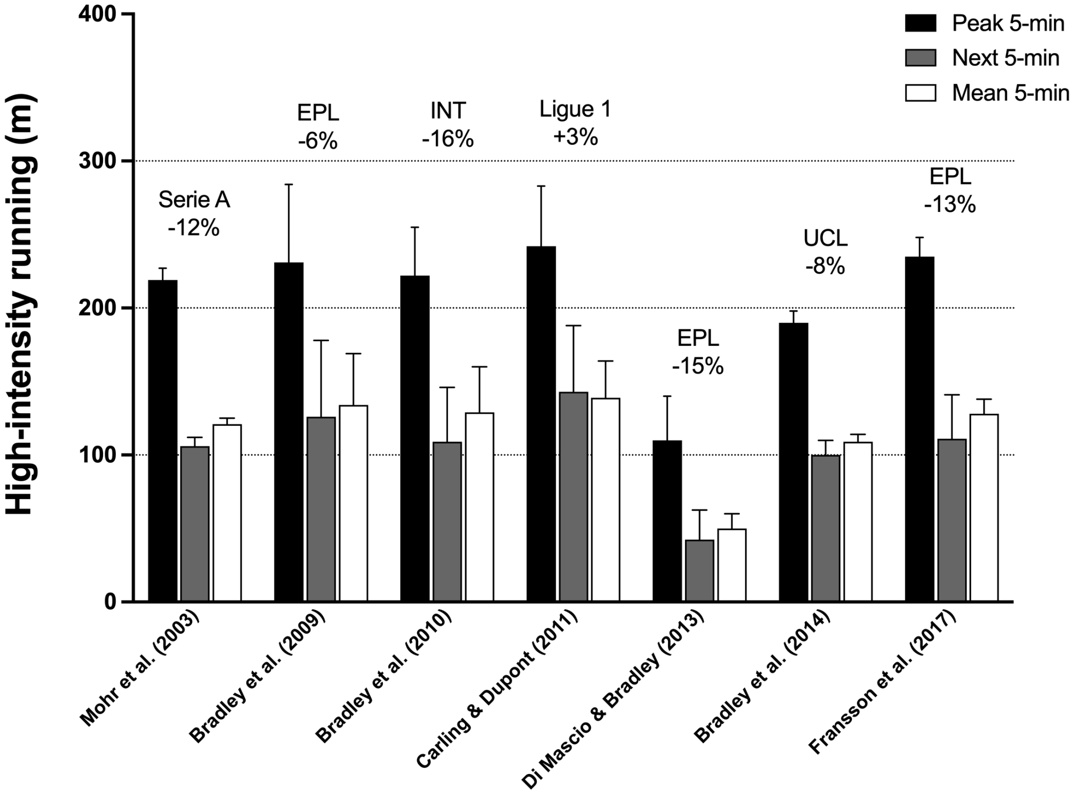


Figure 2.3. Transient decrements in high-intensity running after peak periods of play. Speed thresholds used by studies vary (e.g., ≥14.4 to 19.8 km·h^{-1}). EPL: English Premier League; INT: International; UCL: UEFA Champions League. Adapted from Bradley (2020) and some data were extrapolated from figures. Values are mean and standard deviation (m).

2.3.5 Contextual Factors that influence Match Physical Performance

There are numerous contextual variables that have an impact on physical performance during a competitive match such as formation/playing style, the level of opposition, locations (home and away) and match status (win, draw, lose). Previous studies have investigated the effects of either reference or opposition team formations on match physical performance although the number of the research in the literature considering this contextual factor is scarce (Bradley et al., 2011; Carling, 2011; Baptista et al., 2019; Modric, Versic and Sekulic, 2020). The findings from these studies indicate that formations do not influence the overall match running performance of both the reference and opponent teams; however, they do impact match physical demands when considering the ball possession status (e.g., teams in possession or out of possession of the ball) or playing positions. For instance, teams playing in a 4-5-1 formation covered less high-intensity distance when they were in possession of the ball but more when out of possession compared to orthodox formations such as 4-4-2 and 4-3-3 (Bradley et al., 2011). Regarding positional trends, attackers in a 4-3-3 formation performed

~30% more high-intensity running activities than those in 4-4-2 and 4-5-1 formations. Moreover, when comparing formations with three defensive players (e.g., 3-5-2 formations) to those with four defensive players (e.g., 4-5-1 formations) meaningful differences were observed. Wide defenders in a 3-5-1 formation were more physically demanding with covering ~35% more high-intensity distance compared to those in a 4-5-1 formation (Baptista et al., 2019). Regarding central defensive players, although Baptista et al. (2019) revealed that central defenders in a formation with four players at the back line executed more high-intensity running efforts than those in a formation with three players at the back line, the opposite trend was observed elsewhere (Modric, Versic and Sekulic, 2020).

Existing studies have also evaluated the effects of team ball possession on match-play physical performance by demarcating between high (51-66%) and low (34-50%) proportion of ball possession (Bradley et al., 2013b; da Mota et al., 2016). When making a comparison between the high and low percentage of ball possession, trivial differences were observed in the overall match physical activities. That said, this may be due to less sensitivity to detect disparities in running performance since a current research conducted by Lorenzo-Martinez et al. (2021) has found that the relative distance (m/min) covered by very high-percentage (60-79%) ball possession teams was 2-12% lower, particularly at low and medium velocity compared to high-, low- and very low-percentage ball possession teams (50-60%, 40-50% and 21-40%, respectively). Thus, teams having a high percentage of ball possession seems to typically require a lower conditional response than those having a less percentage of ball possession. Furthermore, more evident differences were witnessed when assessing physical demands when in possession or out of possession. For instance, teams having a higher rate of ball possession covered greater high-intensity distance when in possession but covered less when out of possession compared to those having a lower percentage of ball possession (Bradley et al., 2013b; da Mota et al., 2016). Regrading position-specific trends, attackers ran 71% more distance in high-speed running when their team was in possession of the ball compared to out of possession whilst defenders performed 156% more distance when out of possession compared to in possession (Di Salvo et al., 2009). However, due to a lack of research using repeated measures designs, the effect of both formation and ball possession is still largely unclear (Trewin et al., 2017).

Moreover, it has been reported that the level of opposition influences match running performance, demonstrating that players tend to cover greater total and high-intensity distances when playing against higher quality opposition teams compared to lower quality counterparts (Rampinini et al., 2007; Castellano, Blanco-Villasenor and Alvarez, 2011). Yet, Lago et al. (2010) uncovered that teams playing against higher level teams covered less distance at low intensities (e.g., 0-11 and 11.1-14 km·h^{-1}) whilst Hewitt, Norton and Lyons (2014) found that when the reference team (i.e., Australian women national team) played against teams that similarly ranked (e.g., South Korea and Japan), players performed greater high-intensity activities but fewer low-intensity actions compared to playing against a team that ranked either higher or lower (e.g., United States or Uzbekistan). However, the methodology that previous studies used (e.g., typically categorised teams according to their final ranking at the end of a season or tournament) could lack the sensitivity and stability to differentiate fluctuations in physical performances (Paul, Bradley and Nassis, 2015). Another contextual factor that could influence match physical performance is match status also referred to as score-line. High-intensity running distance (21.1-24 km h^{-1}) has been reported to increase (13%) when the teams were losing compared to winning (Castellano, Blanco-Villasenor and Alvarez, 2011). Likewise, Lago et al. (2010) revealed that an extra 1 m of high-intensity distance (>19.1 km·h^{-1}) was covered for every minute when the teams were losing compared to winning whilst low-intensity distance (<11 km·h^{-1}) increased by 2 m for each minute winning compared to losing. This pattern is also position-specific with attackers spending a greater percentage of time at >14.4 km·h^{-1} (+1.3%) whilst defenders spent a less percentage (-0.7%) when their team were winning compared to losing (Redwood-Brown et al., 2012). However, location (home/away) seems less likely to influence match physical performance than other contextual variables such as the standard of opposition and match status (Castellano, Blanco-Villasenor and Alvarez, 2011; Teixeira et al., 2021) despite home advantage in football such as travel effects, crowd effects and familiarity (Pollard, 2008). There are also other influencing factors such as phases of season (Rampinini et al., 2007), playing surface (Andersson, Ekblom and Krustrup, 2008), player unavailability (Windt et al., 2018), congested periods (Carling et al., 2015) and environmental factors–temperature (Mohr et al.,

2012) and altitude (Aughey et al., 2013). On the whole, a player's physical performance during a match is influenced by various contextual factors to different extent.

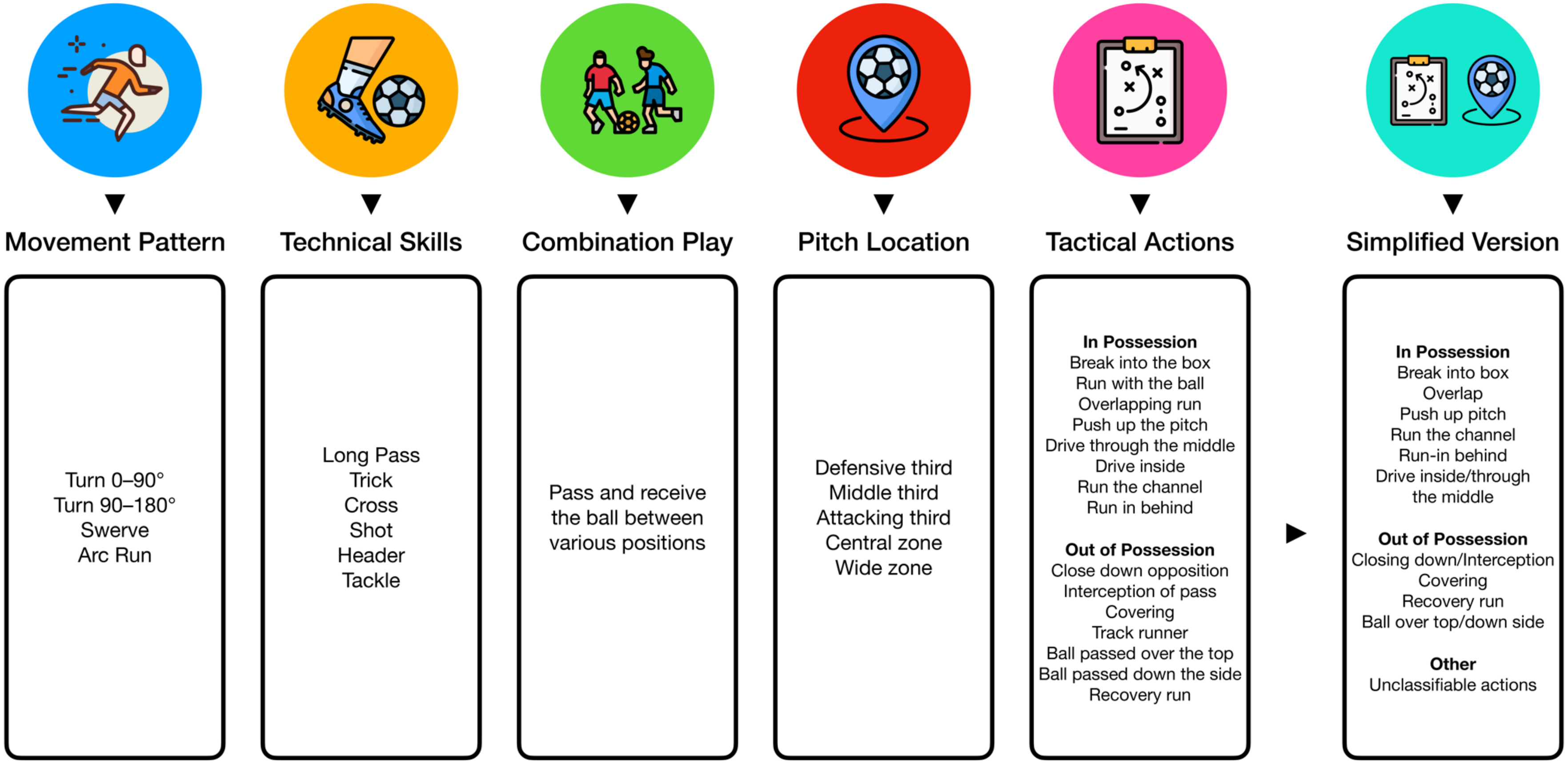
2.3.6 Tactical Analyses During Match-Play

Due to various types of tracking systems such as OTS, GPS and LPS, the movements of players during a match can be denoted using x- and y-coordinates. This can be used to provide novel insights on team collective tactical performance such as spatiotemporal patterns of play that take place dynamically during match-play (Low et al., 2020). Currently, a new body of research has emerged that makes use of positional data for analysing collective tactical performances as a team by measuring position distances (e.g., centroids) or playing spaces (e.g., a player's dispersion). One of the most frequently used methods in the study of collective team tactical performances is the measurement of the team centroid (Memmert, Lemmink and Sampaio, 2017; Sarmento et al., 2018). The definition of the team centroid is the mean x- and y-coordinates of all examined players without goalkeeper, thus indicating a measure of the team's central position (Sampaio and Macas, 2012). This measure provides some tactical insights into positioning of players with regard to the dynamic position of the team with identifying the synchronisation or non-synchronisation of the team centroid, the latter of which may lead to dangerous events during a match (Frencken et al., 2011). In addition to this, using the centroid distance between teammates and distance to closest opposition (e.g., how close the two opposing teams are playing to one another), tactical information in relation to playing styles (e.g., applying pressure or deep-defending strategies) could be identified (Low et al., 2020). Another methodological approach to analysing team tactical behaviour is the quantification of the dispersion of players in a team via calculations of the space they occupy using various methods such as effective playing space/surface area (i.e., measuring the polygonal area of the players within a team on the periphery of play with a convex hull approach) and stretch index (i.e., player dispersion from the centre of the team). Previous studies have consistently demonstrated that wider surface area, stretch index and team width were observed in older age group teams compared to younger counterparts (Folgado et al., 2014; Olthof, Frencken and Lemmink, 2015; Barnabe et al., 2016). Although this tactical maturity trend has also been observed between male and female football players with the former demonstrating larger playing widths (Tenga et al., 2015), this seems to diminish after a certain level of tactical expertise since such trends were observed only between younger groups (e.g., U11 and U15) with the U20 players exhibiting equivalent or even higher values of player dispersion compared to professional counterparts (Vieira et al., 2019). This could suggest that larger values of player dispersion may be an indicator of tactical maturity during the formative years of youth players; however, this distinguishing ability seems to disappear after a certain degree of tactical proficiency. Additionally, the measure of player dispersion from team centroids can identify the width and length of attacking and defensive phases and transition phases of play. For instance, how quickly teams expand their playing space after regaining ball possession, or reduce their playing space after losing ball possession can be identified, particularly during transition phases of play (e.g., attack to defence and vice versa), which could be useful to characterise team collective tactical behaviour. This could help coaches propose better strategies to exploit opponent weaknesses or to strengthen their own team playing patterns. Consequently, these techniques to identify player dispersion could provide coaches and practitioners with information on not only tactical maturity for selected age groups but also certain tactical behaviour during a game. Although the aforementioned approaches to analysing collective team tactical performances using positional data can provide some tactical insights to coaches and practitioners, it is challenging for them to provide players with any objective individual-level feedback using such information. Hence, tactical analysis should be performed at a more detailed level (e.g., individual level) or during specific situations (e.g., attack, defend or transitions phases) based on their team tactic/philosophy, and then these individual tactical performances may be combined to form team tactical performances. Therefore, it would be more beneficial to fuse individual tactical actions of players with physical and technical performances (Figure 2.5) to have a holistic understanding of the true football performance since all of these aspects simultaneously impact performance during a match (Stølen et al., 2005).

2.4 Integrated Approach to Quantifying Match Physical-Tactical Performance

2.4.1 The Introduction of the Integrated Approach

Given the complex nature of football, researchers have generally adopted a reductionist methodology that typically analyses physical, technical or tactical metrics in isolation. Tactical activities are one of the modulatory factors of physical efforts (Schuth et al., 2016). However, tactical context has been completely omitted from the vast majority of research using time-motion analyses over 45 years although a new body of studies has currently emerged that uses positional data for investigating team collective tactical performances. Findings from previous studies using the reductionist approach have provided some insight to practitioners. Yet, it is questionable how receptive coaches are to this basic data (Carling et al., 2019) since sometimes coaches can have difficulty communicating with practitioners (Nosek et al., 2021), especially when data without any context are provided (e.g., not using coaching language and visuals). Ade, Fitzpatrick and Bradley (2016) was the first to devise a method that could quantify physical efforts in relation to tactical purposes called a high-intensity movement programme (HIMP; the initial version of the integrated approach) to provide better insight into physical performance in respect to tactical context. This approach consisted of five main categories: (1) movement patterns, (2) technical skill, (3) combination play, (4) pitch location and (5) tactical actions. Despite this approach reporting excellent inter- and intra-assessor reliability with a Kappa value of >0.8 and >0.9, respectively, some of the HIMP categorisations have been removed and some of the tactical actions have been merged to reduce the complexity of the original approach (Figure 2.4; Bradley and Ade, 2018). To understand this concept more easily, an overview of the conceptual work with the Venn diagrammatical visual from Bradley and Ade (2018) has been redrawn in Figure 2.5. Nevertheless, this approach does not include other metabolically taxing actions such as accelerations that are more repeatedly executed during matches not reaching speeds at high-intensity (Varley and Aughey, 2013). Thus, understanding the complete physical demands of match-play is still limited. That said, this new model could help the coaches' understanding of data as physical data are contextualised with tactical movements using coaching languages. This could ultimately help coaches better translate data into training and give tactical feedback to the players more effectively as tactical actions are quantified at an individual level.



Movement Pattern

Turn 0–90°
Turn 90–180°
Swerve
Arc Run

Technical Skills

Long Pass
Trick
Cross
Shot
Header
Tackle

Combination Play

Pass and receive the ball between various positions

Pitch Location

Defensive third
Middle third
Attacking third
Central zone
Wide zone

Tactical Actions

In Possession
Break into the box
Run with the ball
Overlapping run
Push up the pitch
Drive through the middle
Drive inside
Run the channel
Run in behind

Out of Possession
Close down opposition
Interception of pass
Covering
Track runner
Ball passed over the top
Ball passed down the side
Recovery run

Simplified Version

In Possession
Break into box
Overlap
Push up pitch
Run the channel
Run-in behind
Drive inside/through the middle

Out of Possession
Closing down/Interception
Covering
Recovery run
Ball over top/down side

Other
Unclassifiable actions

Figure 2.4. The categories within high-intensity movement programme (e.g., movement pattern, technical skills, combination play, pitch location and tactical actions) devised by Ade, Fitzpatrick and Bradley (2016), and a simplified version of the integrated approach proposed by Bradley and Ade (2018).

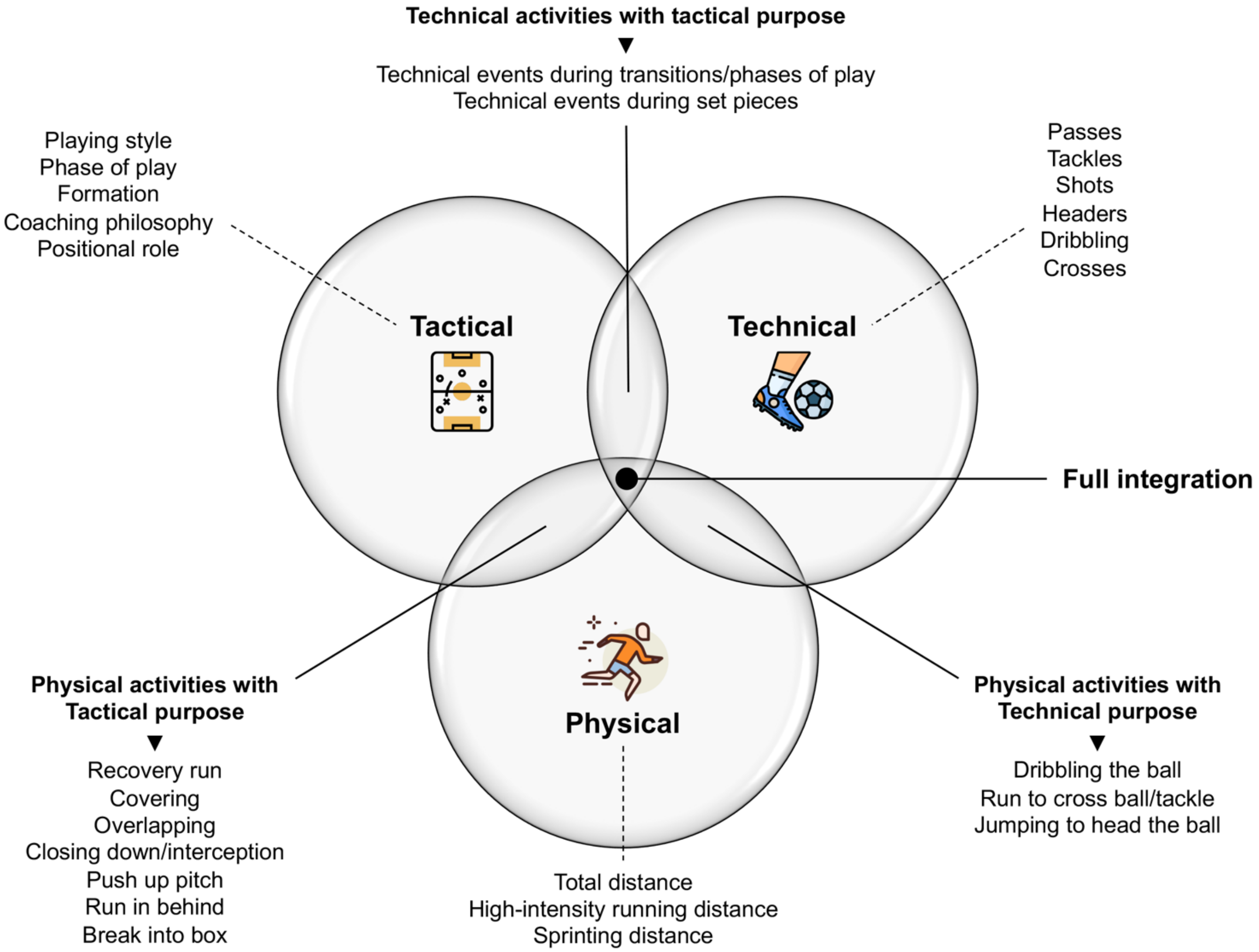


Figure 2.5. An overview of the conceptual work with the Venn diagrammatical graphic. Redrawn from Bradley and Ade (2018).

2.4.2 Tactical Actions within the Integrated Approach

Physical performance in football such as running at higher speed and changing directions quickly during a competitive game is highly complex as it requires the combination of physical, technical, tactical, perceptive and cognitive capabilities (Bate and Jeffreys, 2015; Bradley and Ade, 2018). Physical actions are modulated by tactical movements during a game whereby players either defensively or offensively deploy several options according to different tactical contexts (Schuth et al., 2016). Thus, it is imperative to appropriately fuse physical metrics with tactical activities to better understand physical performances with the game tactical dynamics. According to the description of the tactical variables from the study of Ade, Fitzpatrick and Bradley (2016) in-possession tactical actions can be defined as the movements players perform to receive the ball or decoy opposition players by exploiting space or creating passing options except for 'Push up Pitch' and 'Run with the ball'; however, they have their own suitable label for each tactical purpose. For instance, movements of entering the opposition penalty box are 'Break into the box' whilst those of attacking in behind the defensive line are 'Run in behind the opposition defensive line'. On the other hand, out-of-possession tactical movements can be defined as the actions players execute to defend their own goal (e.g., 'Covering' and 'Recovery Run') or press the opposition team (e.g., 'Close down opposition player').

The definitions of 'Break into the box' and 'Run in behind' are the actions to enter the opposition penalty box and to attack in behind the defensive line, respectively (Ade, Fitzpatrick and Bradley, 2016; Bradley and Ade, 2018). These actions seem to be promising to be measured since firstly, the number of entries in the penalty box appears to be a differentiator between team qualities (Yang et al., 2018) and secondly, the number of passes in behind the defensive line whilst players are making runs in behind is highly related to scoring goals (González-Ródenas et al., 2019). Moreover, measuring 'Running with the ball' and 'Overlapping' actions also appears to be favourable since this could differentiate tactical roles or even playing styles of players. For instance, wide midfielders perform more 'Running with the ball' actions during a match (Carling, 2010) with wide defenders executing more 'Overlapping' activities (Ade, Fitzpatrick and Bradley, 2016). Similar to the in-possession tactical actions, out-of-possession tactical movements appear to be able to demarcate between various tactical roles/playing styles of players. Central defenders tend to perform more ‘Covering’ actions whilst attackers produce more ‘Closing down opposition’ activities (Ade, Fitzpatrick and Bradley, 2016). However, some crossover could have occurred for selected physical-tactical categories within the original integrated method. For instance, a player could produce a high-intensity effort whilst ‘driving through the middle of the pitch’ and simultaneously ‘running with the ball’ (Figure 2.4). It is problematic to classify this type of action since it could be coded into either ‘Drive through the middle of the pitch’ or ‘Run with the ball’, which could cause major reliability issues during the coding process. This type of shortcomings within the HIMP has been addressed by merging some of the tactical actions (Bradley and Ade, 2018). Yet, some tactical actions still provide limited information with regard to the actual tactical purpose of the action but simply indicate their direction and location (e.g., ‘Drive inside/through the middle’ and ‘Run the channel’, Figure 2.4). Moreover, the definition of ‘Closing down opposition’ from Bradley and Ade (2018) indicates only a single aspect of pressing (i.e., running directly toward opposition player on the ball), which is unable to classify other features of pressing activities (e.g., pressing toward the player receiving the ball as well as space near the ball to block a passing line). Thus, a more systematic version of the integrated approach appears to be required in which tactical purposes and direction/location of the actions are separately classified.

2.5 Summary

Time-motion analysis technique has been extensively used to quantify match performance using different EPTS such as optical tracking systems. Among physical performance indicators, high-intensity actions (e.g., high-intensity running and acceleration/deceleration) have been extensively researched as this could help not only prepare players for the physical requirements of modern competitive match-play but also reduce injury risks. High-intensity running performances have been reported to be able to differentiate players from general positional roles (e.g., central defenders or midfielders). However, it appears that a general positional analysis seems to be less sensitive in estimating physical demands of players who have specialised tactical roles during a match (e.g., CDM or CAM). Technical skills, rather than physical performance per se, seem to be a better indicator to predict team success. That said, evaluating technical metrics in isolation is also one-dimensional given the complex nature of football. The contextualisation of physical-tactical actions of players/teams as well as the analysis of collective performance of teams may provide better insights on associations between success in football and match performance. Moreover, analysing peak demands during a match with a rolling average method seems to be more beneficial to provide more precise data for facilitating players to be physically conditioned (i.e., true match intensity) during training sessions compared to average physical demands of match-play with fixed periods (e.g., 0-5, 5-10 min etc.). Fatigue is believed to occur toward the end of a match as well as temporarily following intensified periods of play; however, understanding the cause of the transient decrements in high-intensity running after intense periods is yet incomplete. Overall, although a plethora of research has provided meaningful insights of match performance to coaches and practitioners, little progress has been made with regard to the optimisation of physical data within football teams. This seems to be due to a lack of context (e.g., ‘HOW’ and more importantly ‘WHY’ players produce high-intensity efforts in relation to tactical actions). Recently, a novel approach to not only quantifying physical metrics but contextualising them with tactical activities has been proposed (Figure 2.4). This could help coaches to better understand data, thus translating them into training drills more effectively. Yet, some of the limitations of the original integrated approach should be addressed with its validity and reliability verified.

CHAPTER THREE

THE VALIDITY AND RELIABILITY OF AN INTEGRATED APPROACH FOR QUANTIFYING MATCH PHYSICAL-TACTICAL PERFORMANCE

THE VALIDITY AND RELIABILITY OF AN INTEGRATED APPROACH FOR QUANTIFYING MATCH PHYSICAL-TACTICAL PERFORMANCE

3.1 Abstract

Purpose: This study aimed to: (1) develop an integrated approach to quantifying match physical-tactical performance, (2) comprehensively examine the validity and reliability of this novel approach, and (3) compare data from a novel filter used for the present study to capture high-intensity running with those from an established company to verify its validity. **Method:** Both UEFA qualified coaches and performance analysts (*n*=30) participated to verify the scientific robustness of this new method. The percentage of correct responses was used to verify the validity of the integrated approach and the minimum acceptable agreement was set at 80%. Two well-trained observers analysed a randomly selected English Premier League match for inter- and intra-observer reliability using the kappa statistic. **Result:** A high degree of validity was demonstrated as the mean percentage of correct responses by all participants, accounting for 91.8±4.3% for all, 92.2±4.7% for out-of-possession and 91.6±5.7% for in-possession physical-tactical variables. No differences in the physical-tactical actions were found when comparing the percentage of correct responses for UEFA coaches to that from performance analysts, except for 'Push up Pitch' (*P*=0.031, Effect Size: 0.4). Inter- and intra-observer reliability were found to be strong (κ=0.81) to almost perfect (κ=0.94), respectively. Additional analyses demonstrated that there was a nearly perfect correlation between data derived from the novel filter used for the present study to capture high-intensity running and those obtained from the filter of the commercial data provider (*r*=0.99; *P*<0.001). **Conclusion:** The data demonstrates that the integrated approach is valid and reliable regarding the quantification of physical-tactical performances. Therefore, it is now possible to unveil unique high-intensity profiles of elite players related to key tactical actions. This may help coaches and practitioners better understand the physical-tactical performances of players, as well as effectively translate physical metrics into training.

3.2 Introduction

Football (Soccer) is a complex sport as a myriad of technical, physical and tactical parameters have an influence on a player's match performance (Stølen et al., 2005). To reduce this complexity, researchers have adopted a reductionist approach, where they typically analyse either physical or technical performance in isolation (Bradley and Ade, 2018). Using time-motion analysis, a plethora of research has quantified the physical profiles of elite players during match-play and how it is influenced by other factors such as formations, positions and context (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Rampinini et al., 2009; Lago et al., 2010; Bradley et al., 2011; Bush et al., 2015b; Paraskevas, Smilios and Hadjicharalambous, 2020). Despite low-intensity activities dominating football, high-intensity actions are of greater importance as they are associated with critical situations (Faude, Koch and Meyer, 2012). Furthermore, high-intensity running distances are the most evolving metric in both men's and women's football (Barnes et al., 2014; Bush et al., 2015b; Bradley and Scott, 2020), and also are related to physical capacity of players (Krustrup et al., 2005; Bradley et al., 2013a). Therefore, an increasing attention has been paid to high-intensity activity as it enables practitioners to benchmark current requirements and prepare players for the physical requirements of modern match-play (Bradley and Ade, 2018). Nevertheless, authors have traditionally quantified physical metrics in isolation or effectively 'WHAT' distance players have covered during matches without any context. This ultimately limits the coaches' understanding of the most pertinent performance elements (Bradley and Ade, 2018). According to a systematic review by Castellano, Alvarez-Pastor and Bradley (2014), only ~30% of papers considered tactical or technical variables alongside physical metrics. As players' performance can be influenced by all of the factors above in isolation or collectively (Bangsbo, Mohr and Krustrup, 2006; Carling et al., 2008; Trewin et al., 2017), physical metrics should be integrated with tactical and technical factors to obtain a more holistic understanding of football performance.

Despite hundreds of papers focusing on physical match performance, some studies have incorporated physical, technical and tactical metrics within their method (e.g., tables and figures are included on separate data sets). However, data are still not comprehensively integrated but instead aggregated within the results. Only a single study has been published, which has fused the high-intensity physical-tactical activities of elite players (Ade, Fitzpatrick and Bradley, 2016). This study revealed unique high-intensity running profiles as the data was associated with the tactical purpose of the physical action. For instance, full-backs cover ~10% of their total distance in high-intensity running ‘overlapping’ during transition/attacking play. Moreover, forwards will typically ‘run in behind’ the defence at high-intensity to create an offensive threat. This potentially unveils the modulatory factors of the physical efforts or ‘WHY’ players produce high-intensity running efforts in matches. This innovative methodology could provide not only how much distance players cover but also how they perform their tactical roles during match-play. Thus, this approach seems to provide more complete information on players’ physical data with tactical purposes to coaches and practitioners than the traditional approach.

Although Ade, Fitzpatrick and Bradley (2016) should be commended on such an insightful approach, there are some limitations. This approach does not incorporate other metabolically taxing actions such as accelerations/decelerations and changes of direction (Varley and Aughey, 2013), so understanding comprehensive physical demands of match-play is limited. However, since this methodology still requires a manual coding process, which is very labour intensive, contextualising high-intensity running actions with tactical purposes seems to be a starting point (Bradley and Ade, 2018). Moreover, a major drawback of this original work was the lack of objectivity within the coding process whereby some crossover could occur for selected physical-tactical categories. For instance, a player could produce a high-intensity action ‘driving through the middle’ of the pitch but this does not specify if this is ‘with or without the ball’ or ‘supporting play’. To solve this problem, a modified version of this original approach was proposed (Bradley and Ade, 2018). The variables within the initial integrated approach were adapted and some of them were merged to simplify the method. Yet, some variables still provided limited information regarding the actual tactical purpose of the action, and simply indicated their direction and location. Therefore, to enable this approach to be fully accepted by the academic and applied domains, a more systematic version of this method was warranted. Moreover, scientific disciplines require a robust verification of any novel methodological approach’s validity and reliability before collecting and analysing data (O'Donoghue, 2009). Therefore, this study aimed to: (1) develop a systematic integrated approach to quantifying match physical-tactical performance, (2) comprehensively examine the validity and reliability of this novel approach, and (3) verify the validity of a novel filter used for the present study to capture high-intensity running.

3.3 Method

3.3.1 Participants

Two populations of participants were involved in the present study: 15 UEFA qualified coaches (14 UEFA B coaches and 1 UEFA A coach; age: 27±5 yr; range: 20–38 yr; mean ± SD) with an average experience within the football industry of 5 ± 6 yr (ranging 1–22 yr), and 15 performance analysts (age: 24±5 yr; range: 20–34 yr; mean ± SD) with an average experience within the football industry of 3±1 yr (ranging 1–4 yr). Participants worked for a variety of professional teams at different competitive standards (English Premier League, Championship, League 1 and 2, Women's Super League and others). All participants provided their informed consent before commencing the study and were informed that they were free to withdraw at any point. Prior to data collection, ethical approval was granted by the local Ethics Committee of the appropriate institution.

3.3.2 Systematic Validation Process

3.3.2.1 Stage 1 – Establishment of New Variables and Video Clips

Two additional physical-tactical variables (Move to Receive/Exploit Space and Support Play) were created compared to the original/modified integrated approach (Ade, Fitzpatrick and Bradley, 2016; Bradley and Ade, 2018). This was done through extensive discussion with a highly qualified working group that composed of football science and UEFA qualified coaching staff (all working group members had >10 yr experience within the football industry and were selected due to their expertise and experience in this specific area) in order to provide more information on the tactical purpose of various high-intensity efforts. Table 3.1 illustrates the refined version of the integrated approach.

To enable this approach to be validated, video clips of all physical-tactical actions were derived from randomly selected games. From a total of 1,500 physical-tactical actions, the working group above arbitrarily selected 150 of these actions to be clipped from video footage. Five examples for each variable were then arbitrarily selected with various degrees of difficulty to represent gold standard responses (20 out-of-possession and 35 in-possession clips), and they were approved by the working group. Five clips per variable was deemed to be the optimal number for offering not only variety but it also enabled participants to complete the trial in a reasonable amount of time (30–45 min). The latter point is a major barrier previously experienced in this type of work given the busy schedule of staff working within elite football (Nosek et al., 2021). To enable participants to find the correct player producing the high-intensity effort, a visualisation software (Viz Libero software, Bergen, Norway) was used to initially draw the participants attention to the player in question (Figure 3.1). All of the selected video clips were then randomly placed into presentation slides for the validation process.

Figure 3.1. An example of visualisation for a player producing a high-intensity running.

3.3.2.2 Stage 2 – Pilot Testing and Observer Training

Prior to the validation study, a pilot test was established by showing the presentation to two advanced football experts to verify the video clips as the gold standard responses (They unanimously agreed with all clips). Additionally, for the purpose of reliability tests the principal coder of games underwent approximately two months of training to achieve mastery of the approach, thus minimising errors when coding. Each high-intensity effort during match-play was then viewed using wide-angle video footage to manually tag the action with a relevant tactical purpose label (Table 3.1).

3.3.2.3 Stage 3 – Establishing Validity

A one-on-one session was undertaken in a quiet location to enable the participants to fully concentrate. At the beginning of the session an answer sheet relating to the classification of each variable was provided to participants. Each participant was asked to tick the appropriate box after watching each clip. The presentation was shown to participants, initially introducing the integrated approach followed by numerous video examples of various physical-tactical actions and their associated definitions. Only after participants said that they had understood the concept and the associated variables, were they presented with the 55 test clips. Video clips were played as many times as possible when participants were unclear with the action. To ensure standardisation, the verbal explanation of all variables was similarly delivered to participants throughout the study and care was taken to ensure their decisions were not influenced.

3.3.2.4 Stage 4 – Inter- and Intra-Observer Reliability

The inter-observer reliability of the integrated approach was assessed by two observers coding the first half of a randomly selected match. Two familiarisation sessions were undertaken to discuss each variable and understand the coding process with verbally explaining all variables with visual examples. The observers used the same descriptions throughout the process (Table 3.1). Furthermore, it was informed that high-intensity actions with one tactical action had to be classified as a single action with dual tactical actions (primary and secondary) being coded as a hybrid action and more than three tactical actions being classified as 'Other'. If the high-intensity effort was made up of 70-90% of the primary and 10-30% of the secondary action, it was classified as a hybrid action. However, if this consisted of 50-60% of the primary and 40-50% of the secondary action, then it was classified as 'Other'.

Due to hybrid actions being a mixture of the primary and the secondary actions (Bradley and Ade, 2018), single action events and the primary tactical movements of the hybrid actions were analysed. Intra-observer reliability was undertaken by the researcher coding the first half of a randomly selected match twice with a minimum of 7 days separating each observation to reduce memory effects and the risk of changing views (Alwin, 2007). Coding was performed independently in a quiet location for a maximum of 2 h with breaks every 30 min to guarantee optimal concentration levels (Ade, Fitzpatrick and Bradley, 2016).

Table 3.1. A systematic integrated approach to quantifying match physical-tactical performance.

Variables	**Description**
In Possession	
Push up Pitch	Player moves up the pitch to play offside and/or to squeeze to a higher line.
Break into Box	Player enters the opposition's penalty box to receive the ball. (typically receive ball from a cross - ball in front and wide)
Run in Behind /Penetrate	Player attacks space behind, overtakes and/or unbalances the opposition defence. (typically ball is behind)
Over/Underlap	Player runs from behind to in front of the player on the ball or receiving the ball.
Run with Ball	Player moves with the ball either dribbling with small touches or running at speed with fewer ball touches.
Move to Receive/ Exploit Space	Player moves to receive a pass from a teammate or to create/exploit space. (typically come short or move wide to receive ball)
Support Play	Player supports from behind/level by trying to engage in offensive/transition play. (typically during fast transitions)
Out of Possession	
Interception	Player cuts out pass.
Recovery Run	Player runs back towards their own goal to be goal side when out of position.
Covering	Player moves to cover space or an opposition player while remaining goal side.
Close Down/Press	Player runs directly towards opposition player on or receiving the ball, or towards space or players not on/receiving the ball.
Unclassifiable	
Other	All other variables that could not be categorised by the above.

3.3.3 Novel High-Intensity Filter

High-intensity efforts associated with tactical actions were isolated using a novel filter developed for this study (Figure 3.2) as the data provider could not disclose the proprietary developed filter used. To validate the novel filter, the present study compared the data derived from an established company (TRACAB, ChyronHego, New York, USA) with the new filter. Both filters operated on the premise that high-intensity running was defined at a speed threshold of >19.8 km·h^{-1} (Carling, Le Gall and Dupont, 2012), but the dwell time for the established filter was not disclosed while the new filter used a minimal dwell time of 1 s.

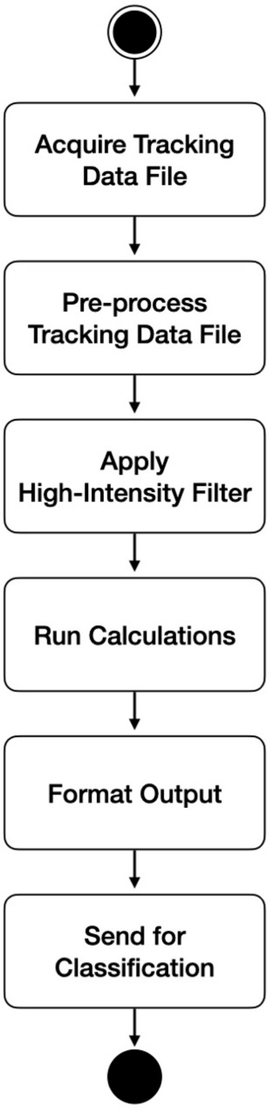


Figure 3.2. The data processing and filter phase prior to integrated classifications.

3.3.4 Statistical Analyses

Data are presented as the mean ± standard deviation (SD). All statistical analyses were conducted using IBM SPSS Statistics for Mac OS X, version 26 (IBM Corp., Armonk, N.Y., USA). Data normality was visually assessed by using QQ plots. The percentage of correct responses were calculated for each variable by dividing the correct responses by the total number of reference clips, then multiply this by 100 to verify the validity of the systematic integrated approach with 80% acting as the minimum acceptable threshold (Thomas, Nelson and Silverman, 2015; Pedreira et al., 2016). Differences between UEFA coaches and performance analysts were determined using independent t-tests. Effect sizes (Cohen's d) for the meaningfulness of the difference were determined as follows: trivial (≤ 0.2), small (> 0.2–0.6), moderate (> 0.6–1.2), large (> 1.2–2.0), very large (> 2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006). The Pearson correlation coefficient was calculated to determine the relationship between the data derived from the novel filter and those from an established data provider, in addition to the percentage of correct answers and years of experience. According to Hopkins et al. (2009), the magnitudes of the correlation coefficients were regarded as trivial ($r \leq 0.1$), small ($r > 0.1–0.3$), moderate ($r > 0.3–0.5$), large ($r > 0.5–0.7$), very large ($r > 0.7–0.9$) and nearly perfect ($r > 0.9$). To measure inter-and intra-observer reliability, the kappa statistic was used. Kappa magnitudes were assessed as follows: none (κ=0–0.20), minimal (κ=0.21–0.39), weak (κ=0.40–0.59), moderate (κ=0.60–0.79), strong (κ=0.80–0.90) and almost perfect (κ>0.90; McHugh, 2012). Statistical significance was set at $P<0.05$.

3.4 Results

3.4.1 Validation of The Integrated Approach

The total mean percentage of correct responses by all participants was 92±4% (range: 80 to 98%). The mean percentage of correct responses for out-of-possession variables was 92±5% (range: 80 to 100%) whilst that for in-possession variables was 92±6% (range: 74 to 100%). The most identifiable tactical action for out-of-possession variables was 'Recovery Run' with 99±5% for UEFA coaches and 97±7% for performance analysts whilst it was 'Run with Ball' for in-possession variables with 97±7% and 99±5%, respectively. In contrast, the least identifiable tactical action for out-of-possession variables was ‘Covering’ with 81±14% for UEFA coaches and 84±11% for performance analysts with ‘Move to Receive/Exploit Space’ for in-possession variables (80±17% and 87±15%, respectively). No differences were found between correct responses for UEFA coaches and performance analysts, except for ‘Push up Pitch’ (ES: 0.4, *P*=0.031). The comparisons between correct responses for UEFA coaches and those for performance analysts for out-of-possession and in-possession variables are shown in Figure 3.3 and 3.4, respectively.

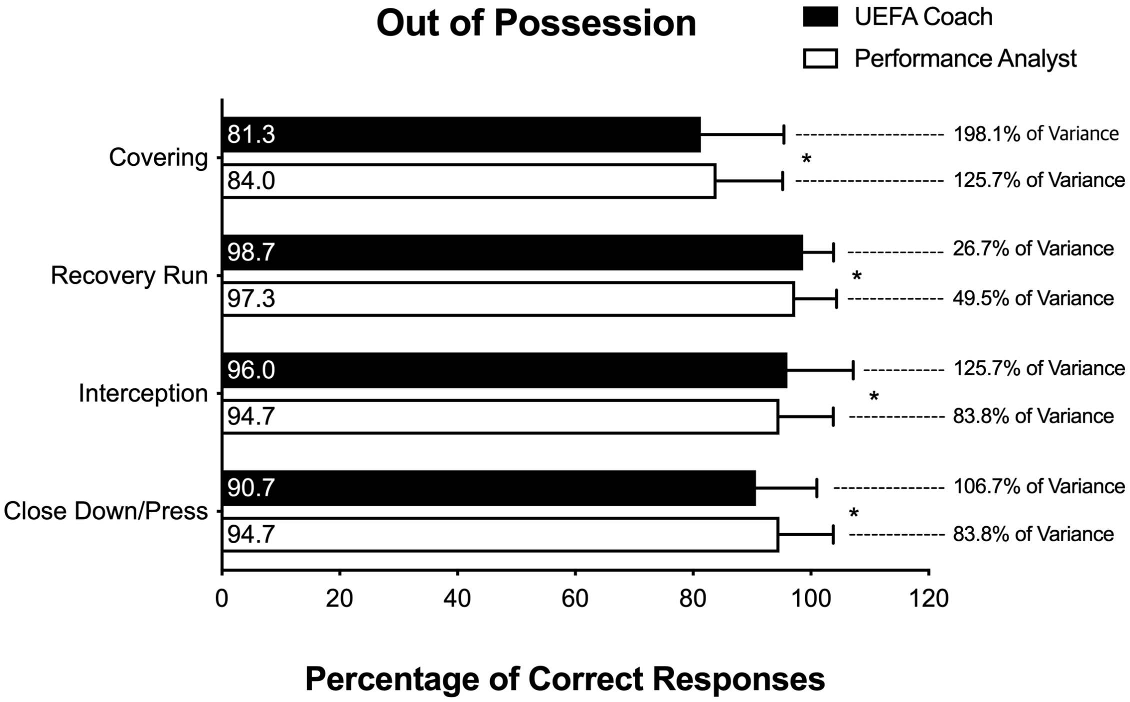


Figure 3.3. Total mean (+SD) values for the percentage of correct responses for out-of-possession variables. Asterisk (*) denotes small effect size.

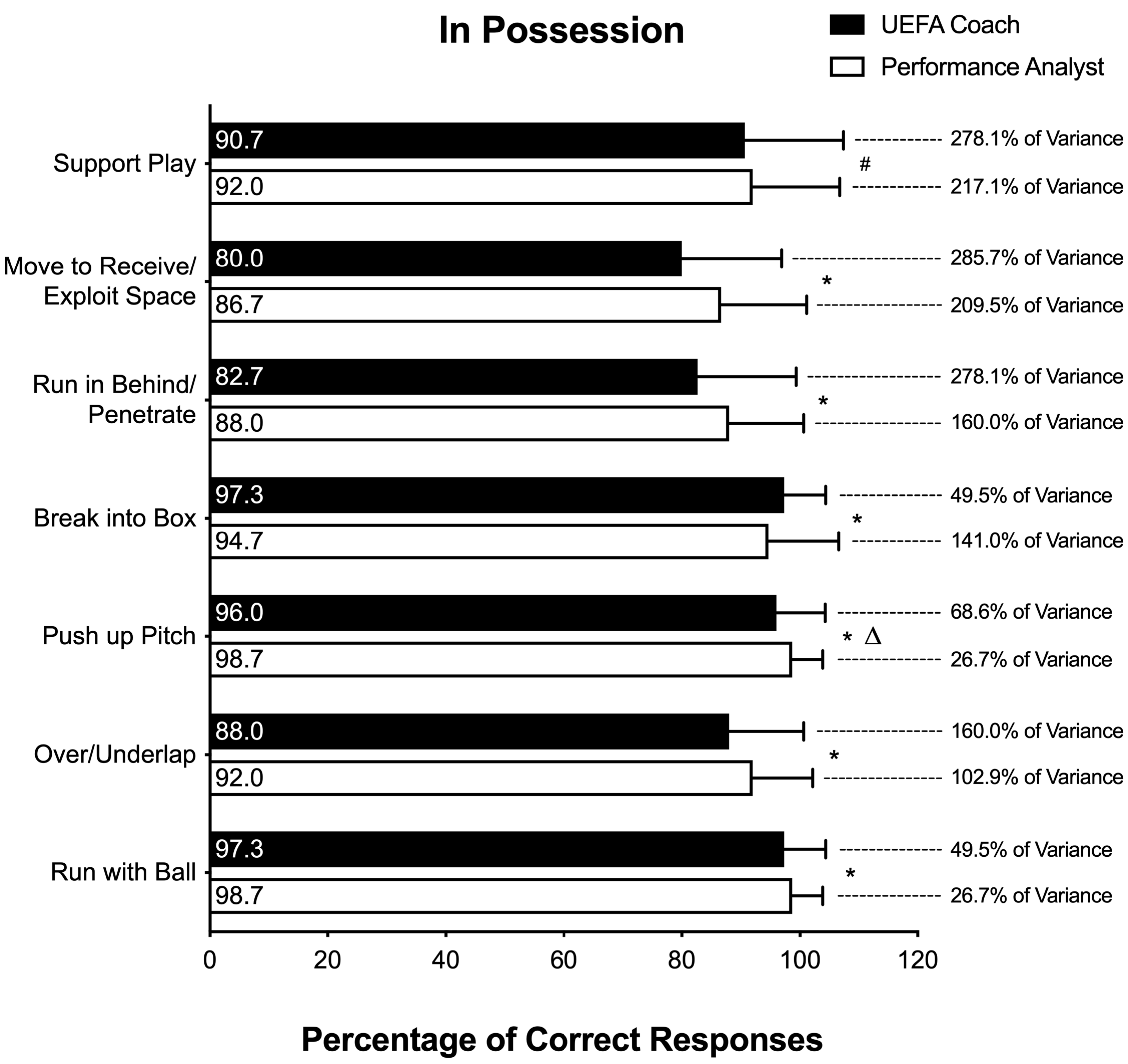


Figure 3.4. Total mean (+SD) values for the percentage of correct responses for in-possession variables. Asterisk (*) denotes small effect size; Hash denotes trivial effect size. $^{\Delta}$Difference between UEFA coaches and performance analysts (P<0.05).

3.4.2 Reliability of The Integrated Approach

There were 241 physical-tactical actions during the first half of a randomly selected match for inter-observer reliability. Out of 241 actions, 202 actions were agreed between the two independent observers (Table 3.2). The agreement was 84% and the kappa statistic of 0.81 reflects a strong level of inter-observer consistency. Regarding intra-observer reliability, the same physical-tactical actions (n=241) were used. Between the first and second trial by the researcher, 228 actions were agreed (Table 3.3), corresponding to 95% of agreement with the kappa statistic value of 0.94, which is interpreted as an almost perfect intra-observer reliability.

Table 3.2. Inter-reliability depicted as the number of tactical actions recorded by the two observers.

Observer 2 / **Observer 1**	Close Down/Press	Interception	Recovery Run	Covering	Run with Ball	Over/Underlap	Push up Pitch	Break into Box	Run in Behind/Penetrate	Move to Receive/ Exploit Space	Support Play	Others	**Grand Total**
Close Down/Press	50		1				2					2	**55**
Interception	1	1											**2**
Recovery Run	4		38	7									**49**
Covering	8		4	40									**52**
Run with Ball					8								**8**
Over/Underlap						0							**0**
Push up Pitch							4						**4**
Break into Box								2					**2**
Run in Behind/Penetrate									16				**16**
Move to Receive/Exploit Space				1					2	24			**27**
Support Play									3	1	16		**20**
Others					1					1	1	3	**6**
Grand Total	**63**	**1**	**43**	**48**	**9**	**0**	**6**	**2**	**21**	**26**	**17**	**5**	**241**

Table 3.3. Intra-reliability depicted as the number of tactical actions recorded by the one observer.

Second trial **First trial**	Close Down/Press	Interception	Recovery Run	Covering	Run with Ball	Over/Underlap	Push up Pitch	Break into Box	Run in Behind/Penetrate	Move to Receive/ Exploit Space	Support Play	Others	**Grand Total**
Close Down/Press	55												**55**
Interception		2											**2**
Recovery Run	2		46									1	**49**
Covering	1		1	50									**52**
Run with Ball					8								**8**
Over/Underlap						0							**0**
Push up Pitch							4						**4**
Break into Box								2					**2**
Run in Behind/Penetrate	1								14	1			**16**
Move to Receive/Exploit Space	1								1	23		2	**27**
Support Play										1	19		**20**
Others											1	5	**6**
Grand Total	**60**	**2**	**47**	**50**	**8**	**0**	**4**	**2**	**15**	**25**	**20**	**8**	**241**

3.4.3 Relationship Trends

A trivial relationship existed between the participants' experience and the mean percentage of their correct responses for all variables (*r*=-0.08, *P*=0.681). However, a nearly perfect correlation was found (*r*=0.99, *P*<0.001, Figure 3.5) between the high-intensity distance covered by players using the novel filter and the distance covered from the filter of the commercial data provider.

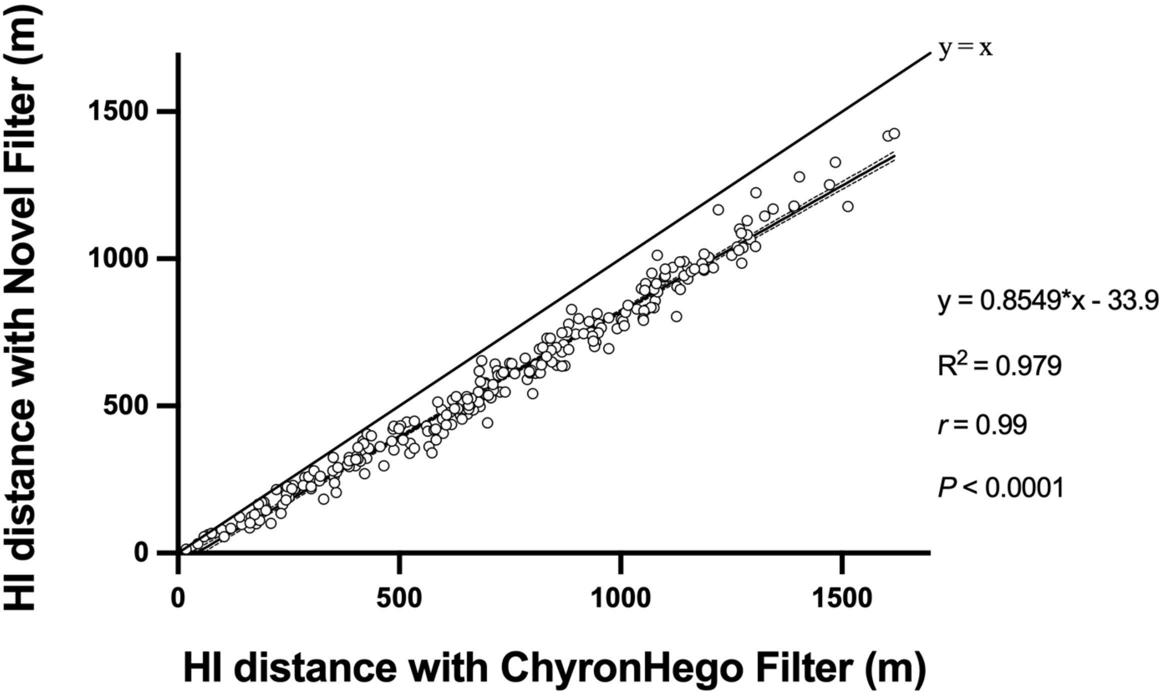


Figure 3.5. Relationship between data derived from the new filter and commercial provider's filter. Line indicates linear trend and dashed lines the 95% confidence intervals. The y=x line denotes the line of identity. HI: high intensity.

3.5 Discussion

This study aimed to (1) develop a systematic integrated approach to quantifying match physical-tactical performance (2) to verify its validity and reliability, (3) examine the validity of a novel filter used for the present study to capture high-intensity running. The new integrated approach was found to have a high degree of validity as evidenced by the strong agreement between the responses of both the UEFA qualified coaches and performance analysts versus the gold standard responses (~90%). No differences regarding the physical-tactical actions were observed when comparing the percentage of correct responses for UEFA coaches to that from performance analysts, except 'Push up Pitch' (*P*=0.031, ES: 0.4). Moreover, the inter- and intra-observer reliability of this approach was found to be strong (κ=0.81) to almost perfect (κ=0.94), respectively. Additional analyses also indicate that the novel high-intensity filter used for the integrated approach correlates to a nearly perfect magnitude with values attained from the filter of the commercial data provider (*r*=0.99, *P*<0.001).

The physical demands of football have been widely examined in the literature, but they have been quantified in isolation without taking tactical and technical performances into account (Bangsbo, Nørregaard and Thorsoe, 1991; Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Modric et al., 2019). A limited number of studies have contextualised the physical match performances of elite players. The integrated approach was initially proposed by Ade, Fitzpatrick and Bradley (2016) and a modified version of this method was adapted by Bradley and Ade (2018). However, there are some limitations associated with some of the physical-tactical actions used such as 'Run the Channel' and 'Drive Inside/Through the Middle'. These two variables provide limited information on the actual tactical purpose of the actions and simply indicate their direction and location. Players could run down the channel 'exploiting/creating space to receive the ball' or 'supporting' teammates when the ball is advanced forward etc. Thus, through a deep discussion with the working group of experts, new variables such as 'Support Play' and 'Move to Receive/Exploit Space' were created to provide more information on the tactical purpose of the actions.

The integrated approach represented in this study has been adapted from previous research (Ade, Fitzpatrick and Bradley, 2016). However, this previous study did not investigate the validation but did examine, to some extent, the reliability of the initial model. A robust verification of validity and reliability for any novel methodological approach needs to be verified before collecting and analysing data (O'Donoghue, 2009). Validity typically refers to the extent to which a method adequately measures what it claims to measure, and it can be achieved by independent verification from experts (Thomas, Nelson and Silverman, 2015). Thus, the present study initially examined the validity of the variables within the integrated approach by evaluating UEFA coaches' and performance analysts' opinions versus the gold standard responses obtained from an expert group. The validity of the integrated approach was confirmed with ~90% agreement, indicating that the categories within the methodology have appropriate definitions and demarcations between tactical actions. Thus, this innovative approach could potentially be used for valid data collection and analysis. Nonetheless, as this innovative approach still needs intense manual work, an automated solution should be the next iteration for researchers (e.g., machine learning).

The present study followed a systematic validation process adapted from Brewer and Jones (2002). The validation process in the present study demonstrates some similarities with previous research that developed a novel instrument to measure tactical/technical performance (Sarmento et al., 2010; Larkin, O'Connor and Williams, 2016; Fernandes et al., 2019; Gong et al., 2019). For instance, validity was established through communication with experts within the field of study (Sarmento et al., 2010; Fernandes et al., 2019). Nonetheless, regarding statistical analysis for validation of performance indicators, different methods were used. Whilst Gong et al. (2019) and Fernandes et al. (2019) used the Aiken's V to assess the validity for performance indicators, Sarmento et al. (2010) and Larkin, O'Connor and Williams (2016) performed no statistical analysis. As no statistical evidence is required for content validity (Thomas, Nelson and Silverman, 2015), this could potentially explain the disparity in methods of analysis. Since an agreement of 80-85% is the minimum threshold for validation verification (Thomas, Nelson and Silverman, 2015; Pedreira et al., 2016), again the physical-tactical variables within the integrated approach are valid (~90% agreement). However, additional research is needed to independently verify the findings of this present study before the area can fully accept this new paradigm. As the detailed definitions are now contained within this method (Table 3.1), research teams should try to adopt this approach to test independently its merits and limitations.

Both UEFA coaches and performance analysts appeared to be able to answer correctly regarding the reference clips for all physical-tactical variables. Additionally, there was no correlation between UEFA coaches/performance analysts’ experience versus their total mean percentage of correct responses. Thus, as this method was intuitive to all participants, understanding this innovative approach does not necessarily require extensive levels of experience within the football industry and advanced football intelligence. The terminology used for the integrated approach has been adapted from coaching language; therefore, UEFA coaches and performance analysts seem to intuitively understand the physical-tactical categories within the approach.

However, some variables performed more favourably than others when calculating the percentage of correct responses. For ‘Covering’, this was consistently lower compared to the other out-of-possession variables. The definition of ‘Covering’ referred to covering space or a player whilst being goal side of the ball, while ‘Recovery Running’ referred to running back toward your own goal when not goal side of the ball (Ade, Fitzpatrick and Bradley, 2016; Bradley and Ade, 2018). Yet, occasionally players tend to cover space or an opponent player when the ball is just past them but they are in a good tactical position. Due to the numerous permutations of these actions and the very brief introductory period during the validation study, these can create some discrepancies. Since there was this type of action in one of the clips for ‘Covering’, this may explain why it had a marginally lower percentage of correct responses for both UEFA coaches and performance analysts. In possession, ‘Run in Behind/Penetrate’ and ‘Move to Receive/Exploit Space’ showed relatively lower percentages of correct responses. This could be due to the increased degrees of diversity in the in-possession variables or due to more unique tactical actions that players attempt when in possession of the ball to trick the opposition team. However, the key demarcation between these actions relates to a player attempting to overtake opponent players in behind (Clemente et al., 2014). Consequently, more refined differentiators between variables, particularly these actions, are warranted. Whilst some variables had relatively lower percentages of correct responses, all variables are >80%, which implies that all variables are acceptable for validity purposes (Thomas, Nelson and Silverman, 2015).

It is important to assess not only validity but also reliability of performance indicators since only valid and reliable variables are reliable in performance analysis (O'Donoghue, 2007). Thus, the present study examined inter- and intra-observer reliability. The data demonstrate strong inter- (κ=0.81) and almost perfect intra-observer reliability (κ=0.94). This finding was in accordance with previous studies that developed a novel tactical match analysis system (Fernandes et al., 2019; Gong et al., 2019). Additionally, similar results were found in the study by Ade, Fitzpatrick and Bradley (2016), reporting excellent inter- (κ > 0.8) and intra-observer reliability (κ > 0.9) of the initial integrated approach. It is worth noting that the present study is the first comprehensive study to examine the validity and reliability of a novel approach for amalgamating physical metric with tactical purposes. The application of this innovative method could generate new insights in the area of football performance. For instance, it could be determined 'HOW' teams/players change their physical-tactical behaviour during the congested fixture period or just after the most intense period during match-play. Nonetheless, it is recommended that only one analyst code games when analysing them manually using this approach as the number of observers and the quality of the observer could influence reliability (Duthie, Pyne and Hooper, 2003).

Since the present study used a novel high-intensity filter to calculate distances at high-intensity (>19.8 km·h^{-1}), validity of this filter should be determined. Some optical tracking systems such as ChyronHego have been validated using gold standard technology such as Vicon (Linke, Link and Lames, 2020). Therefore, the data derived from the new filter used in the present study were compared with that from the manufacturer. A nearly perfect correlation (r=0.99) was found; however, the distance covered at high-intensity running (>19.8 km·h^{-1}) using the novel filter was systematically lower than that obtained from the commercial data provider. This may be explained from two viewpoints. Firstly, a different algorithm was used for the new filter as companies do not typically disclose their algorithm for their established filter. Another perspective is that the dwell time for the manufacturer's filter is different from that of the new filter used for this study. The findings from Varley et al. (2017) support this notion as different filtering methods and dwell times can significantly affect the measurement of physical movements such as high-speed running and sprinting. Whilst some studies have assessed the accuracy of the most widely used tracking technologies in elite team sports by comparing them with VICON as the gold standard (Linke, Link and Lames, 2018; Linke, Link and Lames, 2020), different filters within optical tracking systems have yet to be compared with the gold standard. Thus, further research is warranted to compare different filtering methods within optical tracking systems to the gold standard to examine their accuracy.

3.6 Limitations

There are some limitations that should be addressed. First, the novel integrated approach does not include other intense actions such as accelerations/decelerations that are more frequently performed during match-play and do not reach high-intensity speed thresholds (Varley and Aughey, 2013). Therefore, these should be added into the method in future to understand more complete match physical demands with context. Additionally, the present study used only a single primary action for the validity test because the majority of high-intensity actions performed during match-play are singular. Football is complex and requires players to execute not only a singular action but a series of actions whilst producing high-intensity running (e.g., a player produces a ‘covering’ action for 3 s and then ‘presses’ for 1 s; Bradley and Ade, 2018). Although the number of hybrid actions performed during matches is very small, hybrid actions would add more transparency and insight to coaches and applied practitioners.

3.7 Practical Recommendations

- Practitioners may apply the integrated approach to unveil unique match physical-tactical profiles of players since it was found to be valid and reliable regarding the quantification of physical-tactical performances during match-play.
- The research team within a football club may adopt this approach with testing its merits and limitations independently as further research is required to verify the findings of this present study before the area can fully accept this new paradigm.

3.8 Conclusion

The present study verified the validity and reliability of the integrated approach. Although more refined differentiations for some categories are required, the findings demonstrate that this innovative approach is valid and reliable. The new data derived from the integrated approach could aid practitioners' and coaches' understanding of the physical demands in relation to tactical aspects of the game.

3.9 Linkage to the Next Study

Hundreds of studies have quantified physical match performance in isolation by simply reporting the distance covered, frequency or the time spent along movements ranging from walking to sprinting. This only provides 'WHAT' distance a player has covered during matches without any context. However, it is now feasible to unveil unique high-intensity profiles of players with tactical actions by using this newly developed integrated approach, enabling to produce 'WHY' and 'HOW' players make certain high-intensity actions in relation to tactical purposes across different positions. It means that more advanced comparisons can be made in terms of positions/tactical roles. Thus, the next study will investigate physical-tactical differences between various tactical roles of players.

CHAPTER FOUR

CONTEXTUALISED HIGH-INTENSITY RUNNING PROFILES OF ELITE FOOTBALL PLAYERS WITH REFERENCE TO GENERAL AND SPECIALISED TACTICAL ROLES

CONTEXTUALISED HIGH-INTENSITY RUNNING PROFILES OF ELITE FOOTBALL PLAYERS WITH REFERENCE TO GENERAL AND SPECIALISED TACTICAL ROLES

4.1 Abstract

Purpose: The present study aimed to contextualise physical metrics with tactical actions according to general and specialised tactical roles. **Method:** A total of 244 English Premier League players were analysed by coding physical-tactical actions of players via the fusion of tracking data and video. Data were analysed across 5 general (Central Defensive Players = CDP, Wide Defensive Players = WDP, Central Midfield Players = CMP, Wide Offensive Players = WOP, Central Offensive Players = COP) and 11 specialised positions (Centre Backs = CB, Full-Backs = FB, Wing-Backs = WB, Box-to-Box Midfielders = B2BM, Central Defensive Midfielders = CDM, Central Attacking Midfielders = CAM, Wide Midfielders = WM, Wide Forwards = WF, Centre Forwards = CF). **Result:** COP covered more distance at high-intensity (>19.8 km·h^{-1}) when performing actions such as 'Break into Box', Run in Behind/Penetrate' and 'Close Down/Press' than other positions (ES: 0.6-5.2, *P*<0.01). WOP covered more high-intensity 'Run with Ball' distance (ES: 0.7-1.7, *P*<0.01) whereas WDP performed more 'Over/Underlap' distance than other positions (ES: 0.9-1.4, *P*<0.01). CDP and WDP covered more high-intensity 'Covering' distance than other positions (ES: 0.4-2.4, *P*<0.01). Nonetheless, data demonstrated that implementing specialised positional analysis relative to a generalised approach is more sensitive in measuring physical-tactical performances of players with the latter over or underestimating the match demands of the players compared to the former. **Conclusion:** A contextualised analysis can assist coaches and practitioners when designing position or even player-specific training drills since the data provides unique physical-tactical trends across specialised roles.

4.2 Introduction

As technology plays a more prominent role in modern football (soccer), the reliance on tracking-based technologies has increased significantly (Buchheit and Simpson, 2017). Due to the complex nature of football, researchers have typically adopted a reductionist approach analysing either physical or technical metrics in isolation (Bradley and Ade, 2018). Despite this, a great deal of research has quantified the physical demands of elite players during matches and examined how this is affected by other factors such as positions, formations and opponent standard (Rampinini et al., 2007; Bradley et al., 2009; Bradley et al., 2011). Longitudinal match performance data trends emphasise that the distances covered at high-intensity have increased by ~20-30% with only a 2-4% increase in the total distance covered over the last decade (Barnes et al., 2014; Bradley and Scott, 2020). Consequently, greater attention has been paid to high-intensity actions as it helps practitioners to prepare players for the physical demands of modern match-play through benchmarking contemporary match-play requirements whilst minimising injury risks (Bush et al., 2015b; Beato, Drust and Iacono, 2021).

High-intensity running profiles of various playing positions have been well documented (Bradley et al., 2009; Di Salvo et al., 2009; Di Mascio and Bradley, 2013) and used by coaches and practitioners to target modern football requirements that can be tailored according to different roles (Nosek et al., 2021). Nevertheless, the vast majority of studies in the scientific literature defined positional roles generically such as defenders, midfielders and attackers (Bloomfield, Polman and O'Donoghue, 2007; Sausaman et al., 2019) or in terms of the general positions such as centre backs, full-backs, central midfielders, wide midfielders and forwards (Bradley et al., 2009; Di Salvo et al., 2009). This generalised positional analysis limits our understanding of the true physical demands of players with more specialised tactical roles (e.g., central defensive or attacking midfielders) during a match (Dellal et al., 2011). Additionally, based on previous findings (Di Salvo et al., 2009; Dellal et al., 2011; Scott, Haigh and Lovell, 2020), one could assume that using a generalised positional analysis may be less sensitive in detecting the true physical-tactical match demands compared to a specialised positional method. Thus, research that compares general versus specialised positions is warranted to identify whether disparities exist between the two different positional analyses.

Limited research has quantified the physical demands of elite players using a specialised playing position analysis. It has been reported that central attacking midfielders covered ~10-30% more high-intensity distance than central defensive midfielders (Dellal et al., 2010; Scott, Haigh and Lovell, 2020). However, the methods of differentiating central midfield players into specialised roles in these studies were not disclosed, thus confounding study replication. Konefał et al. (2019b) attempted to quantify performance profiles of specialised tactical roles using heat maps. Yet, this study failed to differentiate full-backs (FB) and wing-backs (WB). Others have determined the tactical roles of wide defensive players (WDP) based on positions that are predefined within a playing system or formation (Baptista et al., 2019; Modric, Versic and Sekulic, 2020). For instance, FB are based on a formation with four players at the back (e.g., 4-3-3 formations) and WB three at the back (e.g., 3-4-3 formations). The definitions of various wide defender subsets are not objectively defined but could relate to FB performing a more defensive role whilst WB could be regarded as a mixture of a FB and a winger due to dual responsibilities (Bush et al., 2015b; Konefał et al., 2015). Hence, differentiating player positions with specialised tactical roles should be accomplished by the observation of each player for the duration of match-play in addition to other analytical modalities (heat maps, average position etc.) in order to detect the true tactical role/playing style of players during match-play.

Although physical metrics provide some insight to practitioners, it is questionable how receptive coaches are to this basic data (Bradley and Ade, 2018). As coaches can sometimes have difficulty communicating with practitioners (Nosek et al., 2021), especially in relation to data that are not contextualised appropriately. This seems to be due to researchers typically asking 'WHAT' distance players covered (Bradley and Ade, 2018). Therefore, analysing 'WHY' players cover that distance is very much warranted since the 'WHY' explains the modulators of the physical efforts. Recently, a systematic methodology that amalgamates physical metrics and their tactical purposes has been developed (Chapter 3). This approach may help coaches and practitioners understand the physical data contextualised to the tactical dynamics, thus allowing more practical application. Combining this approach with detailed specialised tactical roles would provide additional insights of individual physical-tactical demands. Thus, the present study aimed to contextualise physical data with the key tactical purposes of the actions undertaken according to both their general and specialised tactical roles in which comparisons were made between them to determine their sensitivity in measuring physical-tactical performance during match-play.

4.3 Method

4.3.1 Match Analysis and Player Data

Match physical-tactical data were derived from the 2018-19 English Premier League (EPL) season using a systematic integrated approach and a novel filter developed for the purposes of this programme of work. Players' actions were captured by cameras located at roof level during match-play, and their physical-tactical actions were manually coded by using the integrated approach. The validity and reliability of the integrated approach and the new filter used were verified within Chapter 3, from which detailed methodological information can be found. The novel filter isolated high-intensity activities reaching speeds >19.8 $km \cdot h^{-1}$ for a minimal dwell time of 1 s (Carling, Le Gall and Dupont, 2012).

The researcher completed 350 hours of coding to analyse 50 competitive matches. This consisted of the total number of 388 individual outfield players across 1,265 player observations. However, only outfield players who had completed the entire match in the same position were included (244 players across 583 player observations for the analyses of general positions). This consisted of Central Defensive Players (CDP, *n*=179), Wide Defensive Players (WDP, *n*=147), Central Midfield Players (CMP, *n*=167), Wide Offensive Players (WOP, *n*=54) and Central Offensive Players (COP, *n*=36). However, for the analysis of specialised positions, 8 players were excluded since it was ambiguous to sub-categorise them into a specialised tactical role, thus this included 236 players across 529 player observations. This resulted in Centre Backs (CB^2, two at the back, *n*=130; CB^3, three at the back, *n*=49), Full-Backs (FB, *n*=39), Wing-Backs (WB, *n*=70), Box-to-Box Midfielders (B2BM, *n*=94), Central Defensive Midfielders (CDM, *n*=49), Central Attacking Midfielders (CAM, *n*=11), Wide Midfielders (WM, *n*=40), Wide Forwards (WF, *n*=14) and Centre Forwards (CF^1, one centre forward, *n*=14; or CF^2, two centre forwards, *n*=22). All data were analysed for the duration of each half, including stoppage time. Prior to analysis, all original data were anonymised to ensure confidentiality. Research approval was given by the local institutional Ethics Committee.

4.3.2 Match Control and Data Balance

In order to improve the scientific rigor of the research design, matches were randomly selected whilst simultaneously controlling various situational factors. According to Barnes et al. (2014), the number of player observations differs significantly across phases of season, positions, locations (Home/Away), team or opponent standards based on final league ranking. Thus, the number of matches for each factor was initially balanced (Table 4.1). Matches were excluded if goal differential was >3 and a player dismissal happened during a match since these impact match running performances (Carling and Bloomfield, 2010; Bradley and Noakes, 2013).

4.3.3 Demarcation of Player Tactical Roles

A systematic approach was applied to the demarcation between various tactical roles using descriptors of general and specialised roles (Figure 4.1). The method of differentiating specialised tactical roles was adapted from Aalbers and Van Haaren (2019). Once outfield players were assigned to one of the five general tactical roles (Figure 4.2A), they were then specifically sub-categorised according to their specific playing style/formation (Figure 4.2B). As various situational factors have an influence on the style of play that can be modulated by different tactical roles (Schuth et al., 2016; Trewin et al., 2017), context was considered whilst using a player's average position and heat map in an attempt to determine a player's relevant tactical role in the team (Figure 4.1). This was verified by observing video footage of the entire match.

Inter-rater reliability for differentiating specialised tactical roles was assessed by two observers (UEFA qualified coach and the researcher) watching the entire match of players for each specialised tactical role (*n*=55). The agreement was 85% and the kappa statistic of 0.84 reflects a strong level of inter-observer consistency. Intra-observer reliability test undertaken by the researcher showed 100% agreement with the kappa statistic value of 1.00, which is interpreted as a perfect intra-observer reliability (McHugh, 2012).

Table 4.1. The distribution of the sample across various positions and contexts.

Positions	**CDP**				**WDP**				**CMP**				**WOP**				**COP**				**Total**
Month																					
Aug–Nov	56 (31)				50 (34)				61 (36)				16 (30)				6 (17)				189 (32)
Dec–Feb	66 (37)				51 (35)				53 (32)				25 (46)				11 (30)				206 (35)
Mar–May	57 (32)				46 (31)				53 (32)				13 (24)				19 (53)				188 (32)
Location																					
Home	86 (48)				69 (47)				80 (48)				26 (48)				17 (47)				278 (48)
Away	93 (52)				78 (53)				87 (52)				28 (52)				19 (53)				305 (52)
Standard^1																					
A^1	40 (22)				36 (24)				39 (23)				11 (20)				8 (22)				134 (23)
B^1	49 (27)				38 (26)				41 (24)				10 (18)				9 (25)				147 (25)
C^1	46 (26)				40 (27)				47 (28)				20 (37)				12 (33)				165 (28)
D^1	44 (24)				33 (22)				40 (24)				13 (24)				7 (19)				137 (23)
Standard^2	A^1	B^1	C^1	D^1	A^1	B^1	C^1	D^1	A^1	B^1	C^1	D^1	A^1	B^1	C^1	D^1	A^1	B^1	C^1	D^1	
A^2	8(4)	16(9)	12(7)	11(6)	7(5)	12(8)	11(7)	9(6)	6(3)	15(9)	16(9)	9(5)	2(4)	2(4)	4(7)	3(5)	0(0)	4(11)	2(5)	2(5)	151 (26)
B^2	16(9)	6(3)	11(6)	14(8)	15(10)	6(4)	9(6)	8(5)	14(8)	7(4)	7(4)	13(8)	5(9)	2(4)	4(7)	6(11)	1(3)	1(3)	1(3)	3(8)	149 (25)
C^2	9(5)	13(7)	15(8)	7(5)	9(6)	10(7)	13(9)	5(3)	11(6)	10(6)	13(8)	9(5)	2(4)	3(5)	8(15)	1(2)	2(5)	1(3)	6(17)	1(3)	148 (25)
D^2	7(4)	14(8)	8(4)	12(7)	5(3)	10(7)	7(5)	11(7)	8(5)	9(5)	11(6)	9(5)	2(4)	3(5)	4(7)	3(5)	5(14)	3(8)	3(8)	1(3)	135 (23)
Overall	179 (31)				147 (25)				167 (29)				54 (9)				36 (6)				583 (100)

Abbreviations: CDP, Central Defensive Players; WDP, Wide Defensive Players; CMP, Central Midfield Players; WOP; Wide Offensive Players; COP; Central Offensive Players. Phases of Season: Start of season (Aug–Nov), Middle of season (Dec–Feb) and End of season (Mar–May). Standard were classified based on final league ranking, 1st – 5th = A (Top), 6th – 10th = B (Top/Middle), 11th – 15th = C (Middle/Bottom), 16th – 20th = D (Bottom). Superscript 1: the standard of analysed teams (e.g., A^1, B^1, C^1, D^1); Superscript 2: the standard of opposition teams against analysed teams (e.g., A^2, B^2, C^2, D^2). Data in bracket represent the relative proportion of the total sample as a percentage (0.5% rounded down). This table was adapted from Barnes et al. (2014).

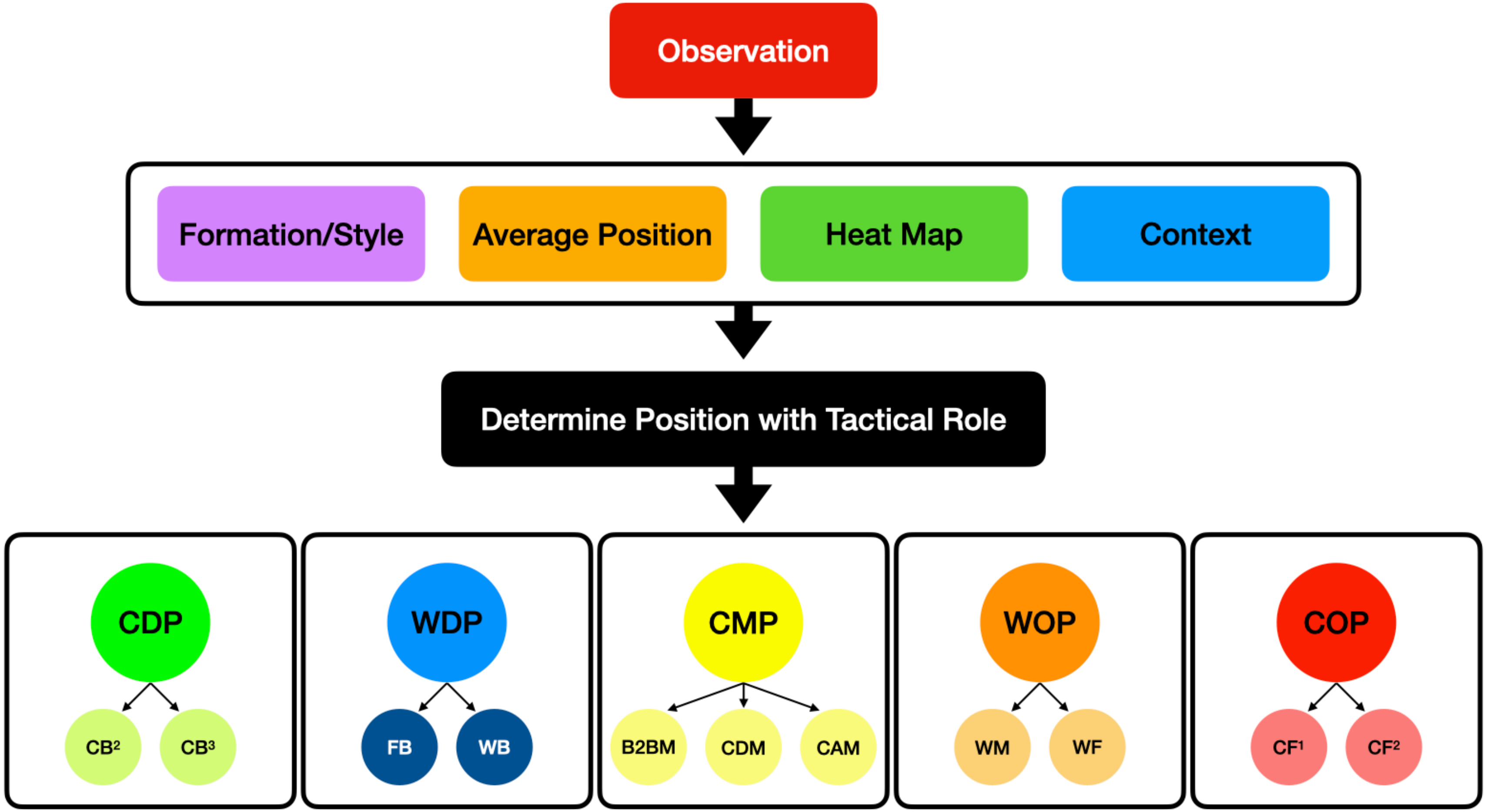


Figure 4.1. The systematic process of determining a player's tactical role in the team. CDP: Central Defensive Players (CB^2: two Centre Backs, CB^3: three Centre Backs), WDP: Wide Defensive Players (FB: Full-Backs, WB: Wing-Backs), CMP: Central Midfield Players (B2BM: Box-to-Box Midfielders, CDM: Central Defensive Midfielders, CAM: Central Attacking Midfielders), WOP: Wide Offensive Players (WM: Wide Midfielders, WF: Wide Forwards), COP: Central Offensive Players (CF^1: one Centre Forward, CF^2: two Centre Forwards).

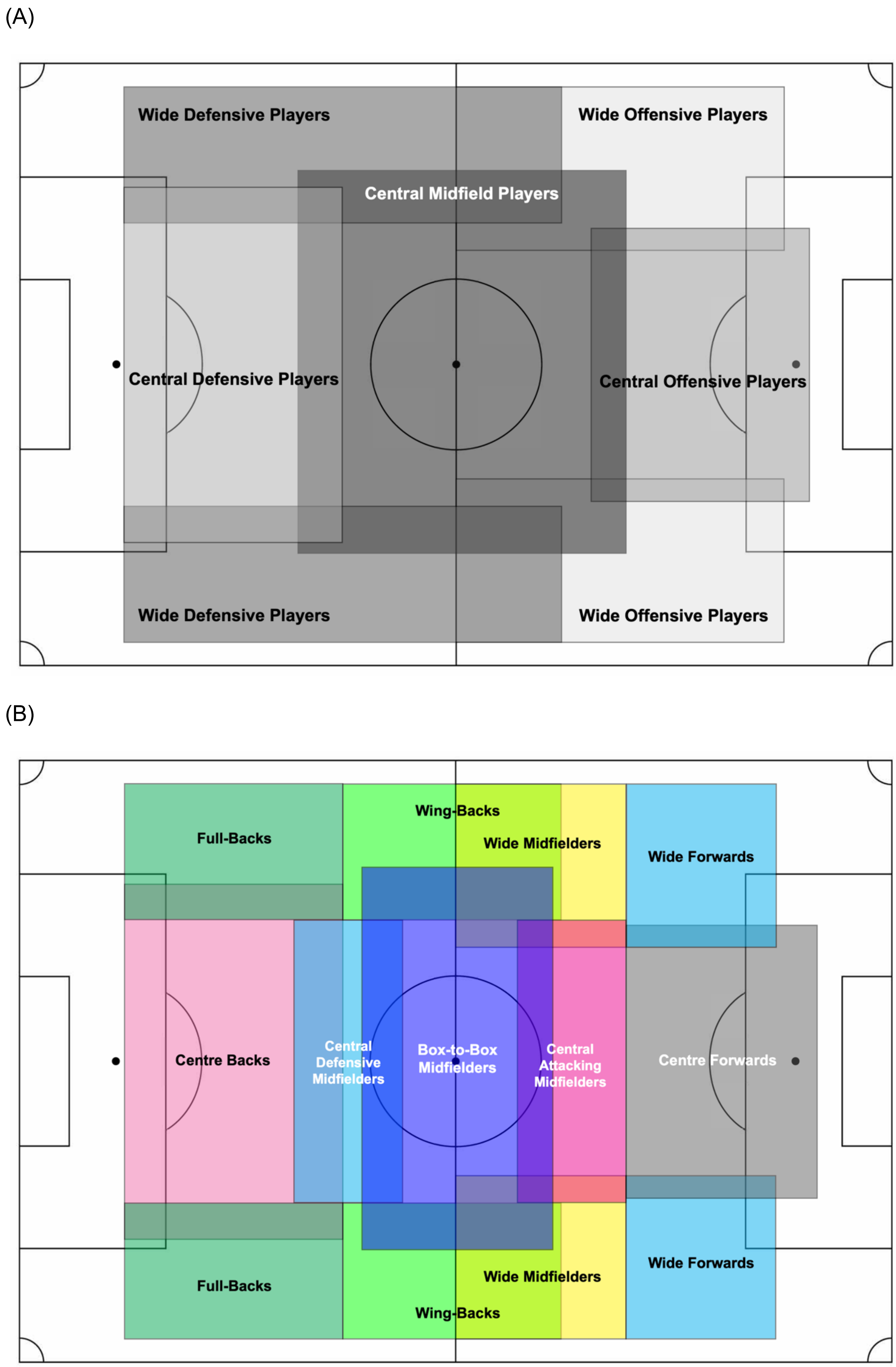


Figure 4.2. General (A) and specialised (B) tactical roles based on match analyses. Adapted from Aalbers and Van Haaren (2019).

4.3.4 The Integrated Approach of Match Performance

Two main coding categories were applied: physical-tactical actions and additional options (movement direction and/or various situational options) to make this approach more systematic (Table 4.2). Isolated high-intensity actions were synchronised with wide-angle video footage of all players throughout matches to categorise the tactical purpose of each action in conjunction with a relevant additional option. All coding occurred using QuickTime Player (Apple Inc, Cupertino, California) to view video and then categorise tactical actions and additional options using Microsoft Excel with drop-down category lists.

The coding process was as follows: high-intensity actions with one tactical action were classified as a single action with dual tactical actions being coded as a hybrid action. High-intensity actions with more than three tactical actions were classified as ‘Other’. If the high-intensity effort was made up of 70-90% of the primary and 10-30% of the secondary action, it was classified as a hybrid action. However, if consisted of 50-60% of the primary and 40-50% of the secondary action, then it was classified as ‘Other’. As hybrid actions are a combination of the primary and the secondary actions (Bradley and Ade, 2018), single action events and the primary tactical movements of the hybrid actions were merged to simplify data outputs.

Using the descriptions (Table 4.2) and a pitch grid (Figure 4.3), additional options of the physical-tactical actions were also analysed. Pitch length was equally divided into three zones to determine defensive, middle and final third. The central zone of the pitch was identical to the width of the penalty box but incorporates half spaces (grey area in Figure 4.3). The penalty box was also divided to form the central and wide areas of the box. The remaining zones were considered wide. This pitch zone description was adapted from Ade, Fitzpatrick and Bradley (2016). Player location was established using the time period (from when the player initiated to reach a speed threshold of >19.8 $km \cdot h^{-1}$ to when it dropped under that threshold). The intra-rater reliability for the additional options that was performed by the researcher (*n*=241) revealed 88% of agreement with the kappa statistic value of 0.87, which is interpreted as a strong intra-observer reliability (McHugh, 2012).

Table 4.2. Physical-tactical variables and additional options (direction or different situational options).

Variables	**Description**	**Additional Options**
In Possession		
Push up Pitch	Player moves up the pitch to play offside and/or to squeeze to a higher line.	Move forward/diagonal (Central) Run down channel (Wide) Move into channel (Central to Wide) Move inside (Wide to Central)
Break into Box	Player enters the opposition's penalty box.	Towards the central zone in the box (Central) Towards one of the wide zones in the box (Wide) Towards the central zone through a wide zone in the box (Wide to Central) Within the box
Run in Behind /Penetrate	Player attacks space behind, overtakes and/or unbalances the opposition defence.	Drive forward/diagonal (Central) Run down channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)
Over/Underlap	Player runs from behind to in front of the player on the ball or receiving the ball.	Run down channel (Wide) Run into channel (Central to Wide)
Run with Ball	Player moves with the ball either dribbling with small touches or running at speed with fewer ball touches.	Drive forward/diagonal/lateral (Central) Run down/up channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)
Move to Receive/ Exploit Space	Player moves to receive a pass from a teammate and/or to create/exploit space.	Move forward/diagonal (Central) Move backward/diagonal/lateral (Central) Run down/up channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)
Support Play	Player supports from behind/level by trying to engage in offensive/transition play.	Drive forward/diagonal (Central) Run down channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)

Table 4.2. (continued)

Variables	Description	Additional Options
Out of Possession		
Interception	Player cuts out the ball during the transition of a pass.	Intercept the ball in offensive third Intercept the ball in offensive-mid third Intercept the ball in defensive-mid third Intercept the ball in defensive third
Recovery Run	Player runs back toward their own goal to be goal side of the ball when out of position.	Run back towards own goal (ball behind) Run back towards own goal from attacking/set play (ball still in front) Ball passed over top/downside (opposition closer to the ball)
Covering	Player moves to cover space or an opposition player while remaining goal side of the ball.	Space/a player Long Ball/Pass (>25m; not beaten by opposition)
Close Down /Press	Player runs directly towards opposition player on or receiving the ball, or towards space or players that are not a viable passing option.	Towards the player on the ball (after ball touch) Towards the player receiving the ball (before ball touch) Space/a player
Unclassifiable		
Other	All other variables that could not be categorised by the above.	Each additional option also has ‘Other’.

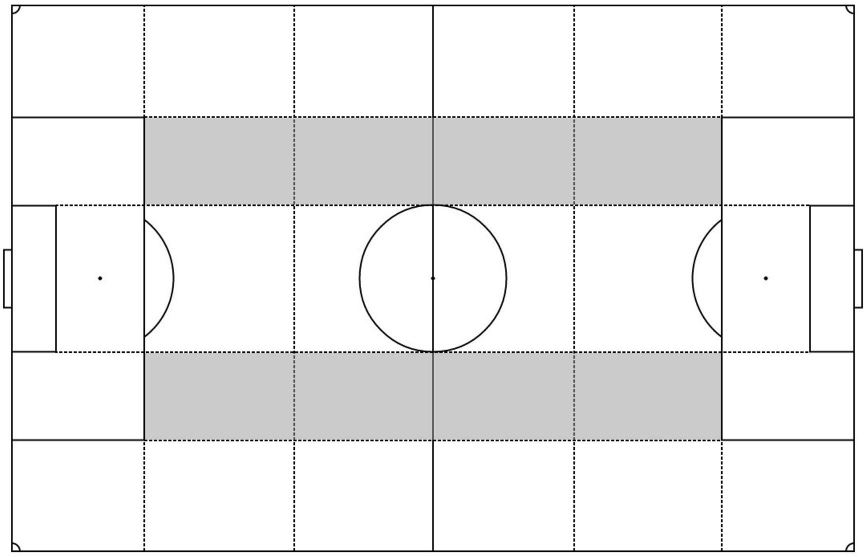


Figure 4.3. The pitch grid used for additional options for a player producing a high-intensity effort (grey areas indicate half spaces). Adapted from Ade, Fitzpatrick and Bradley (2016).

4.3.5 Match-to-Match Variability

Match-to-Match variability was calculated to appropriately detect fluctuations across matches (Gregson et al., 2010; Bush et al., 2015a; Carling et al., 2016). A total of 146 outfield players across 478 individual match observations were included with a median of three games per player (range: 2-7) for general tactical roles (CDP = 163 observations, WDP = 120 observations, CMP = 132 observations, WOP = 40 observations and COP = 23 observations). In contrast, a total of 131 outfield players across 373 individual match observations were involved with a median of two games per player (range: 2-6) for specialised tactical roles (CB^2 = 111 observations, CB^3 = 38 observations, FB = 26 observations, WB = 47 observations, B2BM = 60 observations, CDM = 33 observations, CAM = 4 observations, WM = 27 observations, WF = 9 observations, CF^1 = 6 observations and CF^2 = 12 observations).

4.3.6 Statistical Analyses

Data are presented as the mean ± standard deviation. All statistical analyses were conducted using IBM SPSS Statistics for Mac OS X, version 26 (IBM Corp., Armonk, N.Y., USA). Data normality was verified by Shapiro-Wilk and Kolmogorov-Smirnov tests due to the different number of samples. One-way analyses of variance were used to compare each position with Bonferroni post hoc test used to determine localised differences. Statistical significance was set at $P<0.05$. Effect sizes (Cohen's d) for the meaningfulness of the difference were determined as follows: trivial (≤ 0.2), small (> 0.2–0.6), moderate (> 0.6–1.2), large (> 1.2–2.0), very large (> 2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006). The coefficient of variation (CV) was determined by dividing the standard deviation by the mean and multiply by 100 for the analysis of the match-to-match variability of players (Hopkins, 2000; Carling et al., 2016).

4.4 Results

4.4.1 General Tactical Roles

In possession, COP covered 62-1,434% and 88-32,767% more high-intensity distance for 'Break into Box' and 'Run in Behind/Penetrate' than other positions (ES: 0.6-2.8 and ES: 1.1-5.2, respectively, $P<0.01$) whilst WOP covered 71-323% more distance for 'Run with Ball' than other positions (ES: 0.7-1.7, $P<0.01$). Wide players (WDP and WOP) covered 35-8,254% and 38-748% greater high-intensity 'Support Play' and 'Move to Receive/Exploit Space' distance than CDP and CMP (ES: 0.3-2.9, $P<0.05$), respectively with WDP covering 548-5,340% more 'Over/Underlap' distance compared to other positions (ES: 0.9-1.4, $P<0.01$).

Out of possession, COP ran 89-2,307% greater high-intensity 'Close Down/Press' distances than other positions (ES: 1.1-4.2, $P<0.01$) whilst defensive players (CDP and WDP) performed 25-532% more 'Covering' distance than other positions (ES: 0.4-2.4, $P<0.01$). WDP and CMP performed 34-670% more high-intensity 'Recovery Run' distances than other positions (ES: 0.5-1.8, $P<0.05$). Figure 4.4 depicts contextualised high-intensity distances for general tactical roles. Table 4.3 illustrates detailed information (p-values and effect sizes) on the differences in physical-tactical actions between 'generalised' tactical roles.

4.4.2 Specialised Tactical Roles

In possession, WB, B2BM, CAM and WM covered 535-51,567% greater high-intensity distance for ‘Support Play’ than CB^2, CB^3 and CDM (ES: 1.0-5.0, $P<0.01$) whilst WB, CAM, WM and WF covered 210-828% more for ‘Move to Receive/Exploit Space’ than CB^2, CB^3, FB and CDM (ES: 1.1-2.9, $P<0.01$). WB performed 103-16,925% more ‘Over/Underlap’ distance at high-intensity than other positions (ES: 0.6-1.8, $P<0.01$).

Out of possession, CF^1 performed 43-3,621% greater distance at high-intensity for ‘Close Down/Press’ than other positions (ES: 0.7-5.4, $P<0.01$) while defensive players (CB^2, CB^3, FB, WB and CDM) covered 73-796% greater distance for ‘Covering’ than offensive players (CAM, WM, WF, CF^1 and CF^2; ES: 1.0-2.6, $P<0.01$). WB and B2BM covered 48-1,125% more high-intensity distance producing ‘Recovery Run’ actions compared to CB^2, CB^3, FB, CAM, WF, CF^1 and CF^2 (ES: 0.7-1.9, $P<0.01$) whilst no differences were observed when compared to CDM (ES: 0.3-0.5, $P>0.05$). Figure 4.5 illustrates contextualised high-intensity distances for specialised tactical roles. Table 4.4 exhibits detailed information (p-values and effect sizes) on the differences in physical-tactical actions between ‘specialised’ tactical roles.

4.4.3 Comparison between Specialised Tactical Roles and their General Position

FB covered 34% less high-intensity distance (618±178 m, ES: 0.9, $P<0.01$) whilst WB covered 15% more distance (981±203 m, ES: 0.7, $P<0.01$) when compared to WDP (830±238 m). CDM covered 30% less distance in high-intensity running (532±187 m, ES: 0.7, $P<0.01$) whilst CAM performed 22% more distance than CMP albeit no statistical difference (880±305 m vs 689±251 m, respectively, $P>0.05$). The comparison of total, in-possession and out-of-possession high-intensity distance between general and specialised positions are shown in Table 4.5.

Given the average number of physical-tactical actions performed per match, greater numbers of high-intensity actions for ‘Support Play’, ‘Move to Receive/Exploit Space’ and ‘Run in Behind/Penetrate’ were observed for WB than WDP (ES: 0.3-0.5, $P<0.01$) whilst that was lower for FB (ES: 0.5-0.9, $P<0.01$). Out of possession fewer ‘Recovery Run’ activities were observed for FB than WDP (ES: 0.6, $P<0.01$). Regarding midfield tactical roles, greater numbers of high-intensity activities for ‘Support Play’, ‘Move to Receive/Exploit Space’, ‘Run in Behind/Penetrate' and 'Break into Box' was witnessed for CAM than CMP (ES: 1.0-1.6, *P*<0.01); however, an opposite trend was observed for CDM (ES: 0.7-1.4, *P*<0.01). Out of possession, the average number of high-intensity 'Close Down/Press' actions per game was lower for CDM than CMP (ES: 0.7, *P*<0.01) with CAM demonstrating greater values (ES: 0.8, *P*<0.01). Although there were no differences between CDM and CMP regarding the average number of actions per match for 'Covering' and 'Recovery Run', CAM showed a lower number of such actions than CMP (ES: 1.3-1.6, *P*<0.01). Table 4.6 depicts the average distance and duration per physical-tactical action with the average number of activities per match performed by general and specialised positions.

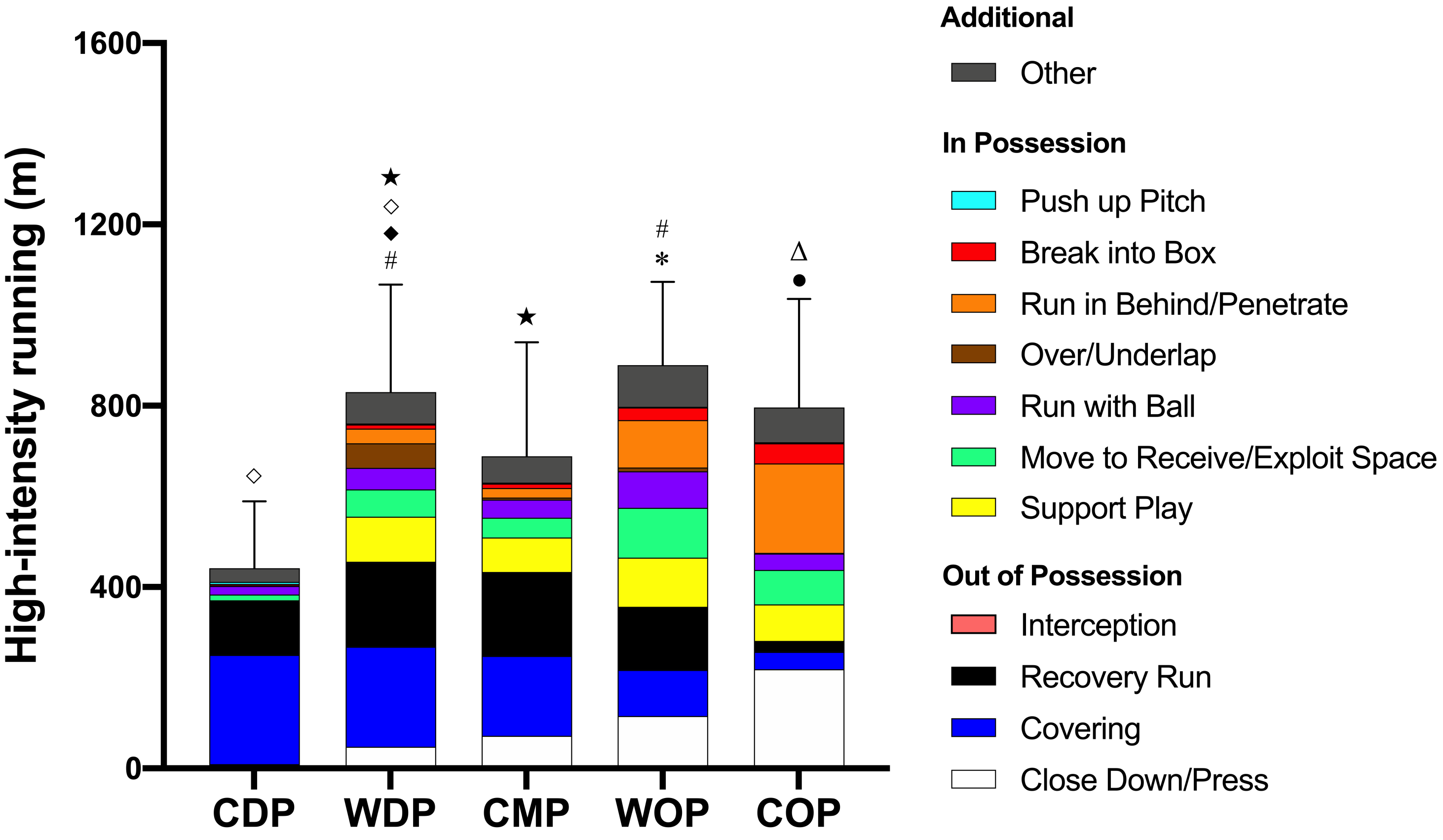


Figure 4.4. Contextualised distances in high-intensity running covered by general positions. •More distance for 'Break into Box' and 'Run in Behind/Penetrate' than others (*P*<0.01). *More distance for 'Run with Ball' than others (*P*<0.01). #More distance for 'Support Play' and 'Move to Receive/Exploit Space' than CDP and CMP (*P*<0.05). ◆More distance for 'Over/Underlap' than others (*P*<0.01). ΔMore distance for Close Down/Press' than others (*P*<0.01). ◇More distance for 'Covering' than CMP, WOP and COP (*P*<0.01). ★More distance for 'Recovery Run' than CDP, WOP and COP (*P*<0.01). 'Interception' and 'Push up Pitch' were very infrequent, thus not visualised on the figure.

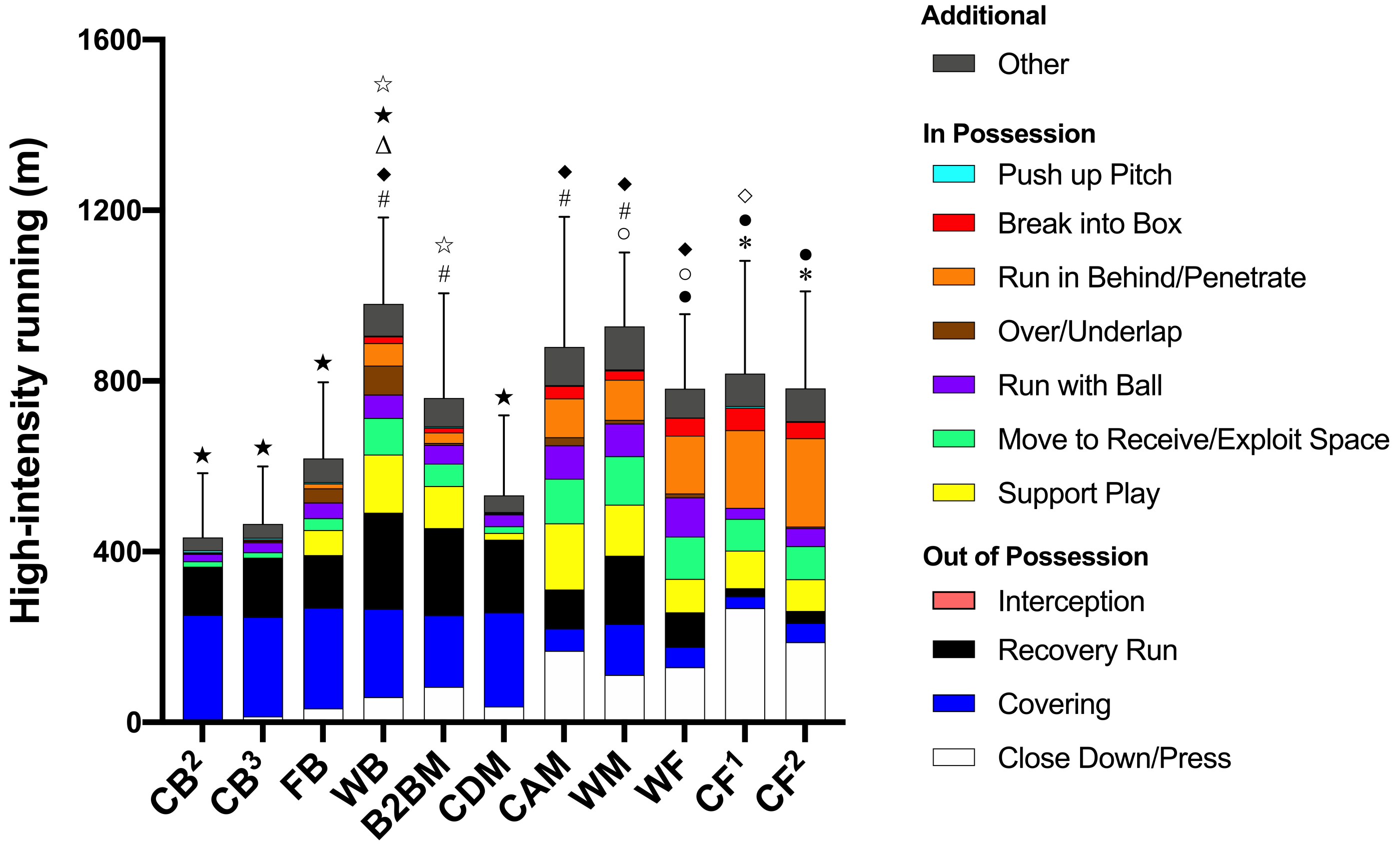


Figure 4.5. Contextualised distances in high-intensity running covered by specialised positions. *More distance for 'Run in Behind/Penetrate' than CB^2, CB^3, FB, WB, B2BM, CDM and WM ($P<0.01$). $^{\bullet}$More distance for 'Break into Box' than CB^2, CB^3, FB, WB, B2BM, CDM and WM ($P<0.05$). $^{\circ}$More distance for 'Run with Ball' than CB^2, CB^3, FB, B2BM, CDM and CF^1 ($P<0.01$). $^{\#}$More distance for 'Support Play' than CB^2, CB^3 and CDM ($P<0.01$). $^{\blacklozenge}$More distance for 'Move to Exploit Space/Receive' than CB^2, CB^3, FB and CDM ($P<0.01$). $^{\Delta}$More distance for 'Over/Underlap' than others ($P<0.01$). $^{\lozenge}$More distance for 'Close Down/Press' than others ($P<0.01$). $^{\bigstar}$More distance for 'Covering' than CAM, WM, WF, CF^1 and CF^2 ($P<0.01$). *More distance for 'Recovery Run' than CB^2, CB^3, FB, CAM, WF, CF^1 and CF^2 ($P<0.01$). 'Interception' and 'Push up Pitch' were very infrequent, thus not visualised on the figure.

Table 4.3. Differences in physical-tactical variables between ‘generalised’ positions along with effect sizes.

Action	**Position**	**Distance (m)**	**Difference and Effect Size**				
			CDP	WDP	CMP	WOP	COP
SP	CDP (*n*=179)	1.3±8.3		*P*<0.001 (2.0)	*P*<0.001 (1.2)	*P*<0.001 (2.9)	*P*<0.001 (2.3)
	WDP (*n*=147)	100.1±73.7			*P*=0.018 (0.3)	*P*=1.000 (0.1)	*P*=1.000 (0.3)
	CMP (*n*=167)	75.6±91.9				*P*=0.023 (0.4)	*P*=1.000 (0.0)
	WOP (*n*=54)	108.6±74.5					*P*=0.539 (0.4)
	COP (*n*=36)	80.0±83.2					
MTR/ES	CDP (*n*=179)	13.0±23.7		*P*<0.001 (1.1)	*P*<0.001 (0.8)	*P*<0.001 (2.5)	*P*<0.001 (1.8)
	WDP (*n*=147)	60.0±55.1			*P*=0.028 (0.3)	*P*<0.001 (0.9)	*P*=0.733 (0.3)
	CMP (*n*=167)	43.6±49.8				*P*<0.001 (1.2)	*P*=0.003 (0.6)
	WOP (*n*=54)	110.3±66.8					*P*=0.011 (0.5)
	COP (*n*=36)	76.2±67.3					
OVL/UDL	CDP (*n*=179)	1.0±7.6		*P*<0.001 (1.4)	*P*=1.000 (0.3)	*P*=1.000 (0.8)	*P*=1.000 (0.1)
	WDP (*n*=147)	54.4±56.5			*P*<0.001 (1.2)	*P*<0.001 (0.9)	*P*<0.001 (1.0)
	CMP (*n*=167)	4.8±14.0				*P*=1.000 (0.3)	*P*=1.000 (0.2)
	WOP (*n*=54)	8.4±13.8					*P*=1.000 (0.6)
	COP (*n*=36)	2.0±6.9					
RWB	CDP (*n*=179)	19.0±29.0		*P*<0.001 (0.8)	*P*<0.001 (0.6)	*P*<0.001 (1.7)	*P*=0.178 (0.6)
	WDP (*n*=147)	46.9±40.5			*P*=1.000 (0.2)	*P*<0.001 (0.7)	*P*=1.000 (0.3)
	CMP (*n*=167)	40.0±42.9				*P*<0.001 (0.9)	*P*=1.000 (0.1)
	WOP (*n*=54)	80.4±54.6					*P*<0.001 (0.9)
	COP (*n*=36)	36.1±37.1					
RIB/PEN	CDP (*n*=179)	0.6±3.3		*P*<0.001 (1.2)	*P*<0.001 (0.8)	*P*<0.001 (2.6)	*P*<0.001 (5.2)
	WDP (*n*=147)	32.6±39.1			*P*=0.157 (0.3)	*P*<0.001 (1.3)	*P*<0.001 (3.1)
	CMP (*n*=167)	20.6±35.9				*P*<0.001 (1.6)	*P*<0.001 (3.5)
	WOP (*n*=54)	104.7±83.6					*P*<0.001 (1.1)
	COP (*n*=36)	197.2±92.8					
BIB	CDP (*n*=179)	2.9±7.2		*P*=0.023 (0.5)	*P*=0.004 (0.5)	*P*<0.001 (1.7)	*P*<0.001 (2.8)
	WDP (*n*=147)	9.1±18.4			*P*=1.000 (0.0)	*P*<0.001 (0.9)	*P*<0.001 (1.6)
	CMP (*n*=167)	9.8±18.2				*P*<0.001 (0.9)	*P*<0.001 (1.6)
	WOP (*n*=54)	27.5±27.2					*P*<0.001 (0.6)
	COP (*n*=36)	44.5±32.7					
PUP	CDP (*n*=179)	4.4±12.3		*P*=0.201 (0.2)	*P*=0.440 (0.2)	*P*=0.280 (0.3)	*P*=1.000 (0.2)
	WDP (*n*=147)	2.2±6.5			*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.0)
	CMP (*n*=167)	2.5±7.1				*P*=1.000 (0.1)	*P*=1.000 (0.1)
	WOP (*n*=54)	1.5±5.6					*P*=1.000 (0.1)
	COP (*n*=36)	1.9±5.8					

Table 4.3. (continued)

Action	Position	Distance (m)	Difference and Effect Size				
			CDP	WDP	CMP	WOP	COP
CD/PRE	CDP (*n*=179)	9.1±15.6		*P*<0.001 (1.4)	*P*<0.001 (1.4)	*P*<0.001 (2.9)	*P*<0.001 (4.2)
	WDP (*n*=147)	48.2±39.3			*P*<0.001 (0.4)	*P*<0.001 (1.3)	*P*<0.001 (2.7)
	CMP (*n*=167)	72.0±64.9				*P*=0.023 (0.7)	*P*<0.001 (1.9)
	WOP (*n*=54)	115.6±71.8					*P*<0.001 (1.1)
	COP (*n*=36)	219.0±117.9					
COV	CDP (*n*=179)	241.5±88.9		*P*=0.375 (0.2)	*P*<0.001 (0.7)	*P*<0.001 (0.7)	*P*<0.001 (2.4)
	WDP (*n*=147)	220.3±94.1			*P*<0.001 (0.4)	*P*<0.001 (1.4)	*P*<0.001 (2.1)
	CMP (*n*=167)	175.7±105.1				*P*<0.001 (0.8)	*P*<0.001 (1.4)
	WOP (*n*=54)	101.3±65.9					*P*=0.014 (1.1)
	COP (*n*=36)	38.2±47.5					
RR	CDP (*n*=179)	116.0±78.5		*P*<0.001 (0.7)	*P*<0.001 (0.8)	*P*=1.000 (0.3)	*P*<0.001 (1.3)
	WDP (*n*=147)	184.1±111.6			*P*=1.000 (0.0)	*P*=0.011 (0.5)	*P*<0.001 (1.6)
	CMP (*n*=167)	182.6±96.8				*P*=0.014 (0.5)	*P*<0.001 (1.8)
	WOP (*n*=54)	136.3±84.5					*P*<0.001 (1.7)
	COP (*n*=36)	23.9± 22.9					
INT	CDP (*n*=179)	2.5±7.3		*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.3)
	WDP (*n*=147)	3.1±7.7			*P*=1.000 (0.0)	*P*=1.000 (0.0)	*P*=0.459 (0.4)
	CMP (*n*=167)	3.3±7.9				*P*=1.000 (0.0)	*P*=0.305 (0.4)
	WOP (*n*=54)	3.0±7.3					*P*=0.941 (0.5)
	COP (*n*=36)	0.3±2.0					
OTH	CDP (*n*=179)	30.4±28.9		*P*<0.001 (0.9)	*P*<0.001 (0.7)	*P*<0.001 (1.8)	*P*<0.001 (1.4)
	WDP (*n*=147)	69.0±52.8			*P*=0.401 (0.2)	*P*=0.013 (0.4)	*P*=1.000 (0.1)
	CMP (*n*=167)	58.4±50.3				*P*<0.001 (0.7)	*P*=0.287 (0.4)
	WOP (*n*=54)	92.3±48.9					*P*=1.000 (0.3)
	COP (*n*=36)	76.7±51.1					

CDP, Central Defensive Players; WDP, Wide Defensive Players; CMP, Central Midfield Players; WOP, Wide Offensive Players; COP, Central Offensive Players. SP: 'Support Play', MTR/ES: 'Move to Receive/Exploit Space', OVL/UDL: 'Overlap/Underlap', RWB: 'Run with Ball', RIB/PEN: 'Run in Behind/Penetrate', BIB: 'Break into Box', PUP: 'Push up Pitch', CD/PRE: 'Close Down/Press', COV: 'Covering', RR: 'Recovery Run', INT: 'Interception', OTH: 'Others'. P-values in green indicate differences with orange demonstrating no differences. Values in bracket represent effect size; trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006).

Table 4.4. Differences in physical-tactical variables between ‘specialised’ positions along with effect sizes.

Action	Position	Distance (m)	Difference and Effect Size										
			CB^2	CB^3	FB	WB	B2BM	CDM	CAM	WM	WF	CF^1	CF^2
SP	CB^2 (*n*=130)	1.7±9.7		*P*=1.000 (0.2)	*P*<0.001 (2.2)	*P*<0.001 (2.8)	*P*<0.001 (1.5)	*P*=1.000 (0.9)	*P*<0.001 (5.0)	*P*<0.001 (3.2)	*P*<0.001 (3.3)	*P*<0.001 (3.7)	*P*<0.001 (2.1)
	CB^3 (*n*=49)	0.3±1.9			*P*<0.001 (1.7)	*P*<0.001 (2.2)	*P*<0.001 (1.2)	*P*=1.000 (0.9)	*P*<0.001 (3.5)	*P*<0.001 (2.4)	*P*=0.004 (2.4)	*P*<0.001 (2.7)	*P*<0.001 (1.5)
	FB (*n*=39)	59.1±52.5				*P*<0.001 (1.1)	*P*=0.069 (0.5)	*P*=0.097 (1.1)	*P*<0.001 (1.4)	*P*=0.002 (0.9)	*P*=1.000 (0.3)	*P*=1.000 (0.5)	*P*=1.000 (0.2)
	WB (*n*=70)	136.5±79.9					*P*=0.01 (0.4)	*P*<0.001 (1.9)	*P*=1.000 (0.2)	*P*=1.000 (0.2)	*P*=0.096 (0.7)	*P*=0.564 (0.6)	*P*=0.004 (0.7)
	B2BM (*n*=94)	98.5±97.5						*P*<0.001 (1.0)	*P*=0.306 (0.6)	*P*=1.000 (0.2)	*P*=1.000 (0.2)	*P*=1.000 (0.1)	*P*=1.000 (0.2)
	CDM (*n*=49)	15.5±24.6							*P*<0.001 (2.7)	*P*<0.001 (1.9)	*P*=0.079 (1.6)	*P*=0.011 (1.8)	*P*=0.021 (1.1)
	CAM (*n*=11)	155.0±107.9								*P*=1.000 (0.4)	*P*=0.153 (0.9)	*P*=0.538 (0.8)	*P*=0.038 (0.8)
	WM (*n*=40)	119.4±73.9									*P*=1.000 (0.6)	*P*=1.000 (0.4)	*P*=0.457 (0.6)
	WF (*n*=14)	77.8±69.8										*P*=1.000 (0.2)	*P*=1.000 (0.0)
	CF^1 (*n*=14)	88.4±70.5											*P*=1.000 (0.2)
	CF^2 (*n*=22)	74.6±91.6											
MTR/ES	CB^2 (*n*=130)	13.3±24.9		*P*=1.000 (0.0)	*P*=1.000 (0.6)	*P*<0.001 (1.7)	*P*<0.001 (1.0)	*P*=1.000 (0.1)	*P*<0.001 (2.9)	*P*<0.001 (2.5)	*P*<0.001 (2.9)	*P*<0.001 (2.1)	*P*<0.001 (1.8)
	CB^3 (*n*=49)	12.3±20.4			*P*=1.000 (0.7)	*P*<0.001 (1.5)	*P*<0.001 (0.9)	*P*=1.000 (0.2)	*P*<0.001 (2.5)	*P*<0.001 (2.1)	*P*<0.001 (2.6)	*P*<0.001 (2.0)	*P*<0.001 (1.4)
	FB (*n*=39)	27.6±25.7				*P*<0.001 (1.1)	*P*=0.291 (0.6)	*P*=1.000 (0.5)	*P*<0.001 (1.9)	*P*<0.001 (1.7)	*P*<0.001 (1.9)	*P*=0.069 (1.3)	*P*=0.004 (1.0)
	WB (*n*=70)	85.5±63.3					*P*<0.001 (0.6)	*P*<0.001 (1.4)	*P*=1.000 (0.3)	*P*=0.102 (0.4)	*P*=1.000 (0.2)	*P*=1.000 (0.2)	*P*=1.000 (0.1)
	B2BM (*n*=94)	52.3±50.7						*P*<0.001 (0.8)	*P*=0.022 (1.0)	*P*<0.001 (1.1)	*P*=0.024 (0.9)	*P*=1.000 (0.4)	*P*=1.000 (0.4)
	CDM (*n*=49)	16.2±19.7							*P*<0.001 (2.4)	*P*<0.001 (2.0)	*P*<0.001 (2.5)	*P*=0.002 (1.9)	*P*<0.001 (1.3)
	CAM (*n*=11)	104.8±75.4								*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.5)	*P*=1.000 (0.4)
	WM (*n*=40)	114.2±68.9									*P*=1.000 (0.2)	*P*=0.318 (0.6)	*P*=0.153 (0.5)
	WF (*n*=14)	99.2±61.3										*P*=1.000 (0.4)	*P*=1.000 (0.3)
	CF^1 (*n*=14)	74.4±55.1											*P*=1.000 (0.0)
	CF^2 (*n*=22)	77.3±75.2											
OVL/UDL	CB^2 (*n*=130)	0.4±3.3		*P*=1.000 (0.3)	*P*<0.001 (1.6)	*P*<0.001 (1.8)	*P*=1.000 (0.6)	*P*=1.000 (0.3)	*P*=1.000 (1.7)	*P*=1.000 (1.1)	*P*=1.000 (1.7)	*P*=1.000 (0.1)	*P*=1.000 (0.7)
	CB^3 (*n*=49)	2.7±13.5			*P*<0.001 (1.0)	*P*<0.001 (1.3)	*P*=1.000 (0.2)	*P*=1.000 (0.1)	*P*=1.000 (0.8)	*P*=1.000 (0.4)	*P*=1.000 (0.5)	*P*=1.000 (0.2)	*P*=1.000 (0.0)
	FB (*n*=39)	33.5±41.9				*P*<0.001 (0.6)	*P*<0.001 (1.2)	*P*<0.001 (1.1)	*P*=1.000 (0.4)	*P*=0.003 (0.8)	*P*=0.221 (0.7)	*P*=0.005 (0.9)	*P*=0.002 (0.9)
	WB (*n*=70)	68.1±62.6					*P*<0.001 (1.5)	*P*<0.001 (1.4)	*P*<0.001 (0.8)	*P*<0.001 (1.2)	*P*<0.001 (1.0)	*P*<0.001 (1.2)	*P*<0.001 (1.2)
	B2BM (*n*=94)	5.0±11.4						*P*=1.000 (0.4)	*P*=1.000 (0.9)	*P*=1.000 (0.3)	*P*=1.000 (0.3)	*P*=1.000 (0.5)	*P*=1.000 (0.2)
	CDM (*n*=49)	1.4±4.2							*P*=1.000 (1.1)	*P*=1.000 (0.7)	*P*=1.000 (1.1)	*P*=1.000 (0.4)	*P*=1.000 (0.3)
	CAM (*n*=11)	19.0±38.1								*P*=1.000 (0.5)	*P*=1.000 (0.4)	*P*=1.000 (0.8)	*P*=1.000 (0.7)
	WM (*n*=40)	8.3±14.4									*P*=1.000 (0.0)	*P*=1.000 (0.7)	*P*=1.000 (0.4)
	WF (*n*=14)	8.9±12.5										*P*=1.000 (1.0)	*P*=1.000 (0.5)
	CF^1 (*n*=14)	0.0±0.0											*P*=1.000 (0.5)
	CF^2 (*n*=22)	3.3±8.6											

Table 4.4. (continued)

Action	Position	Distance (m)	Difference and Effect Size										
			CB^2	CB^3	FB	WB	B2BM	CDM	CAM	WM	WF	CF^1	CF^2
RWB	CB^2 (*n*=130)	17.3±27.6		*P*=1.000 (0.2)	*P*=0.353 (0.7)	*P*<0.001 (1.1)	*P*<0.001 (0.7)	*P*=1.000 (0.4)	*P*<0.001 (1.9)	*P*<0.001 (1.6)	*P*<0.001 (2.5)	*P*=1.000 (0.3)	*P*=0.259 (0.9)
	CB^3 (*n*=49)	23.5±32.3			*P*=1.000 (0.4)	*P*<0.001 (0.8)	*P*=0.194 (0.5)	*P*=1.000 (0.1)	*P*=0.002 (1.3)	*P*<0.001 (1.2)	*P*<0.001 (1.9)	*P*=1.000 (0.1)	*P*=1.000 (0.6)
	FB (*n*=39)	36.8±34.8				*P*=1.000 (0.4)	*P*=1.000 (0.2)	*P*=1.000 (0.3)	*P*=0.103 (0.9)	*P*<0.001 (0.8)	*P*<0.001 (1.4)	*P*=1.000 (0.3)	*P*=1.000 (0.2)
	WB (*n*=70)	54.9±43.6					*P*=1.000 (0.3)	*P*=0.015 (0.7)	*P*=1.000 (0.5)	*P*=0.346 (0.4)	*P*=0.060 (0.8)	*P*=0.581 (0.7)	*P*=1.000 (0.3)
	B2BM (*n*=94)	43.7±44.5						*P*=1.000 (0.4)	*P*=0.295 (0.7)	*P*<0.001 (0.7)	*P*<0.001 (1.1)	*P*=1.000 (0.4)	*P*=1.000 (0.0)
	CDM (*n*=49)	27.8±25.8							*P*=0.007 (1.3)	*P*<0.001 (1.1)	*P*<0.001 (2.0)	*P*=1.000 (0.1)	*P*=1.000 (0.5)
	CAM (*n*=11)	78.5±70.5								*P*=1.000 (0.0)	*P*=1.000 (0.2)	*P*=0.046 (1.0)	*P*=0.760 (0.7)
	WM (*n*=40)	76.2±56.2									*P*=1.000 (0.3)	*P*=0.002 (1.0)	*P*=0.076 (0.6)
	WF (*n*=14)	92.5±49.6										*P*<0.001 (1.7)	*P*=0.012 (1.1)
	CF^1 (*n*=14)	25.6±28.2											*P*=1.000 (0.5)
	CF^2 (*n*=22)	42.9±41.0											
RIB/PEN	CB^2 (*n*=130)	0.5±2.9		*P*=1.000 (0.1)	*P*=1.000 (1.0)	*P*<0.001 (2.0)	*P*=0.002 (1.3)	*P*=1.000 (0.1)	*P*<0.001 (4.6)	*P*<0.001 (2.4)	*P*<0.001 (5.2)	*P*<0.001 (7.5)	*P*<0.001 (5.4)
	CB^3 (*n*=49)	0.9±4.4			*P*=1.000 (0.7)	*P*<0.001 (1.5)	*P*=0.086 (1.0)	*P*=1.000 (0.0)	*P*<0.001 (2.9)	*P*<0.001 (1.7)	*P*<0.001 (3.4)	*P*<0.001 (4.9)	*P*<0.001 (3.7)
	FB (*n*=39)	10.9±20.5				*P*<0.001 (1.1)	*P*=1.000 (0.5)	*P*=1.000 (0.7)	*P*<0.001 (2.1)	*P*<0.001 (1.4)	*P*<0.001 (2.7)	*P*<0.001 (3.9)	*P*<0.001 (3.1)
	WB (*n*=70)	52.4±44.7					*P*=0.002 (0.8)	*P*<0.001 (1.5)	*P*=0.298 (0.8)	*P*<0.001 (0.7)	*P*<0.001 (1.6)	*P*<0.001 (2.5)	*P*<0.001 (2.5)
	B2BM (*n*=94)	24.7±29.3						*P*=0.110 (1.0)	*P*<0.001 (1.8)	*P*<0.001 (1.4)	*P*<0.001 (2.7)	*P*<0.001 (4.0)	*P*<0.001 (3.6)
	CDM (*n*=49)	0.9±4.5							*P*<0.001 (2.9)	*P*<0.001 (1.7)	*P*<0.001 (3.3)	*P*<0.001 (4.8)	*P*<0.001 (3.6)
	CAM (*n*=11)	91.0±73.3								*P*=1.000 (0.0)	*P*=0.578 (0.6)	*P*<0.001 (1.2)	*P*<0.001 (1.2)
	WM (*n*=40)	94.1±81.7									*P*=0.112 (0.5)	*P*<0.001 (1.1)	*P*<0.001 (1.3)
	WF (*n*=14)	135.1±84.5										*P*=0.211 (0.6)	*P*<0.001 (0.8)
	CF^1 (*n*=14)	181.9±79.0											*P*=1.000 (0.3)
	CF^2 (*n*=22)	206.9±101.2											
BIB	CB^2 (*n*=130)	2.8±7.2		*P*=1.000 (0.1)	*P*=1.000 (0.4)	*P*<0.001 (0.9)	*P*=0.013 (0.7)	*P*=1.000 (0.2)	*P*<0.001 (2.8)	*P*<0.001 (1.5)	*P*<0.001 (3.4)	*P*<0.001 (4.0)	*P*<0.001 (2.7)
	CB^3 (*n*=49)	3.3±7.5			*P*=1.000 (0.6)	*P*=0.006 (0.7)	*P*=0.430 (0.5)	*P*=1.000 (0.3)	*P*<0.001 (2.1)	*P*<0.001 (1.1)	*P*<0.001 (2.5)	*P*<0.001 (2.9)	*P*<0.001 (2.0)
	FB (*n*=39)	0.0±0.0				*P*<0.001 (0.9)	*P*=0.031 (0.7)	*P*=1.000 (0.3)	*P*<0.001 (2.6)	*P*<0.001 (1.3)	*P*<0.001 (2.7)	*P*<0.001 (3.0)	*P*<0.001 (2.1)
	WB (*n*=70)	15.8±22.5					*P*=1.000 (0.2)	*P*<0.001 (0.8)	*P*=0.816 (0.6)	*P*=1.000 (0.3)	*P*<0.001 (1.1)	*P*<0.001 (1.5)	*P*<0.001 (0.9)
	B2BM (*n*=94)	11.4±18.2						*P*=0.059 (0.7)	*P*=0.060 (0.9)	*P*=0.049 (0.5)	*P*<0.001 (1.5)	*P*<0.001 (2.0)	*P*<0.001 (1.3)
	CDM (*n*=49)	1.2±6.5							*P*<0.001 (2.3)	*P*<0.001 (1.2)	*P*<0.001 (2.6)	*P*<0.001 (3.0)	*P*<0.001 (2.1)
	CAM (*n*=11)	29.4±25.0								*P*=1.000 (0.3)	*P*=1.000 (0.5)	*P*=0.032 (0.8)	*P*=1.000 (0.3)
	WM (*n*=40)	22.3±23.8									*P*=0.010 (0.8)	*P*<0.001 (1.2)	*P*=0.017 (0.6)
	WF (*n*=14)	42.4±31.4										*P*=1.000 (0.3)	*P*=1.000 (0.1)
	CF^1 (*n*=14)	53.4±34.8											*P*=0.760 (0.4)
	CF^2 (*n*=22)	38.9±30.7											

Table 4.4. (continued)

Action	Position	Distance (m)	Difference and Effect Size										
			CB^{2}	CB^{3}	FB	WB	B2BM	CDM	CAM	WM	WF	CF^{1}	CF^{2}
PUP	CB^{2} (*n*=130)	4.6±12.1		*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.3)	*P*=1.000 (0.1)	*P*=1.000 (0.3)	*P*=1.000 (0.3)	*P*=1.000 (0.2)	*P*=1.000 (0.4)	*P*=1.000 (0.1)	*P*=1.000 (0.3)
	CB^{3} (*n*=49)	4.0±12.8			*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*=1.000 (0.1)	*P*=1.000 (0.3)	*P*=1.000 (0.3)	*P*=1.000 (0.2)	*P*=1.000 (0.4)	*P*=1.000 (0.1)	*P*=1.000 (0.3)
	FB (*n*=39)	3.5±7.9				*P*=1.000 (0.3)	*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*=1.000 (0.3)	*P*=1.000 (0.2)	*P*=1.000 (0.5)	*P*=1.000 (0.0)	*P*=1.000 (0.3)
	WB (*n*=70)	1.6±6.0					*P*=1.000 (0.2)	*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.3)	*P*=1.000 (0.3)	*P*=1.000 (0.1)
	B2BM (*n*=94)	3.1±8.5						*P*=1.000 (0.2)	*P*=1.000 (0.3)	*P*=1.000 (0.1)	*P*=1.000 (0.4)	*P*=1.000 (0.0)	*P*=1.000 (0.3)
	CDM (*n*=49)	1.4±4.0							*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.4)	*P*=1.000 (0.4)	*P*=1.000 (0.1)
	CAM (*n*=11)	1.0±3.3								*P*=1.000 (0.2)	*P*=1.000 (0.5)	*P*=1.000 (0.4)	*P*=1.000 (0.0)
	WM (*n*=40)	2.0±6.4									*P*=1.000 (0.4)	*P*=1.000 (0.2)	*P*=1.000 (0.2)
	WF (*n*=14)	0.0±0.0										*P*=1.000 (0.7)	*P*=1.000 (0.3)
	CF^{1} (*n*=14)	3.3±6.8											*P*=1.000 (0.4)
	CF^{2} (*n*=22)	1.1±5.0											
CD/PRE	CB^{2} (*n*=130)	7.2±12.5		*P*=1.000 (0.4)	*P*=0.415 (1.6)	*P*<0.001 (1.8)	*P*<0.001 (2.0)	*P*=0.046 (1.6)	*P*<0.001 (4.5)	*P*<0.001 (3.3)	*P*<0.001 (3.8)	*P*<0.001 (5.6)	*P*<0.001 (5.5)
	CB^{3} (*n*=49)	14.1±21.3			*P*=1.000 (0.8)	*P*<0.001 (1.2)	*P*<0.001 (1.4)	*P*=1.000 (0.9)	*P*<0.001 (2.8)	*P*<0.001 (2.2)	*P*<0.001 (2.3)	*P*<0.001 (3.6)	*P*<0.001 (3.5)
	FB (*n*=39)	32.7±23.9				*P*=0.652 (0.7)	*P*<0.001 (1.0)	*P*=1.000 (0.2)	*P*<0.001 (2.2)	*P*<0.001 (1.7)	*P*<0.001 (1.8)	*P*<0.001 (3.0)	*P*<0.001 (2.9)
	WB (*n*=70)	59.0±44.3					*P*=0.169 (0.5)	*P*=1.000 (0.6)	*P*<0.001 (1.8)	*P*<0.001 (1.0)	*P*<0.001 (1.2)	*P*<0.001 (2.9)	*P*<0.001 (2.3)
	B2BM (*n*=94)	83.4±57.1						*P*<0.001 (0.9)	*P*<0.001 (1.3)	*P*=0.307 (0.5)	*P*=0.120 (0.7)	*P*<0.001 (2.5)	*P*<0.001 (1.7)
	CDM (*n*=49)	37.2±31.1							*P*<0.001 (2.2)	*P*<0.001 (1.6)	*P*<0.001 (1.7)	*P*<0.001 (3.1)	*P*<0.001 (2.8)
	CAM (*n*=11)	167.4±125.3								*P*=0.082 (0.7)	*P*=1.000 (0.3)	*P*<0.001 (0.7)	*P*=1.000 (0.2)
	WM (*n*=40)	110.8±60.9									*P*=1.000 (0.3)	*P*<0.001 (1.7)	*P*<0.001 (1.1)
	WF (*n*=14)	129.4±98.1										*P*<0.001 (1.1)	*P*=0.058 (0.7)
	CF^{1} (*n*=14)	267.9±148.8											*P*<0.001 (0.7)
	CF^{2} (*n*=22)	188.0±82.9											
COV	CB^{2} (*n*=130)	244.6±88.2		*P*=1.000 (0.1)	*P*=0.277 (0.1)	*P*<0.001 (0.4)	*P*=1.000 (0.8)	*P*<0.001 (0.2)	*P*<0.001 (2.2)	*P*<0.001 (1.5)	*P*<0.001 (2.3)	*P*<0.001 (2.6)	*P*<0.001 (2.4)
	CB^{3} (*n*=49)	233.2±91.2			*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*=0.002 (0.7)	*P*=1.000 (0.1)	*P*<0.001 (2.1)	*P*<0.001 (1.4)	*P*<0.001 (2.1)	*P*<0.001 (2.4)	*P*<0.001 (2.2)
	FB (*n*=39)	236.6±100.9				*P*=1.000 (0.3)	*P*=0.003 (0.7)	*P*=1.000 (0.1)	*P*<0.001 (2.0)	*P*<0.001 (1.4)	*P*<0.001 (2.1)	*P*<0.001 (2.4)	*P*<0.001 (2.2)
	WB (*n*=70)	207.4±93.4					*P*=0.270 (0.4)	*P*=1.000 (0.1)	*P*<0.001 (1.7)	*P*<0.001 (1.0)	*P*<0.001 (1.8)	*P*<0.001 (2.1)	*P*<0.001 (1.9)
	B2BM (*n*=94)	167.6±94.6						*P*=0.057 (0.5)	*P*=0.003 (1.3)	*P*=0.264 (0.6)	*P*<0.001 (1.3)	*P*<0.001 (1.6)	*P*<0.001 (1.4)
	CDM (*n*=49)	220.6±117.8							*P*<0.001 (1.6)	*P*<0.001 (1.0)	*P*<0.001 (1.6)	*P*<0.001 (1.8)	*P*<0.001 (1.7)
	CAM (*n*=11)	52.9±41.1								*P*=1.000 (1.1)	*P*=1.000 (0.1)	*P*=1.000 (0.7)	*P*=1.000 (0.2)
	WM (*n*=40)	119.9±62.1									*P*=0.543 (1.2)	*P*=0.049 (1.6)	*P*=0.092 (1.3)
	WF (*n*=14)	48.2±45.2										*P*=1.000 (0.5)	*P*=1.000 (0.1)
	CF^{1} (*n*=14)	27.3±32.7											*P*=1.000 (0.4)
	CF^{2} (*n*=22)	45.1±54.4											

Table 4.4. (continued)

Action	**Position**	**Distance (m)**	**Difference and Effect Size**										
			CB^2	CB^3	FB	WB	B2BM	CDM	CAM	WM	WF	CF^1	CF^2
RR	CB^2 (*n*=130)	108.5±74.1		*P*=1.000 (0.4)	*P*=1.000 (0.1)	*P*<0.001 (1.2)	*P*<0.001 (1.1)	*P*=0.006 (0.8)	*P*=1.000 (0.3)	*P*=0.144 (0.6)	*P*=1.000 (0.4)	*P*=0.014 (1.3)	*P*=0.004 (1.2)
	CB^3 (*n*=49)	136.0±86.8			*P*=1.000 (0.2)	*P*<0.001 (0.8)	*P*=0.002 (0.7)	*P*=1.000 (0.4)	*P*=1.000 (0.5)	*P*=1.000 (0.2)	*P*=1.000 (0.7)	*P*<0.001 (1.5)	*P*<0.001 (1.5)
	FB (*n*=39)	119.4±74.6				*P*<0.001 (1.0)	*P*<0.001 (0.8)	*P*=0.693 (0.6)	*P*=1.000 (0.4)	*P*=1.000 (0.5)	*P*=1.000 (0.5)	*P*=0.012 (1.6)	*P*=0.005 (1.5)
	WB (*n*=70)	221.7±120.0					*P*=1.000 (0.2)	*P*=0.060 (0.5)	*P*<0.001 (1.1)	*P*=0.010 (0.6)	*P*<0.001 (1.3)	*P*<0.001 (1.8)	*P*<0.001 (1.8)
	B2BM (*n*=94)	200.8±103.4						*P*=1.000 (0.3)	*P*=0.004 (1.1)	*P*=0.403 (0.5)	*P*<0.001 (1.2)	*P*<0.001 (1.9)	*P*<0.001 (1.8)
	CDM (*n*=49)	167.1±83.0							*P*=0.484 (1.0)	*P*=1.000 (0.1)	*P*=0.058 (1.1)	*P*<0.001 (2.0)	*P*<0.001 (2.0)
	CAM (*n*=11)	89.9±72.5								*P*=1.000 (0.8)	*P*=1.000 (0.2)	*P*=1.000 (1.4)	*P*=1.000 (1.4)
	WM (*n*=40)	156.4±80.2									*P*=0.253 (1.0)	*P*<0.001 (2.0)	*P*<0.001 (1.9)
	WF (*n*=14)	79.0±71.1										*P*=1.000 (1.2)	*P*=1.000 (1.1)
	CF^1 (*n*=14)	18.1±21.9											*P*=1.000 (0.4)
	CF^2 (*n*=22)	27.7±23.3											
INT	CB^2 (*n*=130)	2.5±7.1		*P*=1.000 (0.0)	*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.4)
	CB^3 (*n*=49)	2.6±7.9			*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.4)
	FB (*n*=39)	2.8±6.9				*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.3)	*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.3)	*P*=1.000 (0.5)
	WB (*n*=70)	3.4±8.3					*P*=1.000 (0.0)	*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*=1.000 (0.0)	*P*=1.000 (0.2)	*P*=1.000 (0.3)	*P*=1.000 (0.5)
	B2BM (*n*=94)	3.5±8.1						*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*=1.000 (0.0)	*P*=1.000 (0.2)	*P*=1.000 (0.3)	*P*=1.000 (0.5)
	CDM (*n*=49)	3.3±6.6							*P*=1.000 (0.4)	*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*=1.000 (0.4)	*P*=1.000 (0.6)
	CAM (*n*=11)	1.1±3.6								*P*=1.000 (0.3)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.5)
	WM (*n*=40)	3.5±7.7									*P*=1.000 (0.3)	*P*=1.000 (0.4)	*P*=1.000 (0.6)
	WF (*n*=14)	1.6±5.9										*P*=1.000 (0.1)	*P*=1.000 (0.4)
	CF^1 (*n*=14)	0.9±3.2											*P*=1.000 (0.5)
	CF^2 (*n*=22)	0.0±0.0											
OTH	CB^2 (*n*=130)	29.6±27.3		*P*=1.000 (0.1)	*P*=0.102 (0.8)	*P*<0.001 (1.1)	*P*<0.001 (0.9)	*P*=1.000 (0.4)	*P*<0.001 (1.9)	*P*<0.001 (2.1)	*P*=0.149 (1.3)	*P*=0.016 (1.4)	*P*<0.001 (1.6)
	CB^3 (*n*=49)	32.4±33.0			*P*=0.974 (0.6)	*P*<0.001 (0.8)	*P*=0.002 (0.7)	*P*=1.000 (0.2)	*P*=0.008 (1.4)	*P*<0.001 (1.6)	*P*=0.534 (1.0)	*P*=0.084 (1.1)	*P*=0.007 (1.2)
	FB (*n*=39)	55.4±47.9				*P*=1.000 (0.3)	*P*=1.000 (0.2)	*P*=1.000 (0.4)	*P*=1.000 (0.6)	*P*<0.001 (0.9)	*P*=1.000 (0.3)	*P*=1.000 (0.4)	*P*=1.000 (0.5)
	WB (*n*=70)	74.5±58.5					*P*=1.000 (0.2)	*P*=0.003 (0.7)	*P*=1.000 (0.3)	*P*=0.184 (0.5)	*P*=1.000 (0.1)	*P*=1.000 (0.0)	*P*=1.000 (0.0)
	B2BM (*n*=94)	65.9±55.7						*P*=0.066 (0.5)	*P*=1.000 (0.4)	*P*=0.003 (0.6)	*P*=1.000 (0.0)	*P*=1.000 (0.2)	*P*=1.000 (0.2)
	CDM (*n*=49)	39.4±28.6							*P*=0.051 (1.3)	*P*<0.001 (1.5)	*P*=1.000 (0.9)	*P*=0.458 (0.9)	*P*=0.072 (1.1)
	CAM (*n*=11)	89.9±70.8								*P*=1.000 (0.2)	*P*=1.000 (0.4)	*P*=1.000 (0.2)	*P*=1.000 (0.2)
	WM (*n*=40)	100.8±50.0									*P*=1.000 (0.7)	*P*=1.000 (0.5)	*P*=1.000 (0.5)
	WF (*n*=14)	67.8±37.4										*P*=1.000 (0.2)	*P*=1.000 (0.2)
	CF^1 (*n*=14)	75.9±62.2											*P*=1.000 (0.0)
	CF^2 (*n*=22)	77.2±44.3											

CB^2, two Centre Backs; CB^3, three Centre Backs; FB, Full-Backs; WB, Wing-Backs; B2BM, Box-to-Box Midfielders; CDM, Central Defensive Midfielders; CAM, Central Attacking Midfielders; WM, Wide Midfielders; WF, Wide Forwards; CF^1, one Centre Forward; CF^2, two Centre Forwards. SP: ‘Support Play’, MTR/ES: ‘Move to Receive/Exploit Space’, OVL/UDL: ‘Overlap/Underlap’, RWB: ‘Run with Ball’, RIB/PEN: ‘Run in Behind/Penetrate’, BIB: ‘Break into Box’, PUP: ‘Push up Pitch’, CD/PRE: ‘Close Down/Press’, COV: ‘Covering’, RR: ‘Recovery Run’, INT: ‘Interception’, OTH: ‘Others’. P-values in green indicate differences with orange demonstrating no differences. Values in bracket represent effect size; trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006).

Table 4.5. The comparison of high-intensity distance between general and specialised positions.

Type	Position	High-intensity Running Distance (m)			Difference and Effect Size
		Total	IP	OOP	
General	CDP (*n*=179)	442±147	42±46	369±126	Total: CDP > CB^2# (ES: 0.1); CB^3 > CDP# (ES: 0.2); CB^3 > CB^2# (ES: 0.2) IP: CDP > CB^2# (ES: 0.0); CB^3 > CDP# (ES: 0.1); CB^3 > CB^2# (ES: 0.1) OOP: CDP > CB^2# (ES: 0.0); CB^3 > CDP# (ES: 0.1); CB^3 > CB^2# (ES: 0.2)
Specialised	CB^2 (*n*=130)	433±151	41±45	363±127	
	CB^3 (*n*=49)	465±135	47±50	386±121	
General	WDP (*n*=147)	830±238	305±165	456±150	Total: WDP > FB* (ES: 0.9); WB > WDP*/FB* (ES: 0.7/1.9) IP: WDP > FB* (ES: 0.9); WB > WDP*/FB* (ES: 0.7/1.8) OOP: WDP > FB# (ES: 0.4); WB > WDP# (ES: 0.2); WB > FB* (ES: 0.7)
Specialised	FB (*n*=39)	618±178	171±105	392±129	
	WB (*n*=70)	981±203	415±155	491±159	
General	CMP (*n*=167)	689±251	197±174	434±174	Total: CMP > CDM* (ES: 0.7); CAM > B2BM#/CMP# (ES: 0.5/0.7); CAM > CDM* (ES: 1.6); B2BM > CDM* (ES: 1.0); B2BM > CMP# (ES: 0.3) IP: CMP > CDM* (ES: 0.8); CAM > B2BM*/CMP*/CDM* (ES: 1.4/1.6/3.8); B2BM > CDM* (ES: 1.3); B2BM > CMP# (ES: 0.2) OOP: CMP > CDM#/CAM# (ES: 0.0/0.7); B2BM > CMP#/CDM#/CAM# (ES: 0.1/0.2/0.8); CDM > CAM# (ES: 0.7)
Specialised	B2BM (*n*=94)	760±245	239±158	455±175	
	CDM (*n*=46)	532±187	64±49	428±176	
	CAM (*n*=11)	880±305	479±224	311±183	
General	WOP (*n*=54)	890±184	441±155	356±139	Total: WOP > WF# (ES: 0.6); WM > WOP# (ES: 0.2); WM > WF* (ES: 0.8) IP: WOP > WM# (ES: 0.0); WF > WOP#/WM# (ES: 0.1/0.1) OOP: WM > WOP# (ES: 0.3); WM > WF* (ES: 1.0); WOP > WF* (ES: 0.7)
Specialised	WM (*n*=40)	928±173	436±170	391±120	
	WF (*n*=14)	782±175	456±100	258±149	
General	COP (*n*=36)	796±239	438±188	282±139	Total: COP > CF^2# (ES: 0.1); CF^1 > COP#/CF^2# (ES: 0.1/0.1) IP: COP > CF^1# (ES: 0.1); CF^2 > COP#/CF^1# (ES: 0.0/0.1) OOP: COP > CF^2# (ES: 0.2); CF^1 > COP#/CF^2# (ES: 0.2/0.4)
Specialised	CF^1 (*n*=14)	817±264	427±157	314±183	
	CF^2 (*n*=22)	783±227	445±209	261±102	

CDP: Central Defensive Players; WDP: Wide Defensive Players; CMP: Central Midfield Players; WOP: Wide Offensive Players; COP: Central Offensive Players. CB^2: two Centre Backs; CB3: three Centre Backs; FB: Full-Backs; WB: Wing-Backs; B2BM: Box-to-Box Midfielders; CDM: Central Defensive Midfielders; CAM: Central Attacking Midfielders; WM: Wide Midfielders; WF: Wide Forwards; CF^1: one Centre Forward; CF^2: three Centre Forwards. Distances covered for 'unclassified actions' were excluded. ES: Effect Size: trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006). Asterisk (*) denotes differences (P<0.05); Hash (#) denotes no differences (P>0.05). IP: In Possession, OOP: Out of Possession. Values are represented as means and standard deviations (m).

Table 4.6. Average distance and duration per physical-tactical action with average number of actions per match across various tactical roles.

Type	Position	Variable	In Possession						Out of Possession			Overall
			SP	MTR/ES	OVL/UDL	RWB	RIB/PEN	BIB	CD/PRE	COV	RR	
General	CDP (*n*=163)	Distance (m)	26±19	18±8	36±11	17±8	18±6	14±7	15±5	18±8	26±15	20±11
		Duration (s)	3±3	2±1	4±2	2±1	2±1	1±1	1±1	2±1	3±2	2±1
		Actions (No.)	0±0	1±1	0±0	1±2	0±0	0±0	1±1	13±4	4±3	23±6
Specialised	CB^2 (*n*=130)	Distance (m)	28±19	18±8	26±8	17±7	16±6	16±9	15±5	18±8	27±15	20±11
		Duration (s)	3±3	2±1	3±1	2±1	2±1	2±1	1±1	2±1	3±2	2±1
		Actions (No.)	0±0	1±1	0±0	1±2	0±0	0±0	0±1	14±4	4±2	22±7
	CB^3 (*n*=49)	Distance (m)	13	17±9	43±6	19±9	21±6	12±2	15±5	19±9	26±14	20±11
		Duration (s)	1	2±1	5±1	2±1	3±1	1±0	1±1	2±1	3±2	2±1
		Actions (No.)	0±0	1±1	0±0	1±2	0±0	0±1	1±1	12±4	5±3	23±6
General	WDP (*n*=120)	Distance (m)	24±13	20±10	28±14	22±12	20±9	19±7	15±5	20±10	27±14	22±12
		Duration (s)	3±2	2±1	3±2	2±2	2±1	2±1	1±1	2±1	3±2	2±2
		Actions (No.)	4±3	3±3	2±2	2±2	2±2	0±1	3±2	11±4	7±4	38±10
Specialised	FB (*n*=39)	Distance (m)	22±13	19±8	28±13	21±12	21±11	0	15±5	20±10	24±12	21±11
		Duration (s)	2±2	2±1	3±2	2±2	2±1	0	1±1	2±1	3±2	2±2
		Actions (No.)	3±2*	1±1*	1±1	2±1	1±1*	0*	2±2	12±4	5±3*	30±7*
	WB (*n*=70)	Distance (m)	25±14	20±11	28±15	22±12	20±8	18±7	15±5	20±10	27±14	22±12
		Duration (s)	3±2	2±1	3±2	2±2	2±1	2±1	1±1	2±1	3±2	2±2
		Actions (No.)	5±3****	4±3****	2±2	3±2	3±2****	1±1***	4±3	11±4	8±4	45±8****
General	CMP (*n*=132)	Distance (m)	23±13	19±9	22±16	20±10	20±10	19±10	16±7	20±10	24±13	21±11
		Duration (s)	3±2	2±1	2±2	2±1	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	3±4	2±2	0±1	2±2	1±2	1±1	4±4	9±5	8±4	34±11
Specialised	B2BM (*n*=94)	Distance (m)	23±14	19±10	21±10	21±10	21±10	19±10	16±7	20±10	25±14	21±12
		Duration (s)	3±2	2±1	2±1	2±1	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	4±4	3±2	0±1	2±2	1±1	1±1	5±3	9±5	8±4	37±11
	CDM (*n*=46)	Distance (m)	23±13	16±6	13±3	19±10	22±4	28±22	15±6	20±10	23±12	20±11
		Duration (s)	3±2	2±1	1±0	2±1	3±1	3±3	1±1	2±1	3±2	2±2
		Actions (No.)	1±1*	1±1*	0±0	1±1	0±0*	0±0*	2±0*	11±5	7±3	26±8*
	CAM (*n*=11)	Distance (m)	23±11	19±9	30±27	23±11	19±9	17±7	18±8	20±12	22±13	20±11
		Duration (s)	3±2	2±1	3±3	3±2	2±1	2±1	2±1	2±2	3±2	2±1
		Actions (No.)	7±4****	6±3****	1±1	3±3	5±4****	2±1****	9±8****	3±2*	4±2*	43±14***
General	WOP (*n*=40)	Distance (m)	23±12	22±12	21±8	22±12	21±10	20±8	18±8	21±10	24±13	21±11
		Duration (s)	3±2	2±2	2±1	2±2	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	5±3	5±3	0±1	4±2	5±4	1±1	7±3	5±3	6±3	42±7
Specialised	WM (*n*=40)	Distance (m)	23±12	22±12	22±8	23±12	22±11	19±8	17±8	21±10	24±13	22±11
		Duration (s)	3±2	2±2	2±1	3±2	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	5±3	5±3	0±1	3±2	4±4	1±1	6±3	6±3	6±3	44±7
	WF (*n*=14)	Distance (m)	22±11	20±10	18±6	20±10	19±9	20±9	19±9	20±9	24±13	20±10
		Duration (s)	2±2	2±1	2±1	2±1	2±1	2±1	2±1	2±1	3±2	2±1
		Actions (No.)	4±2	5±3	1±1	5±2	7±4	2±1	7±4	2±2*	3±3	39±7

Table 4.6. (continued)

Type	Position	Variable	In Possession						Out of Possession			Overall
			SP	MTR/ES	OVL/UDL	RWB	RIB/PEN	BIB	CD/PRE	COV	RR	
General	COP (*n*=23)	Distance (m)	29±16	22±11	24±5	22±11	21±10	19±7	20±10	20±9	25±14	21±11
		Duration (s)	3±2	2±2	3±1	2±2	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	3±2	4±3	0±0	2±2	9±4	2±2	11±6	2±2	1±1	38±10
Specialised	CF^1 (*n*=14)	Distance (m)	29±16	22±11	0	25±15	21±9	19±8	20±11	19±8	32±11	21±11
		Duration (s)	3±2	3±2	0	3±2	2±1	2±1	2±2	2±1	4±2	2±2
		Actions (No.)	3±2	3±2	0	1±1	9±3	3±2	13±7	1±1	1±1	38±11
	CF^2 (*n*=22)	Distance (m)	29±16	22±12	24±5	21±10	22±11	18±7	19±10	20±9	23±14	21±11
		Duration (s)	3±2	2±2	3±1	2±1	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	3±2	4±3	0±0	2±2	10±5	2±1	10±4	2±3	1±1	38±9
General	Overall	Distance (m)	24±14	20±10	27±14	21±11	21±10	19±8	17±8	19±9	25±14	21±11
		Duration (s)	3±2	2±1	3±2	2±2	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	3±3	2±3	1±1	2±2	2±3	1±1	4±4	10±5	6±4	33±12
Specialised	Overall	Distance (m)	24±14	20±10	27±14	21±11	21±10	18±8	17±8	19±9	25±15	21±11
		Duration (s)	3±2	2±1	3±2	2±2	2±1	2±1	2±1	2±1	3±2	2±2
		Actions (No.)	3±3	2±3	1±1	2±2	2±3	1±1	4±4	10±5	6±4	32±12

General Positions: CDP, Central Defensive Players; WDP, Wide Defensive Players; CMP, Central Midfield Players; WOP, Wide Offensive Players; COP, Central Offensive Players. Specialised Positions: CB^2, two Centre Backs; CB^3, three Centre Backs; FB, Full-Backs; WB, Wing-Backs; B2BM, Box-to-Box Midfielders; CDM, Central Defensive Midfielders; CAM, Central Attacking Midfielders; WM, Wide Midfielders; WF, Wide Forwards; CF^1, one Centre Forward; CF^2, two Centre Forwards. SP: 'Support Play', MTR/ES: 'Move to Receive/Exploit Space', OVL/UDL: 'Overlap/Underlap', RWB: 'Run with Ball', RIB/PEN: 'Run in Behind/Penetrate', BIB: 'Break into Box', CD/PRE: 'Close Down/Press', COV: 'Covering', RR: 'Recovery Run'. 'Push up Pitch' and 'Interception' were excluded as no differences were found between all positions. Values are means and standard deviations. *Fewer number of actions per match than their general position ($P<0.01$). **Fewer number of actions per match than their general position ($P<0.05$). ***Greater number of actions per match than their general position ($P<0.05$). ****Greater number of actions per match than their general position ($P<0.01$).

4.4.4 Additional Options of the Physical-Tactical Actions

In possession (Figure 4.6A and B), CMP and WOP performed more ‘Support Play’ actions in the central zone than WDP and CDP (ES: 0.3-2.9, *P*<0.05). WDP executed more ‘Support Play’ actions in a wide area (ES: 0.3-1.5, *P*<0.01) with WOP performing more these from a wide to the central zone (ES: 0.5-1.8, *P*<0.01) compared to other positions. WDP and WOP performed more ‘Run with Ball’ activities in a wide area than CDP, CMP and COP (ES: 0.5-1.6, *P*<0.01) while WOP executed more these actions from a wide to the central zone compared to all other positions (ES: 0.6-1.6, *P*<0.01). COP completed more ‘Break into Box’ actions toward the central zone in the box than all other positions (ES: 0.8-2.7, *P*<0.01) with wide players (WOP and WDP) executing more these actions toward a wide zone in the box compared to CDP and CMP (ES: 0.5-1.6, *P*<0.01).

Out of possession (Figure 4.6C), COP performed more ‘Close Down/Press’ actions both toward the player on the ball and receiving the ball compared to all other positions (ES: 0.8-3.4, *P*<0.01). CDP performed more ‘Covering–long ball/pass’ activities than other positions (ES: 1.0-2.1, *P*<0.01) whilst CDP and WDP performed more ‘Recovery Run–Ball passed over top/downside’ actions than CMP, WOP and COP (ES: 1.2-1.4, *P*<0.01).

4.4.5 Proportion of Single, Hybrid and Unclassified Physical-Tactical Actions

A total of 18,948 physical-tactical actions were analysed to determine the proportion of these actions. The percentage of single actions accounted for 77.7% (14,728 actions) whilst 13.2% (2,505 actions) and 9.1% (1,715 actions) were for hybrid and unclassified actions, respectively. The most frequent 10 configurations of hybrid actions (primary-secondary actions) are illustrated in Figure 4.7.

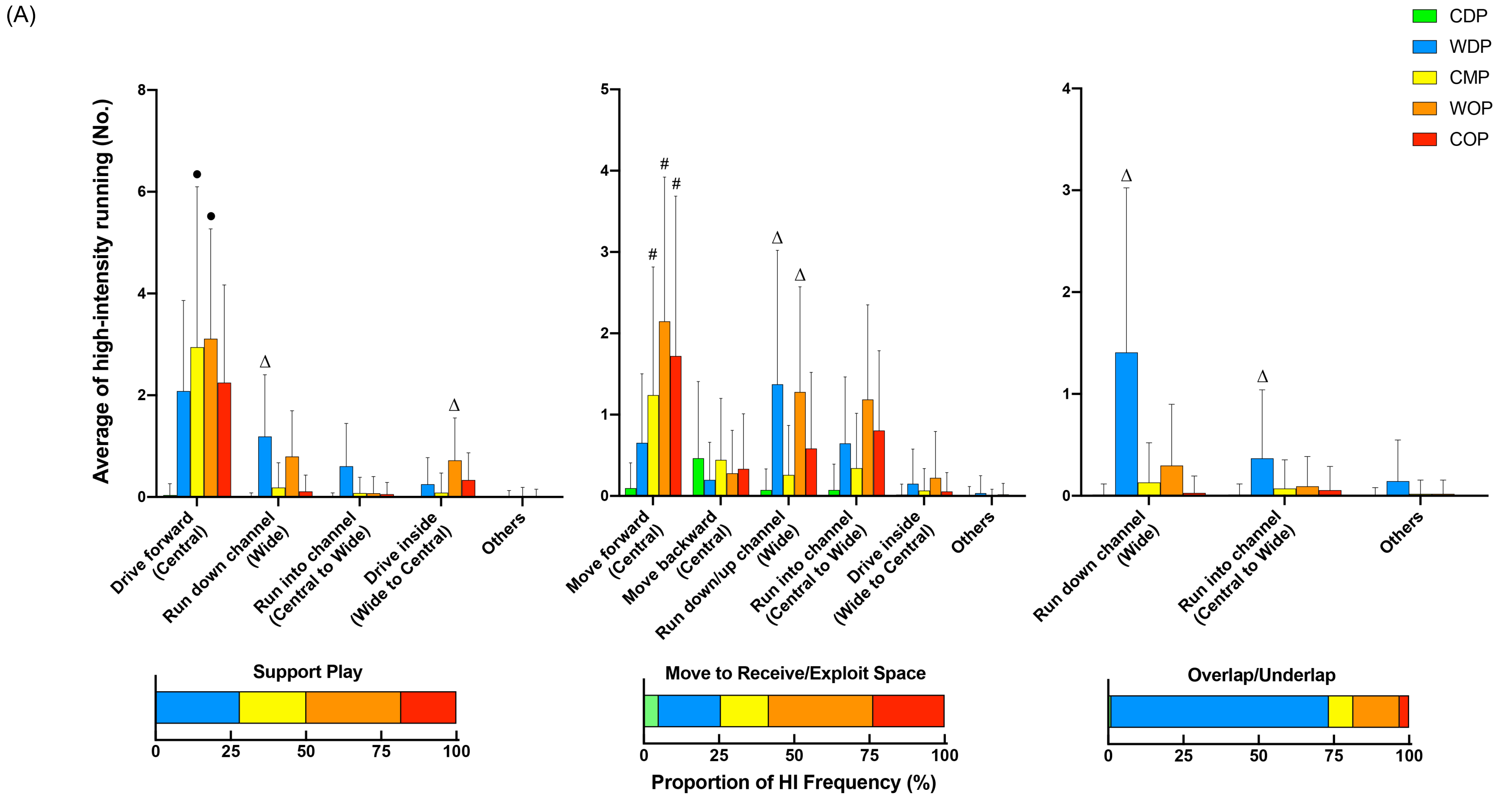


Figure 4.6. Comparison of additional options for in- (A and B) and out-of-possession (C) variables between general positions. Symbols denote differences (*P*<0.05). $^{\Delta}$More actions performed than all other positions. $^{\bullet}$More actions performed than WDP and CDP. $^{\#}$More actions performed than CDP and WDP. *More actions performed than CDP and CMP. $^{\blacklozenge}$More actions performed than COP and WOP. $^{\diamond}$More actions performed than CDP and COP. ‘Push up Pitch’ and ‘Interception’ were excluded as no differences were found between all positions (*P*>0.05). Values are average numbers of physical-tactical actions per match.

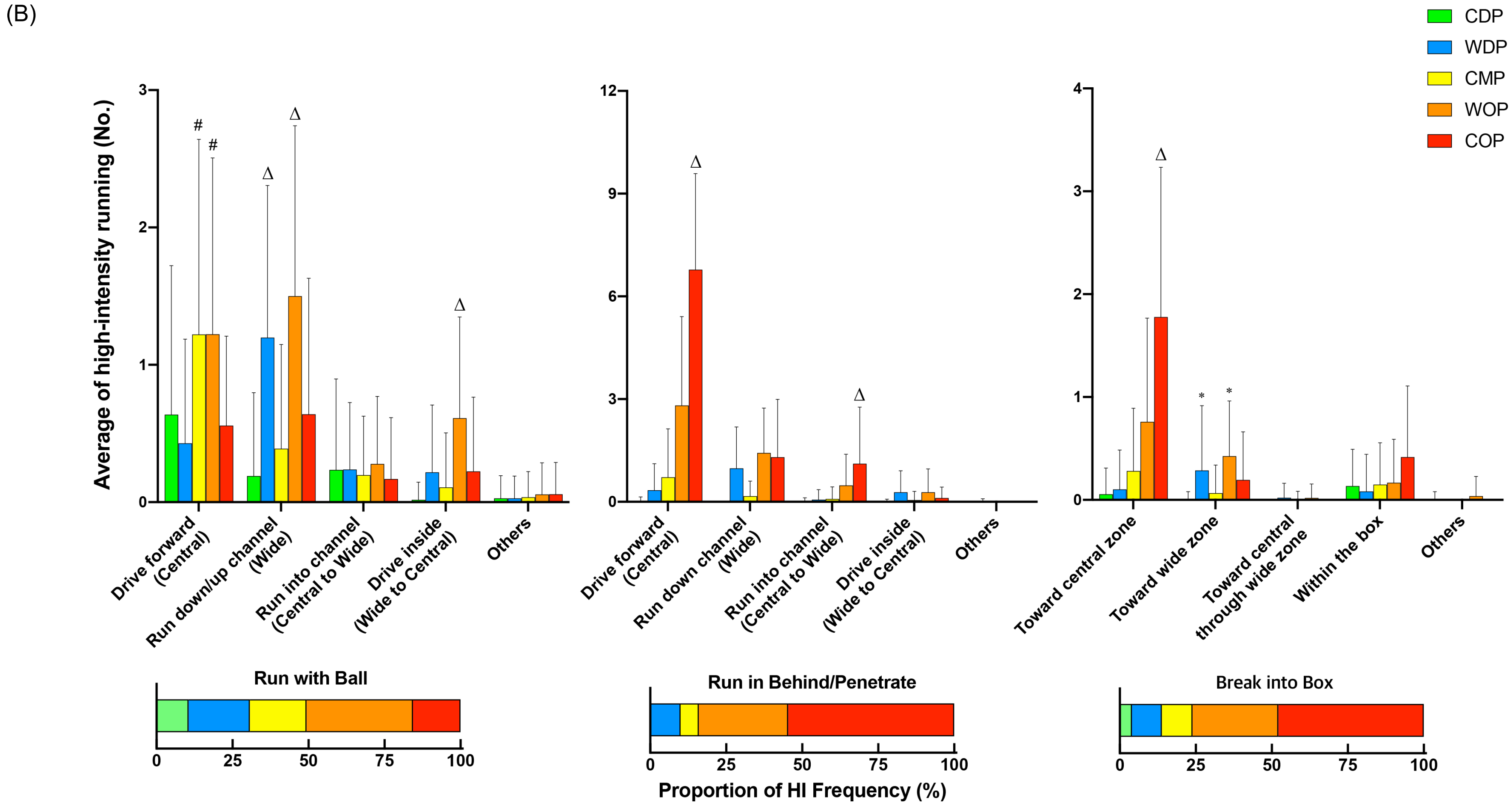


Figure 4.6. Comparison of additional options for in- (A and B) and out-of-possession (C) variables between general positions. Symbols denote differences (*P*<0.05). $^{\Delta}$More actions performed than all other positions. $^{\bullet}$More actions performed than WDP and CDP. $^{\#}$More actions performed than CDP and WDP. *More actions performed than CDP and CMP. $^{\blacklozenge}$More actions performed than COP and WOP. $^{\diamond}$More actions performed than CDP and COP. ‘Push up Pitch’ and ‘Interception’ were excluded as no differences were found between all positions (*P*>0.05). Values are average numbers of physical-tactical actions per match.

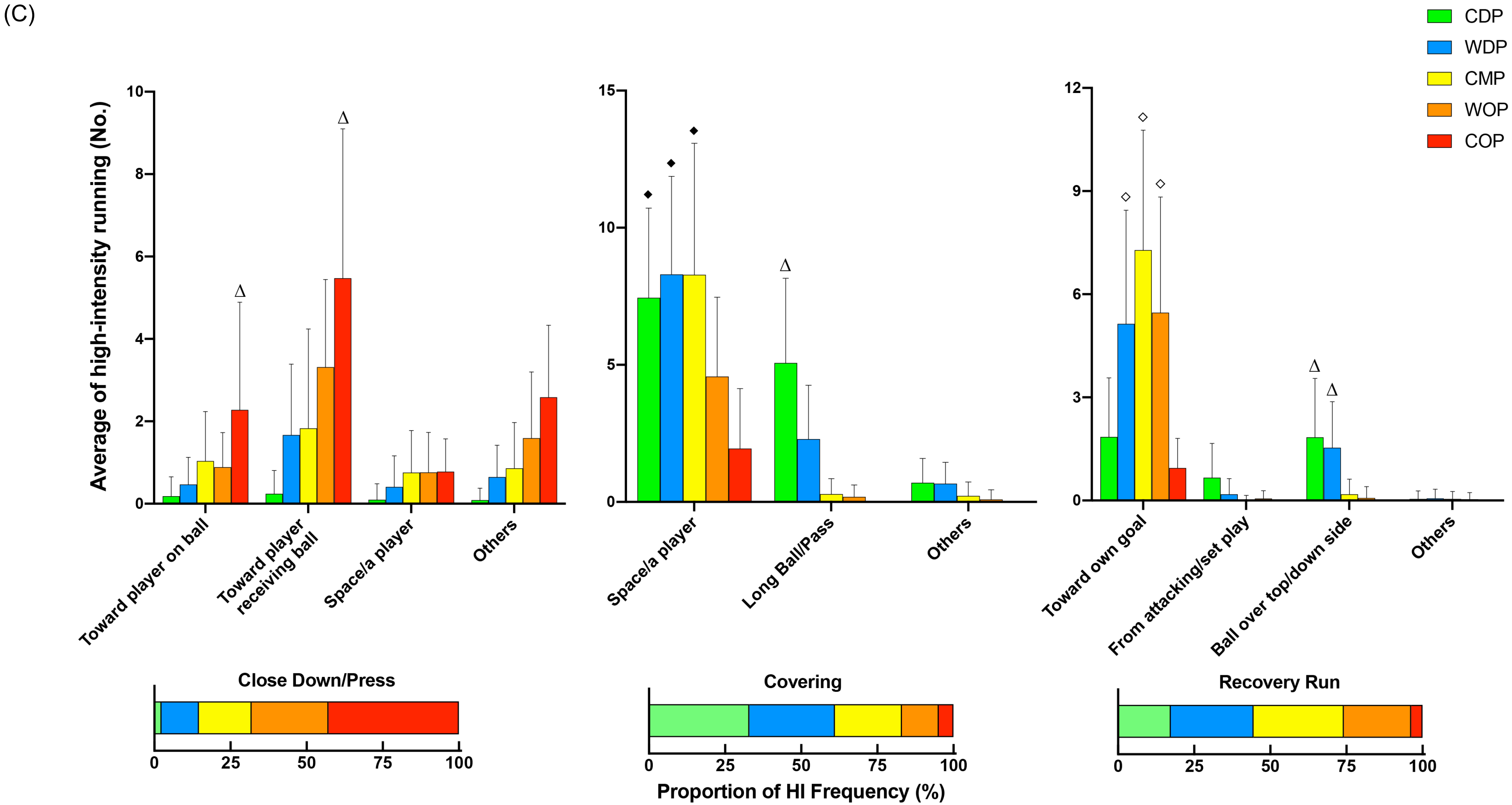


Figure 4.6. Comparison of additional options for in- (A and B) and out-of-possession (C) variables between general positions. Symbols denote differences (P<0.05). $^{\Delta}$More actions performed than all other positions. $^{\bullet}$More actions performed than WDP and CDP. $^{\#}$More actions performed than CDP and WDP. *More actions performed than CDP and CMP. $^{\blacklozenge}$More actions performed than COP and WOP. $^{\diamond}$More actions performed than CDP and COP. ‘Push up Pitch’ and ‘Interception’ were excluded as no differences were found between all positions (P>0.05). Values are average numbers of physical-tactical actions per match.

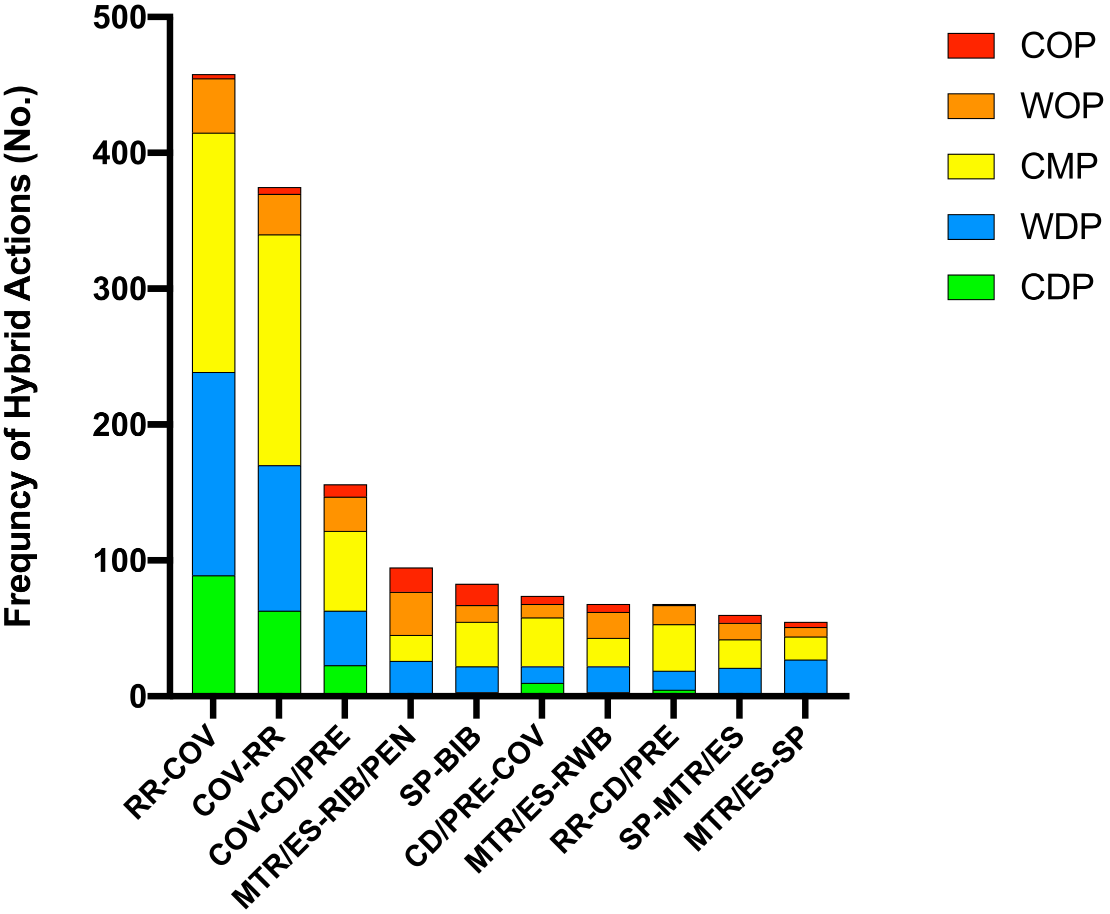


Figure 4.7. The frequency of hybrid actions (primary–secondary) by different positions. RR: 'Recovery Run', COV: 'Covering', CD/PRE: 'Close Down/Press', MTR/ES: 'Move to Receive/Exploit Space', SP: 'Support Play', RWB: 'Run with Ball', RIB/PEN: 'Run in Behind/Penetrate', BIB: 'Break into Box'.

4.4.6 Match-to-Match Variability for High-Intensity Distance and Contextualised Data

The mean percentage of CVs for high-intensity distances produced by general tactical roles was 22±13% with CDP (27±15%), WDP (21±11%), CMP (21±11%), WOP (13±6%) and COP (24±14%). On the other hand, the mean percentage of CVs for high-intensity distance generated by specialised tactical roles was 21±14% with CB^2 (26±15%), CB^3 (29±18%), FB (23±13%), WB (15±9%), B2BM (15±8%), CDM (21±14%), CAM (20±10%), WM (13±7%), WF (8±5%), CF^1 (20±25%) and CF^2 (26±12%). Match-to-match variability in contextualised performance was very high across all variables. Regardless of physical-tactical variables except for 'Push up Pitch' and 'Interception', the mean percentages of CVs for the physical-tactical performances by general and specialised positions were 67±25% and 62±29%, respectively.

4.5 Discussion

The present study is the first to contextualise physical performance profiles of elite players with tactical activities executed across various tactical roles, whereby comparisons were made between general and specialised positions to determine disparities between them. Players' physical-tactical demands of play are significantly under or overestimated if adopting generalist positions (e.g., CMP, WDP and etc.), thus using a specialised positional analysis is critical to improving the sensitivity of player match performance. Data provides insights into 'WHY' players cover the high-intensity running distance during matches, which can ultimately help coaches and practitioners to design position- or even player-specific training drills. However, the reader should be aware that the match-to-match variability for high-intensity running distance (CV: 21-22%) and physical-tactical actions (CV: 62-67%) were high, which agrees with previous findings (Gregson et al., 2010; Bush et al., 2015a; Ade, Fitzpatrick and Bradley, 2016; Carling et al., 2016). This could indicate that these context-based parameters are sensitive to the way teams set up tactically from game to game but also how each team modulates their own running performance and that of the opposition.

Previous studies demonstrated that the physical demand of match-play was highly dependent on playing positions with central defenders covering the lowest high-intensity running distance and wide midfielders the greatest (Bradley et al., 2009; Di Salvo et al., 2009), which is in accordance with the findings of the present study. Interestingly, the studies above revealed that high-intensity running distance covered by wide midfielders (~1000-1200 m) was greater than that covered by wide defenders (~900-1000 m) although the present study demonstrated that there was no difference between WDP and WOP (~830 m vs ~890 m). Some discrepancies in the distance covered may occur between studies possibly due to different filtering methods and dwell times adopted (Varley et al., 2017). That being said, it is more likely because the playing style of WDP has evolved from the traditional FB to WB in modern football, especially in the EPL where the physical demands of match-play have increased significantly over the last decade (Bush et al., 2015b). This notion is further supported by the proportion in the sample of FB and WB in the present study (35% vs 65%, respectively). Nonetheless, without context it is difficult to draw firm conclusions regarding 'WHY' such demands have increased. The findings of the present study demonstrated that the increased physical demands of modern WDP (e.g., WB styles) appears to be due to them actively engaging in attacking and transition phases whilst performing high-intensity ‘Support Play’ and ‘Over/Underlap’ activities when in possession, and ‘Recovery Run’ actions when dispossessed (i.e., out of possession), which is consistent with previous findings (Konefał et al., 2015; Ade, Fitzpatrick and Bradley, 2016). This particular trend of WDP in modern European football may exist as a function of tactical evolution (Konefał et al., 2015), and depends upon a team’s philosophy/tactic (e.g., how the team uses WDP during a match). Therefore, applied staff should consider the playing style of their WDP within the team (e.g., FB or WB) when prescribing training drills that are tailored to the players given the substantial differences in the physical-tactical demands between them. Additionally, as the integrated approach is sensitive enough to detect specific playing styles of players with their unique physical-tactical attributes, this has some potential benefits for recruitment. For instance, players who have the physical-tactical attributes matched to the team’s playing style could be shortlisted for scouting. However, to be able to build team and positional-level physical-tactical profiles, recruitment teams need to be able to use the same level of detail presented in this study to recruit players that possess the physical qualities to execute the team’s desired tactical plan.

Unlike previous research that analysed physical metrics in isolation (Rampinini et al., 2007; Di Salvo et al., 2009), the present study demonstrated unique physical-tactical match profiles inherent in various tactical roles. In possession, COP covered more high-intensity distance for ‘Break into Box’ (ES: 0.6-2.8) and ‘Run in Behind/Penetrate’ (ES: 1.1-5.2) compared to other positions. This could be explained by offensive players attacking space in behind the opponent back line and/or entering the box to score a goal (da Costa et al., 2009). Additionally, WOP performed greater ‘Run with Ball’ distance at high-intensity (ES: 0.8-1.7) whilst WDP ran more ‘Over/Underlap’ distance (ES: 0.9-1.4) compared to other positions, both of which agree with previous findings (Carling, 2010; Ade, Fitzpatrick and Bradley, 2016). Furthermore, WDP and WOP performed more high-intensity distance for ‘Support Play’ (ES: 0.3-2.9) and ‘Move to Receive/Exploit Space’ (ES: 0.3-2.5) than CDP and CMP. It is noteworthy in that CMP covered less distance at high-intensity for ‘Support Play’ than WDP and WOP given the purpose of the action. ‘Support Play’ is when the ball is played forward quickly and the players behind or level with the ball tend to produce high-intensity efforts to become involved in the attacking/transition phase of play, which is vital to produce an offensive threat (Bradley, 2020). This disparity may be due to a variety of tactical roles within CMP (e.g., B2BM, CDM and CAM) in which the highest percentage spread in high-intensity running distance (32-33%) has been reported (Bradley and Scott, 2020). Furthermore, this could be explained with the data for specialised tactical roles, demonstrating that no differences were observed in the high-intensity distance covered for 'Support Play' between B2BM, CAM, WB and WM, but all of them covered ~670-890% greater distance than CDM.

Out of possession, COP performed more high-intensity 'Close Down/Press' activities than other positions (ES: 1.1-4.2). This may be due to the increased adoption in modern football of the 'pressing' tactic (Low et al., 2021). Nonetheless, when it comes to specialised tactical roles, CF^1 covered ~40% greater high-intensity distance for such actions compared to CF^2 (~270 m vs ~190 m, respectively). This is possibly be due to the number of players up front as forwards since a single centre forward (e.g., forwards in a 4-5-1 formation) tends to cover greater high-intensity distance when out of possession (Bradley et al., 2011) compared to two players up front (e.g., forwards in a 4-4-2 formation). In contrast, CDP covered less distance at high-intensity for 'Close Down/Press' but greater for 'Covering' compared to other positions. This might be because CDP have limited space to achieve high-intensity running (>19.8 $km \cdot h^{-1}$) to close the opponent down when defending but have more space behind them to cover space or a player whilst being goal side, especially when they are around the half line (Modric, Versic and Sekulic, 2020). This could be confirmed by the fact that the average high-intensity distance covered by CDP for 'Closing Down/Press' was lower than COP (~15m vs ~20m, respectively). CDP may accelerate more to close down the opponent since maximal accelerations are often executed at velocities below high-intensity speed thresholds (Varley and Aughey, 2013). This suggests that the ability to frequently perform accelerations is a key requirement for CDP to be prepared for. Collectively, physical-tactical performance data clearly explains 'WHY' players cover the high-intensity running distance during a match. It would be more effective to use the data of specialised tactical roles when prescribing training drills whilst replicating physical-tactical demands of play since applying generalist positions could lead to the misinterpretation of the contextualised data in selected positions.

No studies in the literature have attempted to compare match running performance analysed with the general positional analysis (e.g., CMP) to that with the specialised positional analysis (e.g., B2BM, CDM and CAM) for determining their sensitivity. The comparison of the physical-tactical characteristics between the two different analyses has revealed that the player's physical-tactical demand of play can be under or overestimated if using the general positional analysis. When comparing FB and WB to their general role (WDP), 34% less and 15% more high-intensity distance was covered by respective tactical roles. Furthermore, the average numbers of high-intensity activities per match for 'Recover Run', as well as 'Support Play', 'Move to Receive/Exploit Space' and 'Run in Behind/Penetrate' could be overestimated for FB whilst these could be underestimated for WB except for 'Recovery Run' if using the general positional analysis. This trend could be due to WB running higher up the pitch to get involved in the attacking or the transition phase of play after the team regains the possession of the ball, and then producing 'Recovery Run' actions to get goal side when a turnover in possession occurs (Konefał et al., 2015). WB play akin to WM given that no differences were observed between them regarding all of the in-possession categories except for 'Over/Underlap' and 'Run in Behind/Penetrate'. On the other hand, CDM covered 30% less high-intensity distance compared to their general role (CMP) whilst CAM performed 22% more albeit with no statistical difference. Specifically, the average number of high-intensity 'Close Down/Press' actions performed by CDM (*n*=2) and CAM (*n*=9) per game could be over or underestimated with the use of the general positional analysis (CMP, *n*=5) whereas CAM could perform fewer high-intensity 'Covering' actions per match. This clearly shows their different tactical duties during a match. For example, CAM are more likely to support the press whilst attackers are aggressively closing down the opponent on the ball or receiving the ball (Michels, 2001); however, CDM tend to stay back to ensure defensive coverage whilst blocking space in front of the defence (Aalbers and Van Haaren, 2019). Moreover, in possession greater numbers of high-intensity 'Support Play', 'Move to Receive/Exploit Space', 'Run in Behind/Penetrate' and 'Break into Box' actions were executed for CAM compared to their general position (CMP); however, an opposite trend was seen for CDM. Thus, again coaches and practitioners should consider the specific tactical roles of players within the team when conditioning their players during training sessions. However, such detailed positional analysis is labour-intensive as it requires the observations of each player per match to be considered in light of numerous contextual factors that can influence match performance (Rampinini et al., 2007; Bradley et al., 2011). Hence, the development and adoption of machine learning approaches will be key in automatically classifying these specialised tactical roles (Aalbers and Van Haaren, 2019).

More granular data were disclosed with the additional options within the integrated approach. Supported by the findings from Ade, Fitzpatrick and Bradley (2016), the present study demonstrated that WOP completed more high-intensity actions for 'Support Play' and 'Run with Ball' while driving inside (from a wide to the central zone) than other positions. Also, wide players (WDP and WOP) performed more high-intensity activities in a wide area ('Over/Underlap' and 'Support Play' for WDP only; 'Move to Receive/Exploit Space' and 'Run with Ball' for both of them) compared to other positions. This could be because wide defensive and midfield players tend to deliver more crosses from a wide area after high-intensity running (Konefał et al., 2015; Ade, Fitzpatrick and Bradley, 2016). Moreover, whilst COP produced more high-intensity efforts for 'Break into Box–toward the central area in the box' than other positions, WOP and WDP executed more high-intensity actions for 'Break into Box–toward a wide area in the box'. This may be due to the fact that wide players (WOP and WDP) are more likely to initiate their high-intensity actions from a wide zone (James, Mellalieu and Hollely, 2002), and then possibly run towards a wide zone in the box when a cross is about to be made from the opposite wide area. This data may be used to determine where players should initiate and end their explosive actions at high-intensity for the purpose of certain tactical actions when structuring training sessions (e.g., simulated situations or patterns of play).

Out of possession, COP performed more 'Close Down/Press' actions both toward the player on the ball and receiving the ball than all other positions, which agrees with Ade, Fitzpatrick and Bradley (2016). This may be due to the specific tactical role of attackers tending to trigger pressing (Michels, 2001). Forwards could close down and/or press toward the opposition player receiving the ball as soon as a pass is made, typically from the central to a wide area, and then perhaps players next to them (e.g., WF and CAM) could support the press collectively toward space to block the passing line or an opponent player moving to receive the ball (Lucchesi, 2004). Additionally, CDP completed more high-intensity activities for ‘Covering–long ball/pass’ than other positions whilst CDP and WDP executed more high-intensity actions for ‘Recovery Run–Ball passed over top/downside’. Similar findings have been reported in which central and wide defenders perform more high-intensity actions when the opponent team plays the ball long towards the defensive line (e.g., ball over the top and ball down the side) compared to other positions (Ade, Fitzpatrick and Bradley, 2016). Thus, it seems to be important for defensive players (CDP and WDP) to have the ability to quickly turn their body (e.g., 90-180° turns) to cover long ball/pass or to produce ‘Recovery Run’ when the ball is played over top or downside of the back line.

To improve the transparency around the data collection procedures, the proportion of single (*n*=14,728), hybrid (*n*=2,505) and unclassified actions (*n*=1,715) were calculated, accounting for 78%, 13% and 9%, respectively. Among hybrid actions, the most frequent 5 patterns of hybrid actions (primary–secondary actions) for out-of-possession actions were ‘Recovery Run–Covering’, ‘Covering–Recovery Run’, ‘Covering–Close Down/Press’, Close Down/Press–Covering and ‘Recovery Run–Close Down/Press’. In contrast, the most frequent 5 in-possession variables were ‘Move to Receive/Exploit Space–Run in Behind/Penetrate’, ‘Support Play–Break into Box’, ‘Move to Receive/Exploit Space–Run with Ball’, ‘Support Play–Move to Receive/Exploit Space’ and ‘Move to Receive/Exploit Space–Support Play’. Such information may help facilitate coaches and practitioners to simulate specific scenarios with a combination of tactical actions during training sessions (Ade et al., 2021), such as drills that mimic the attack-to-defence transition phases with players producing ‘Support Play–Break into Box’ as a hybrid action followed by ‘Recovery Run–Covering’ when dispossessed. The present study provides such detailed information on tactically ‘WHY’ and ‘HOW’ players perform high-intensity running actions during a match; however, it should be noted that match-to-match variabilities for high-intensity distance and contextualised actions were high (CV: ~20%) and very high (CV: ~60-65%), respectively, which is in line with previous studies (Gregson et al., 2010; Bush et al., 2015a; Ade, Fitzpatrick and Bradley, 2016; Carling et al., 2016). Hence, the reader should be aware of these high variabilities when interpreting data and making decisions.

4.6 Limitations

The samples of certain positions (e.g., CAM and WF) were relatively small compared to other positions, which could have affected the trends presented in this study. However, this could be due to the stringent game selection criteria for balancing and controlling data and/or such positions being more likely replaced with substitutions (Carling et al., 2014). Moreover, as the match-to-match variability for high-intensity distance (CV: 21-22%) and physical-tactical performance (CV: 62-67%) were high, the reader should always be aware that the present findings are extremely niche in relation to the EPL and the specific cultural and stylistic elements of that league, and thus may not necessarily apply to other elite leagues.

4.7 Practical Recommendations

- Physical-tactical characteristics (i.e., 'WHY' and 'HOW' players perform high-intensity running efforts during a match) of various tactical roles presented in the study could be used to design training drills (Figure 4.4, 4.5, 4.6 and 4.7). However, match physical-tactical demands of players were found to be over or underestimated if using a general positional analysis (e.g., FB and CM). Therefore, profiling individual players with their specific playing styles/tactical roles (e.g., WB or FB and CDM or CAM) within the team should be considered for designing position- or even player-specific training drills according to their own physical-tactical characteristics.
- Since the integrated approach appeared to be sensitive in detecting a player's playing style during a match, players having the physical-tactical characteristics matched to the team's playing style could be shortlisted for scouting (Carling, Williams and Reilly, 2005). Therefore, recruitment teams need to be able to use this level of detail to optimise the recruitment of players with physical qualities that align with the team's desired tactical plan. However, caution should be exercised when making decisions due to the high match-to-match variability for physical-tactical performances (CV: 62-67%).

4.8 Conclusion

Using generalist positions is less sensitive to estimate the actual isolated physical and contextualised demands of players and this may under and overestimate overall physical performance metrics of selected positions. The contextualised data trends presented could have huge practical implications for the design of positional play and position specific training sessions as well as recruitment. Finally, readers should be aware of the high degree of match-to-match variability exhibited in physical-tactical actions and understand that metric stability will be difficult to establish.

4.9 Linkage to the Next Study

This present study provides physical-tactical trends of various positions. However, limited evidence exists in the literature to support a link between success in football and physical capacity or match running performance (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2013a). Possible reasons may be due to a lack of tactical information in relation to high-intensity running activities (Carling, 2013) and/or the methodologies that previous studies have used such as including only individual players who completed the entire match playing in the same position to understand position-specific trends rather than actual team patterns (Bradley et al., 2016). Thus, the next study will examine ‘team’ performances alongside individual player data according to final league ranking through fusing physical metrics with tactical actions to identify associations between success in football and physical-tactical performances. This may help demarcate between various team standards and/or league rankings in elite football.

CHAPTER FIVE

TIER-SPECIFIC CONTEXTUALISED HIGH-INTENSITY RUNNING PROFILES IN THE ENGLISH PREMIER LEAGUE: MORE ON-BALL MOVEMENT AT THE TOP

TIER-SPECIFIC CONTEXTUALISED HIGH-INTENSITY RUNNING PROFILES IN THE ENGLISH PREMIER LEAGUE: MORE ON-BALL MOVEMENT AT THE TOP

5.1 Abstract

Purpose: The present study aimed to determine the physical-tactical profiles of both elite football teams and individual players according to final league rankings. **Method:** A total of 50 English Premier League matches (*n*=100 team observations and 583 player observations) were analysed by coding physical-tactical actions of teams/players through the amalgamation of tracking data and video. Final league rankings were categorised into Tiers: (A) 1st–5th ranking (*n*=25), (B) 6th–10th ranking (*n*=26), (C) 11th–15th ranking (*n*=26) and (D) 16th–20th ranking (*n*=23). **Result:** Tier A teams covered 39-51% more high-intensity distance for 'Move to Receive/Exploit Space' (ES: 1.3-1.6, $P<0.01$) and 'Run with Ball' (ES: 0.9-1.0, $P<0.05$) than Tier C and D, and 23-94% more distance for 'Over/Underlap' (ES: 1.0, $P<0.01$), 'Run in Behind/Penetrate' (ES: 0.7, $P<0.05$) and 'Break into Box' (ES: 0.9, $P<0.05$) compared to Tier C. Central and Wide Defensive Players in Tier A covered 65-551% more high-intensity 'Move to Receive/Exploit Space' distance compared to other Tiers (ES: 0.6-1.0, $P<0.01$). Central Midfield Players in Tier A ran 78-112% more high-intensity distance for 'Run with Ball' compared to Tiers B and C (ES: 0.6-0.7, $P<0.05$) whilst Wide Offensive Players in Tier A covered 145-149% more distance performing 'Run in Behind/Penetrate' actions compared to Tier B and C (ES: 1.2-1.3, $P<0.01$). Tier A teams also performed 24-57% more shots on target, ball touches and passes as well as 4-9% higher pass accuracy than other Tiers (ES: 0.7-1.8, $P<0.05$). Moreover, the additional options within the physical-tactical actions and zonal differences unveiled more meaningful insights into 'HOW' top Tier teams physically and tactically perform. **Conclusion:** Although match-to-match variabilities produced by teams were high for high-intensity distance (13%) and physical-tactical actions (48%), the contextualised data help improve our understanding of a team's playing style relative to their competitive standard.

5.2 Introduction

The energetic demands of football (soccer) during a match can be indirectly quantified via time-motion analysis, which can provide valuable data to applied coaching staff (Carling et al., 2008). A plethora of research has quantified the physical demands of elite football during match-play in relation to playing position, formation, fatigue, competitive standard and so forth (Mohr, Krustrup and Bangsbo, 2003; Di Salvo et al., 2007; Rampinini et al., 2007; Bradley et al., 2011; Castellano, Blanco-Villasenor and Alvarez, 2011). Despite an abundance of research, limited evidence exists on the relationship between success in football and physical performance (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2013a; Sæterbakken et al., 2019). This ambiguity seems to be due to limited consideration of the tactical context pertaining to the physical data as tactical scenarios during match-play are one of the factors modulating the physical actions that occur in football (Schuth et al., 2016).

Previous research that examined associations between physical data and final league rankings has demonstrated that lower-ranked clubs ran greater total distance in high-speed running during match-play with higher-ranked teams performing more when in possession of the ball (Di Salvo et al., 2009; Rampinini et al., 2009; Bradley et al., 2016; Brito Souza et al., 2020). Although success in football appears to be more likely associated with greater high-intensity in-possession actions whilst maintaining possession to create more space and attacking threats, it is unknown what types of tactical actions are performed pertaining to high-intensity efforts (Bradley et al., 2016; Brito Souza et al., 2020). Therefore, to improve our understanding of team success, tactical context should be tagged alongside the physical metrics. Furthermore, such limited relationships are possibly due to the methodological approach most previous research has adopted (Mohr, Krustrup and Bangsbo, 2003; Rampinini et al., 2007; Barnes et al., 2014; Bradley et al., 2016). For instance, only individual player performances rather than collective team performances are considered. As football is a team sport where physical and tactical performances of players are affected by not only opponent but also teammate activities (Bradley, 2020), more research is warranted to understand if team performance characteristics are informative when trying to gain insights into the determinants of success.

Technical performances, rather than physical performance per se (e.g., high-intensity running distance), seem to be better indications to predict a team's success and to differentiate between various team standards and/or league rankings in elite football (Rampinini et al., 2007; Konefał et al., 2019a). Higher-ranked clubs tend to have a greater number of shots on target, ball touches and passes, as well as a higher percentage of pass accuracy compared to lower-ranked clubs (Castellano, Casamichana and Lago, 2012; Konefał et al., 2019a). However, using technical metrics in isolation is still one-dimensional and insufficient to understand a team's success and to differentiate between team standards and/or league rankings in football given the fact that players' performances are impacted by the combination of physical, tactical, technical and psychological as well as contextual parameters (Trewin et al., 2017; Bradley, 2020). Some studies have attempted to integrate physical metrics with technical data, but the method they used was not an integration but an aggregation of such performances within their results (Barnes et al., 2014; Bradley et al., 2016).

Currently, a systematic integrated approach that can contextualise physical metrics with key tactical purposes has been established (Chapter 3); however, this approach still does not include technical performance. This is due to this novel approach still requiring a manual coding process, which is labour intensive. Therefore, amalgamating high-intensity running activities with the key tactical purpose of the action could be a starting point (Bradley and Ade, 2018). Despite this shortcoming, the novel approach appears to be a possible solution to better understand a team's success through discriminating between team standards since various physical-tactical patterns of teams/players according to their final league ranking may be identified (e.g., tactically 'WHY' and 'HOW' top class teams cover high-intensity distance during a match). Therefore, this present study aimed to determine the physical-tactical profiles of elite football teams and individual players with reference to final league rankings to identify associations between success and physical-tactical data alongside technical metrics.

5.3 Method

5.3.1 Match Analysis and Team and Player Physical-Tactical Data

Match physical-tactical data were collected from the 2018-19 English Premier League (EPL) season using a systematic integrated approach and a new filter developed for this programme of work. Players' motions were captured by cameras placed at roof level during matches and their physical-tactical actions were manually coded using the integrated approach. The validity and reliability of this approach and the new filter used were verified within Chapter 3, from which detailed methodological information can be found. Using the novel filter, high-intensity activities reaching speeds >19.8 $km \cdot h^{-1}$ for a minimal dwell time of 1 s were isolated (Carling, Le Gall and Dupont, 2012).

The researcher underwent 350 hours of coding to analyse 50 competitive games. This consisted of the total number of 388 individual outfield players across 1,265 player observations within 20 different teams. All of the physical-tactical actions of players for each match were summarised to analyse team performances (those who were subbed in or out were included; *n*=100 match observations). However, regarding an individual player's analysis, only outfield players who had completed the entire match in the same position were included (*n*=583 player observations). This consisted of 179 Central Defensive Players (CDP), 147 Wide Defensive Players (WDP), 167 Central Midfield Players (CMP), 54 Wide Offensive Players (WOP) and 36 Central Offensive Players (COP). All data were analysed for the duration of each half, including stoppage time. Prior to analysis, all original data were anonymised to ensure confidentiality. Research approval was given by the local Ethics Committee of the appropriate institution.

5.3.2 Match Control and Data Balance

For the purpose of improving the scientific rigor of the research design, matches were arbitrarily chosen while concurrently controlling several contextual factors. In accordance with Barnes et al. (2014), the number of player observations largely differs across phases of season, locations (Home/Away), team or opponent standards based on final league ranking. Thus, the number of matches for each feature was initially balanced (Table 5.1). Matches were omitted if goal differential was >3 and a player dismissal occurred since these impact match running performances (Carling and Bloomfield, 2010; Bradley and Noakes, 2013).

5.3.3 League Ranking Categorisations into Tiers

The classification of final league rankings was determined using four Tiers: (A) 1st–5th ranking (*n*=25 match observations), (B) 6th–10th ranking (*n*=26 match observations), (C) 11th–15th ranking (*n*=26 match observations), (D) 16th–20th ranking (*n*=23 match observations). Categorising league ranking is challenging due to inter- and intra-season variations of team performance; however, a generic process was applied in order to explore the physical-tactical performances in relation to different Tiers (Bradley et al., 2016).

5.3.4 The Integrated Approach of Match Performance

Two main coding categories were applied: physical-tactical actions and additional options (movement direction and/or various situational options) to make this approach more systematic (Table 5.2). Isolated high-intensity actions were synchronised with wide-angle video footage of all players throughout matches in order to classify the tactical purpose of each action in conjunction with a relevant additional option. All coding occurred using QuickTime Player (Apple Inc, Cupertino, California) to view video footage of high-intensity efforts and then categorise their tactical actions and additional options using Microsoft Excel with drop-down category lists.

The coding process was as follows: high-intensity actions with one tactical action were coded as a single action with dual tactical actions being classified as a hybrid action. High-intensity activities with more than three tactical actions were coded as ‘Other’. If the high-intensity action consists of 70-90% of the primary and 10-30% of the secondary action, it was classified as a hybrid action. But if it is made up of 50-60% of the primary and 40-50% of the secondary action, then it was coded as ‘Other’. As hybrid actions are a combination of the primary and secondary actions (Bradley and Ade, 2018), single action events and the primary tactical movements of the hybrid actions were merged to simplify data outputs.

Additional options of the physical-tactical actions were also analysed using the descriptions (Table 5.2) and a pitch grid (Figure 5.1). Pitch length was equally divided into three zones to determine defensive, middle and final third. The central zone of the pitch was identical to the width of the penalty box but incorporates half spaces. The penalty box was also divided to form the central and wide areas of the box. The remaining zones were considered wide. This pitch zone description was adapted from Ade et al. (Ade, Fitzpatrick and Bradley, 2016). Player location was established using the time period (from when the player initiated to reach a speed threshold of >19.8 km·h^{-1} to when it dropped under that threshold). The intra-rater reliability for the additional options that was undertaken by the researcher (*n*=241) revealed 88% of agreement with the kappa statistic value of 0.87, which is interpreted as a strong intra-observer reliability (McHugh, 2012).

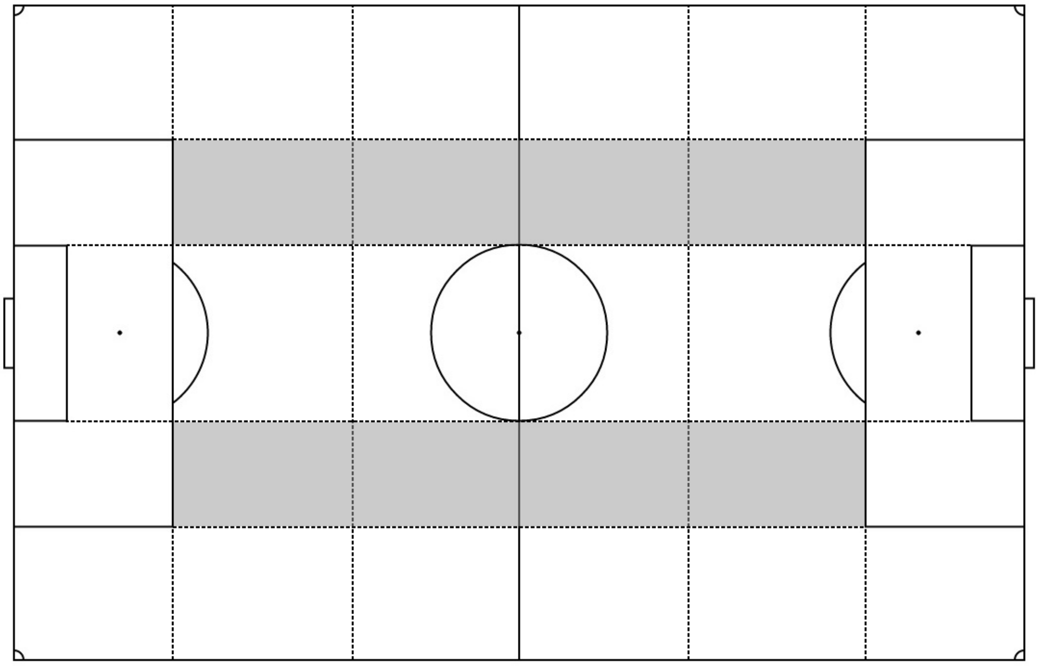


Figure 5.1. The pitch grid used for additional options for a player producing a high-intensity effort with half spaces (areas in grey). Adapted from Ade, Fitzpatrick and Bradley (2016).

Table 5.1. The distribution of the match sample across different four Tiers and contexts.

Tier	A^1	B^1	C^1	D^1	Total
Month					
Aug–Nov	11 (44)	9 (34)	9 (34)	5 (21)	34 (34)
Dec–Feb	7 (28)	9 (34)	8 (30)	10 (43)	34 (34)
Mar–May	7 (28)	8 (30)	9 (34)	8 (34)	32 (32)
Location					
Home	16 (64)	11 (42)	13 (50)	10 (43)	50 (50)
Away	9 (36)	15 (57)	13 (50)	13 (56)	50 (50)
Opponent Tier					
A^2	4 (16)	9 (34)	7 (26)	5 (21)	25 (25)
B^2	9 (36)	4 (15)	6 (23)	7 (30)	26 (26)
C^2	7 (28)	6 (23)	8 (30)	5 (21)	26 (26)
D^2	5 (20)	7 (26)	5 (19)	6 (26)	23 (23)
Overall	25 (25)	26 (26)	26 (26)	23 (23)	100 (100)

Phases of Season: Start of season (Aug–Nov), Middle of season (Dec–Feb) and End of season (Mar–May). Standard were classified based on final league ranking, 1st–5th = A (Top), 6th–10th = B (Top/Middle), 11th–15th = C (Middle/Bottom), 16th–20th = D (Bottom). Superscript 1: the standard of analysed teams (e.g., A^1, B^1, C^1, D^1); Superscript 2: the standard of opposition teams against analysed teams (e.g., A^2, B^2, C^2, D^2). Data in bracket represent the relative proportion of the total sample as a percentage (first decimal rounded down). This table was adapted from Barnes et al. (2014).

Table 5.2. Physical-tactical variables and additional options (direction or different situational options).

Variables	**Description**	**Additional Options**
In Possession		
Push up Pitch	Player moves up the pitch to play offside and/or to squeeze to a higher line.	Move forward/diagonal (Central) Run down channel (Wide) Move into channel (Central to Wide) Move inside (Wide to Central)
Break into Box	Player enters the opposition's penalty box.	Towards the central zone in the box (Central) Towards one of the wide zones in the box (Wide) Towards the central zone through a wide zone in the box (Wide to Central) Within the box
Run in Behind /Penetrate	Player attacks space behind, overtakes and/or unbalances the opposition defence.	Drive forward/diagonal (Central) Run down channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)
Over/Underlap	Player runs from behind to in front of the player on the ball or receiving the ball.	Run down channel (Wide) Run into channel (Central to Wide)
Run with Ball	Player moves with the ball either dribbling with small touches or running at speed with fewer ball touches.	Drive forward/diagonal/lateral (Central) Run down/up channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)
Move to Receive/ Exploit Space	Player moves to receive a pass from a teammate and/or to create/exploit space.	Move forward/diagonal (Central) Move backward/diagonal/lateral (Central) Run down/up channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)
Support Play	Player supports from behind/level by trying to engage in offensive/transition play.	Drive forward/diagonal (Central) Run down channel (Wide) Run into channel (Central to Wide) Drive inside (Wide to Central)

Table 5.2. (continued)

Variables	Description	Additional Options
Out of Possession		
Interception	Player cuts out the ball during the transition of a pass.	Intercept the ball in offensive third Intercept the ball in offensive-mid third Intercept the ball in defensive-mid third Intercept the ball in defensive third
Recovery Run	Player runs back toward their own goal to be goal side of the ball when out of position.	Run back towards own goal (ball behind) Run back towards own goal from attacking/set play (ball still in front) Ball passed over top/downside (opposition closer to the ball)
Covering	Player moves to cover space or an opposition player while remaining goal side of the ball.	Space/a player Long Ball/Pass (>25m; not beaten by opposition)
Close Down /Press	Player runs directly towards opposition player on or receiving the ball, or towards space or players that are not a viable passing option.	Towards the player on the ball (after ball touch) Towards the player receiving the ball (before ball touch) Space/a player
Unclassifiable		
Other	All other variables that could not be categorised by the above.	Each additional option also has 'Other'.

5.3.5 Correlation Analyses

The correlations within physical-tactical actions were analysed in relation to ‘within’ dualities (teammates performing together) and ‘between’ dualities (Team A vs Team B), and also those between technical metrics and the contextualised actions were examined to determine the relationship between match performance data.

5.3.6 Technical Performance Data

Technical tracking data from the matches analysed were collected from an established company (OPTA Sports, London, United Kingdom). The reliability of this system has been verified (Liu et al., 2013). For example, the inter-reliabilities conducted by two independent operators were found to be a very good agreement with the kappa value of 0.92 and 0.94. Technical events such as the number of shots, shots on target, ball touches, passes, crosses, dribbles, long passes, accurate long passes and interceptions as well as pass accuracy were analysed. All individual data for each match were summarised to represent team performances. The definitions of such activities were described in detail elsewhere (Liu et al., 2013).

5.3.7 Match-to-Match Variability of Physical-Tactical Team Performance

The match-to-match variabilities of team performances were calculated to appropriately detect fluctuations between matches and reported as a coefficient of variation (Carling et al., 2016). A total of 19 teams across 99 match observations were included with a median of four matches per team, ranging between 3 and 8 matches (Tier A: 25 observations, Tier B: 26 observations, Tier C: 25 observations and Tier D: 23 observations).

5.3.8 Statistical Analyses

Data are presented as the mean ± standard deviation. All statistical analyses were conducted using IBM SPSS Statistics for Mac OS X, version 26 (IBM Corp., Armonk, N.Y., USA). Data normality was verified by Shapiro-Wilk and Kolmogorov-Smirnov tests. One-way analyses of variance were used to compare match performances by each Tier with Tukey’s post hoc test used to determine localised differences. Statistical significance was set at $P<0.05$. Effect sizes

(Cohen's d) for the meaningfulness of the difference were determined as follows: trivial (≤ 0.2), small (> 0.2–0.6), moderate (> 0.6–1.2), large (> 1.2–2.0), very large (> 2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006). The Pearson correlation coefficient was analysed to determine the relationship between match performance data. According to Hopkins et al. (2009), the magnitudes of the correlation coefficients were regarded as trivial (r ≤0.1), small (r >0.1–0.3), moderate (r >0.3–0.5), large (r >0.5–0.7), very large (r >0.7–0.9) and nearly perfect (r >0.9). The coefficient of variation (CV) was determined by dividing the standard deviation by the mean and multiply by 100 for the analysis of the match-to-match variability of team performances (Gregson et al., 2010; Bush et al., 2015a; Carling et al., 2016).

5.4 Result

5.4.1 Team Data: Contextualised High-Intensity Distance Across Tiers

Total, in-possession and out-of-possession high-intensity distances covered by various Tiers are presented in Table 5.3. In possession, Tier A teams covered 39-51% more distance at high-intensity for 'Move to Receive/Exploit Space' compared to Tier C and D (770±154 m vs 553±183 m and 511±176 m, respectively; ES: 1.3-1.6, P<0.01) and 35-44% more for 'Run with Ball' (530±174 m vs 369±162 m and 394±109 m, respectively; ES: 0.9-1.0, P<0.05). Clubs in Tier A covered 23-94% more high-intensity distances for 'Over/Underlap' compared to Tier C (198±121 m vs 102±74 m; ES: 1.0, P<0.01), 'Run in Behind/Penetrate' (694±184 m vs 565±176 m; ES: 0.7, P<0.05) and 'Break into Box' (226±87 m vs 156±76 m; ES: 0.9, P<0.05). None of the physical-tactical out-of-possession variables showed differences between Tiers (ES: 0.0-0.5, P>0.05). Figure 5.2 illustrates contextualised high-intensity distances covered by teams in different Tiers. Table 5.4 shows detailed information (p-values and effect sizes) on the differences in physical-tactical actions between teams in various Tiers.

Table 5.3. High-intensity distances across various Tiers.

Tier	A	B	C	D	Difference and Effect Size
Total	7778±1039	7242±962	7078±1233	7153±1190	# (ES: 0.1-0.6)
IP	3277±533	2914±742	2439±647	2447±512	A > C*/D* (ES: 1.4-1.6) A > B# (ES: 0.6)
OOP	3835±838	3653±798	3968±878	4057±952	# (ES: 0.1-0.5)
Other	666±195	675±191	671±173	649±239	# (ES: 0.0-0.1)

ES: Effect Size: trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006). Asterisk (*) denotes differences (*P*<0.05); Hash (#) denotes no differences (*P*>0.05). IP: In Possession, OOP: Out of Possession. Values are represented as means and standard deviations (m).

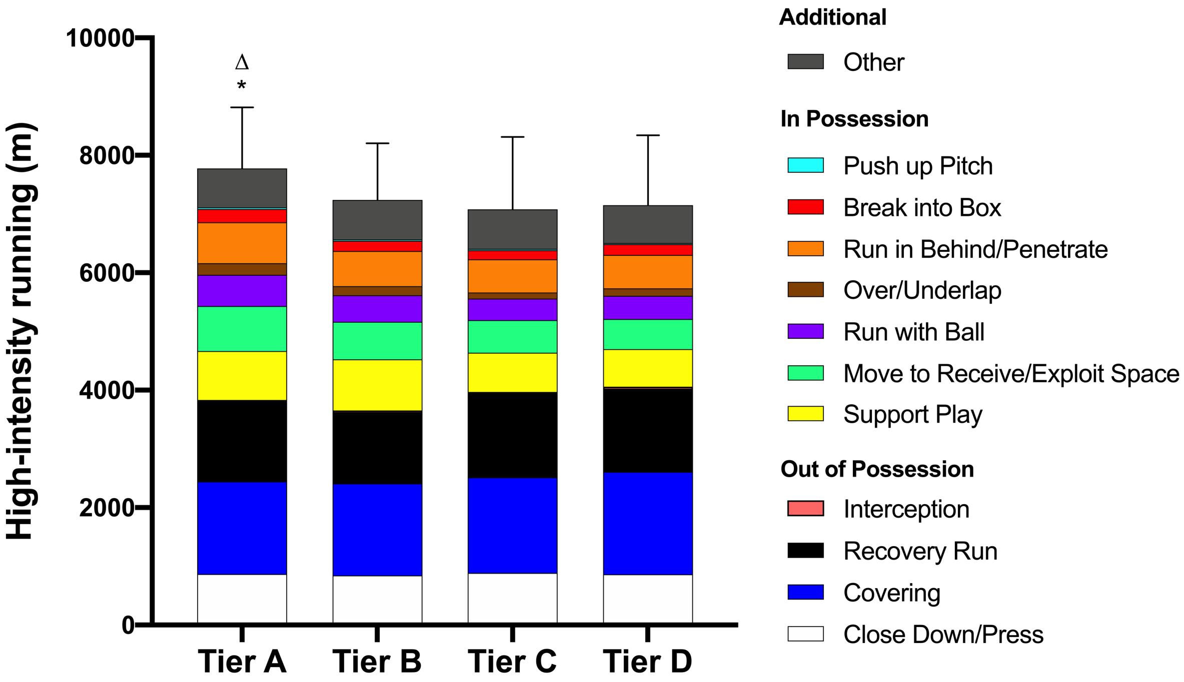


Figure 5.2. Team contextualised high-intensity distance covered by various Tiers. *Distances covered for 'Move to Receive/Exploit Space' (*P*<0.01) and 'Run with Ball' (*P*<0.05) were greater than Tier C and D. $^{\Delta}$Distances covered for 'Over/Underlap' (*P*<0.01), 'Run in Behind/Penetrate' (*P*<0.05) and 'Break into Box' (*P*<0.05) were greater than Tier C. The volume of distances covered for 'Interception' and 'Push up Pitch' was relatively small, thus they are invisible on the figure.

Table 5.4. Differences in physical-tactical variables between ‘teams’ in different Tiers along with effect sizes.

Action	**Tier**	**Distance (m)**	**Difference and Effect Size**			
			A	B	C	D
SP	A (*n*=25)	830.6± 326.9		*P*=0.959 (0.1)	*P*=0.265 (0.6)	*P*=0.165 (0.7)
	B (*n*=26)	874.1± 412.7			*P*=0.093 (0.6)	*P*=0.052 (0.7)
	C (*n*=26)	671.4± 245.0				*P*=0.989 (0.1)
	D (*n*=23)	643.6± 204.4				
MTR/ES	A (*n*=25)	769.7± 154.3		*P*=0.067 (0.7)	*P*<0.001 (1.3)	*P*<0.001 (1.6)
	B (*n*=26)	637.7± 230.4			*P*=0.378 (0.4)	*P*=0.094 (0.7)
	C (*n*=26)	553.4± 183.3				*P*=0.858 (0.2)
	D (*n*=23)	510.6± 175.9				
OVL/UDL	A (*n*=25)	198.1± 120.5		*P*=0.383 (0.4)	*P*=0.003 (1.0)	*P*=0.064 (0.6)
	B (*n*=26)	155.7± 75.4			*P*=0.180 (0.7)	*P*=0.765 (0.3)
	C (*n*=26)	102.2± 74.7				*P*=0.747 (0.3)
	D (*n*=23)	129.3± 101.9				
RWB	A (*n*=25)	530.1± 174.4		*P*=0.311 (0.4)	*P*=0.003 (3.0)	*P*=0.021 (3.3)
	B (*n*=26)	452.1± 181.7			*P*=0.251 (2.2)	*P*=0.586 (2.6)
	C (*n*=26)	161.6± 31.7				*P*=0.950 (1.9)
	D (*n*=23)	109.4± 22.8				
RIB/PEN	A (*n*=25)	693.6± 184.1		*P*=0.198 (0.5)	*P*=0.038 (0.7)	*P*=0.054 (0.8)
	B (*n*=26)	599.4± 165.1			*P*=0.883 (0.2)	*P*=0.913 (0.2)
	C (*n*=26)	565.0± 176.3				*P*=0.959 (0.0)
	D (*n*=23)	567.7± 144.8				
BIB	A (*n*=25)	226.3±87.0		*P*=0.196 (0.6)	*P*=0.049 (0.9)	*P*=0.472 (0.4)
	B (*n*=26)	172.4±91.6			*P*=0.923 (0.2)	*P*=0.960 (0.1)
	C (*n*=26)	155.7±75.9				*P*=0.689 (0.3)
	D (*n*=23)	186.0±126.9				
PUP	A (*n*=25)	28.9±31.7		*P*=0.900 (0.2)	*P*=0.878 (0.2)	*P*=0.483 (0.4)
	B (*n*=26)	22.7±37.5			*P*=1.000 (0.0)	*P*=0.868 (0.2)
	C (*n*=26)	22.2±26.0				*P*=0.891 (0.2)
	D (*n*=23)	15.6±32.5				

Table 5.4. (continued)

Action	Tier	Distance (m)	Difference and Effect Size			
			A	B	C	D
CD/PRE	A (*n*=25)	867.0±269.2		*P*=0.994 (0.1)	*P*=0.995 (0.1)	*P*=1.000 (0.0)
	B (*n*=26)	845.2±396.7			*P*=0.958 (0.1)	*P*=0.996 (0.1)
	C (*n*=26)	887.0±242.2				*P*=0.993 (0.1)
	D (*n*=23)	863.9±257.6				
COV	A (*n*=25)	1579.8±326.9		*P*=0.999 (0.0)	*P*=0.977 (0.1)	*P*=0.515 (0.4)
	B (*n*=26)	1566.3±333.6			*P*=0.951 (0.1)	*P*=0.437 (0.4)
	C (*n*=26)	1626.8±477.8				*P*=0.754 (0.2)
	D (*n*=23)	1743.4±482.0				
RR	A (*n*=25)	1363.8±442.5		*P*=0.684 (0.4)	*P*=0.955 (0.1)	*P*=0.978 (0.1)
	B (*n*=26)	1213.4±335.9			*P*=0.360 (0.5)	*P*=0.448 (0.5)
	C (*n*=26)	1433.6± 588.6				*P*=1.000 (0.0)
	D (*n*=23)	1419.9±533.6				
INT	A (*n*=25)	24.4±29.7		*P*=0.967 (0.1)	*P*=0.945 (0.2)	*P*=0.862 (0.2)
	B (*n*=26)	27.8±28.4			*P*=0.733 (0.3)	*P*=0.987 (0.1)
	C (*n*=26)	20.4±18.7				*P*=0.543 (0.5)
	D (*n*=23)	30.2±24.2				
OTH	A (*n*=25)	666.1±195.2		*P*=0.998 (0.0)	*P*=1.000 (0.0)	*P*=0.991 (0.1)
	B (*n*=26)	675.3±191.4			*P*=1.000 (0.0)	*P*=0.967 (0.1)
	C (*n*=26)	670.8±172.7				*P*=0.980 (0.1)
	D (*n*=23)	648.7±239.0				

SP: ‘Support Play’, MTR/ES: ‘Move to Receive/Exploit Space’, OVL/UDL: ‘Overlap/Underlap’, RWB: ‘Run with Ball’, RIB/PEN: ‘Run in Behind/Penetrate’, BIB: ‘Break into Box’, PUP: ‘Push up Pitch’, CD/PRE: ‘Close Down/Press’, COV: ‘Covering’, RR: ‘Recovery Run’, INT: ‘Interception’, OTH: ‘Others’. P-values in green indicate differences with orange demonstrating no differences. Values in bracket represent effect size; trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006).

5.4.2 Player Data: Contextualised High-Intensity Distance Across Tiers

Table 5.5 denotes total, in-possession and out-of-possession high-intensity distances covered by different positions in various Tiers. CDP in Tier A covered 176-551% more high-intensity 'Move to Receive/Exploit Space' distance than those in Tier B, C and D (30±36 m vs 11±20 m, 5±11 m and 8±14 m, respectively, ES: 0.7-1.0, *P*<0.01) whilst also covering 375% more high-intensity 'Push up Pitch' distance compared to Tier C (9±18 m vs 2±7 m, ES: 0.5, *P*<0.05; Figure 5.3A).

In possession WDP in Tier A ran 65-90% more high-intensity distance for 'Move to Receive/Exploit Space' than those in Tier B, C and D (90±68 m vs 55±58 m, 48±44 m and 48±34 m, respectively, ES: 0.6-0.8, *P*<0.05) while also covering 114-144% more distances for 'Over/Underlap' and 'Run in Behind/Penetrate' compared to Tier C (71±68 m vs 33±40 m and 45±48 m vs 18±26 m, respectively, ES: 0.7, *P*<0.05). Out of possession WDP in Tier A performed 56% more high-intensity distance for 'Recovery Run' than those in Tier B (227±108 m vs 146±74 m, ES: 0.9, *P*<0.01; Figure 5.3B).

CMP in Tier A ran 78-112% more distance at high-intensity for 'Run with Ball' compared to Tier B and C (59±56 m vs 33±35 m and 28±30 m, respectively, ES: 0.6-0.7, *P*<0.05). Apart from this, none of the other tactical actions exhibited differences for CMP (Figure 5.3C).

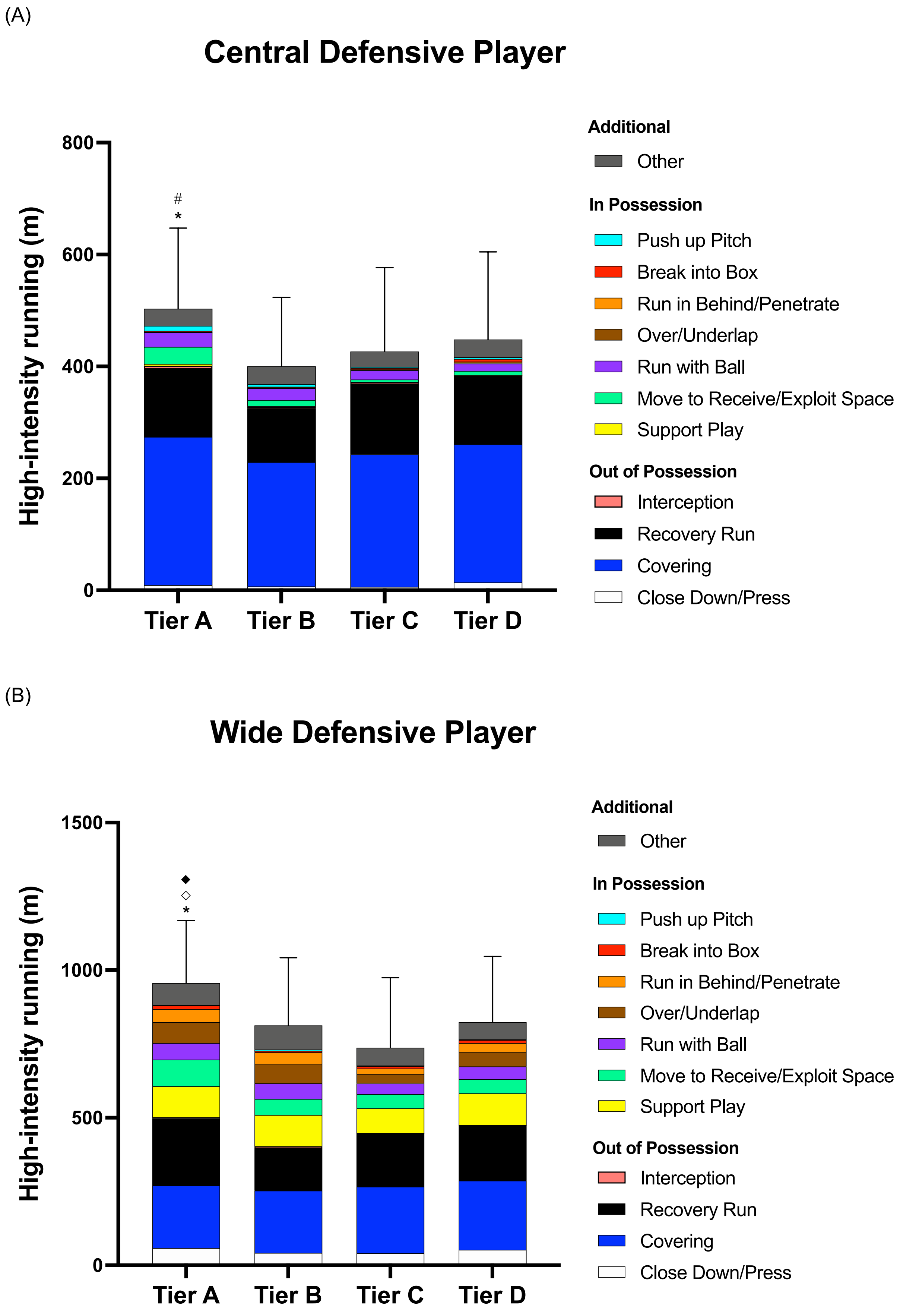
In possession WOP in Tier A covered 145-149% more high-intensity distance for 'Run in Behind/Penetrate' than Tier B and C (176±114 m vs 72±53 m and 70±53 m, respectively, ES: 1.2-1.3, *P*<0.01) while also covering 290% more distance for 'Break into Box' compared to Tier C (48±33 m vs 12±13 m, ES: 1.6, *P*<0.01). However, out of possession WOP in Tier D covered 138% more distance at high-intensity for 'Covering' than those in Tier A (133±59 m vs 56±59 m, ES: 1.3, *P*<0.05; Figure 5.3D).

COP in Tier D covered 378-410% more high-intensity distance for 'Covering' than Tier A and B (76±75 m vs 15±23 m and 16±21 m, respectively, ES: 1.1-1.2, *P*<0.05) whilst none of other physical-tactical actions showed differences (Figure 5.3E). Table 5.6 illustrates detailed information (p-values and effect sizes) on the differences in physical-tactical actions between positions in various Tiers.

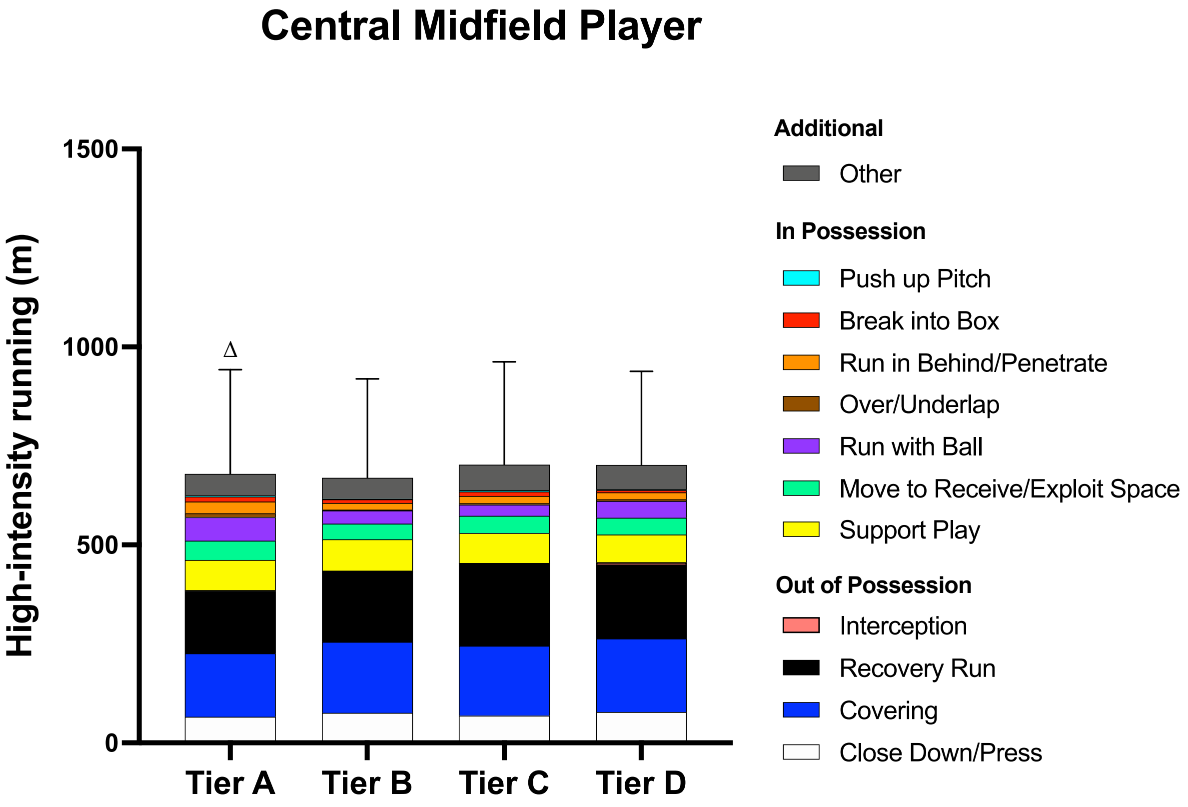
Table 5.5. High-intensity distance (m) between positions in different Tiers.

Position		Tier				Difference and Effect Size
		A	B	C	D	
CDP	Total	503±144	400±123	427±150	448±157	A > B* (ES: 0.8) A > C#/D# (ES: 0.4-0.5)
	IP	72±52	40±39	28±45	33±39	A > B*/C*/D* (ES: 0.7-0.9)
	OOP	401±104	328±121	372±124	384±142	# (ES: 0.1-0.6)
WDP	Total	956±211	813±229	737±237	823±224	A > B*/C* (ES: 0.7-1.0) A > D# (ES: 0.6)
	IP	380±162	328±177	229±117	291±167	A > C* (ES: 1.1) A > B#/D# (ES: 0.3-0.5)
	OOP	502±153	403±130	448±159	475±142	A > B* (ES: 0.7) A > C#/D# (ES: 0.2-0.3)
CMP	Total	680±263	669±250	702±260	702±237	# (ES: 0.0-0.1)
	IP	240±208	182±189	185±152	184±144	# (ES: 0.3)
	OOP	386±187	434±148	454±160	456±195	# (ES: 0.3-0.4)
WOP	Total	886±291	897±152	841±151	963±123	# (ES: 0.0-0.4)
	IP	575±138	475±139	353±153	438±90	A > C* (ES: 1.5) A > B#/D# (ES: 0.7-1.2)
	OOP	247±163	331±83	387±143	421±92	A < C*/D* (ES: 0.9-1.4) A < B# (ES: 0.6)
COP	Total	751±154	847±227	769±211	829±384	# (ES: 0.1-0.5)
	IP	458±100	522±199	379±143	407±291	# (ES: 0.2-0.6)
	OOP	213±110	236±170	321±124	351±117	# (ES: 0.2-1.2)

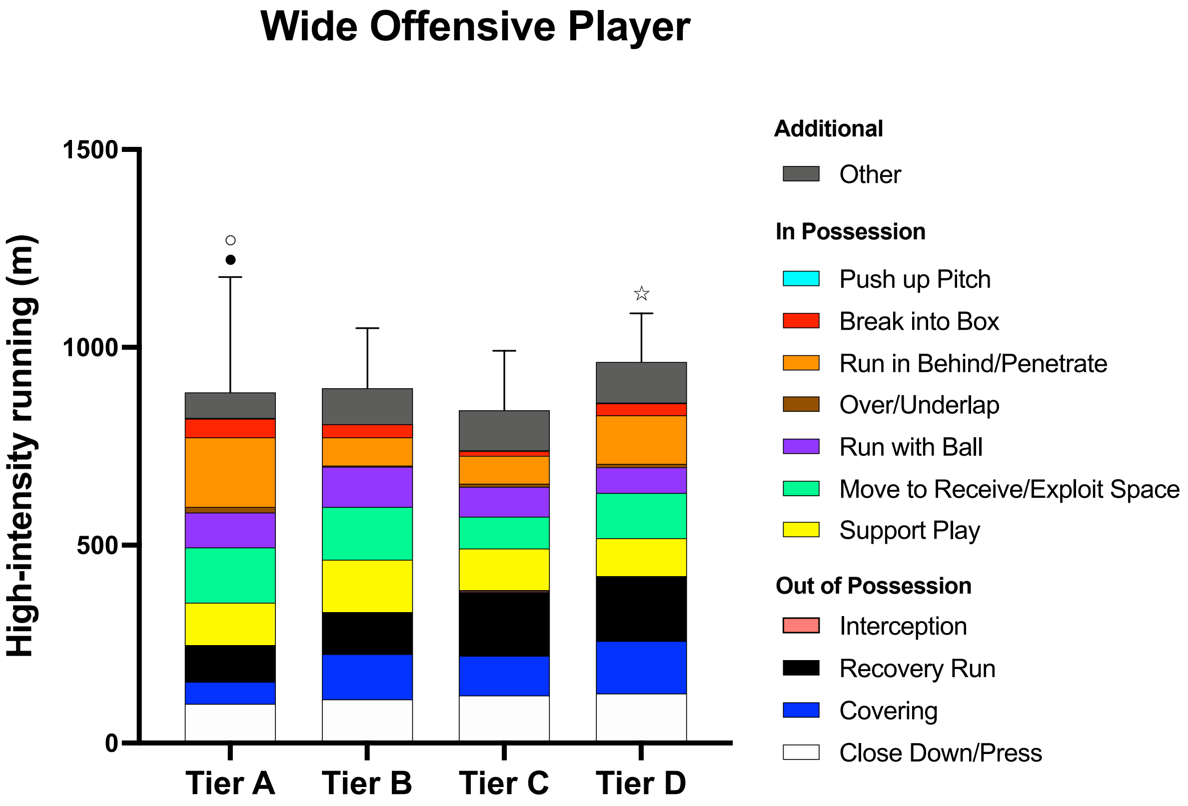
Abbreviations: CDP, Central Defensive Players; WDP, Wide Defensive Players; CMP, Central Midfield Players; WOP, Wide Offensive Players; COP; Central Offensive Players. ES: ES: Effect Size: trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006). Asterisk (*) denotes differences ($P<0.05$); Hash (#) denotes no differences ($P>0.05$). IP: In Possession, OOP: Out of Possession. Values are represented as means and standard deviations (m). Distance covered for 'Other' was included for total but excluded for IP and OOP.


(A)
Central Defensive Player
High-intensity running (m)
0
200
400
600
800
Tier A
Tier B
Tier C
Tier D
#
*
Additional
Other
In Possession
Push up Pitch
Break into Box
Run in Behind/Penetrate
Over/Underlap
Run with Ball
Move to Receive/Exploit Space
Support Play
Out of Possession
Interception
Recovery Run
Covering
Close Down/Press
(B)
Wide Defensive Player
High-intensity running (m)
0
500
1000
1500
Tier A
Tier B
Tier C
Tier D
◆
◇
*
Additional
Other
In Possession
Push up Pitch
Break into Box
Run in Behind/Penetrate
Over/Underlap
Run with Ball
Move to Receive/Exploit Space
Support Play
Out of Possession
Interception
Recovery Run
Covering
Close Down/Press

(C)


Central Midfield Player

(D)


Wide Offensive Player

(E)

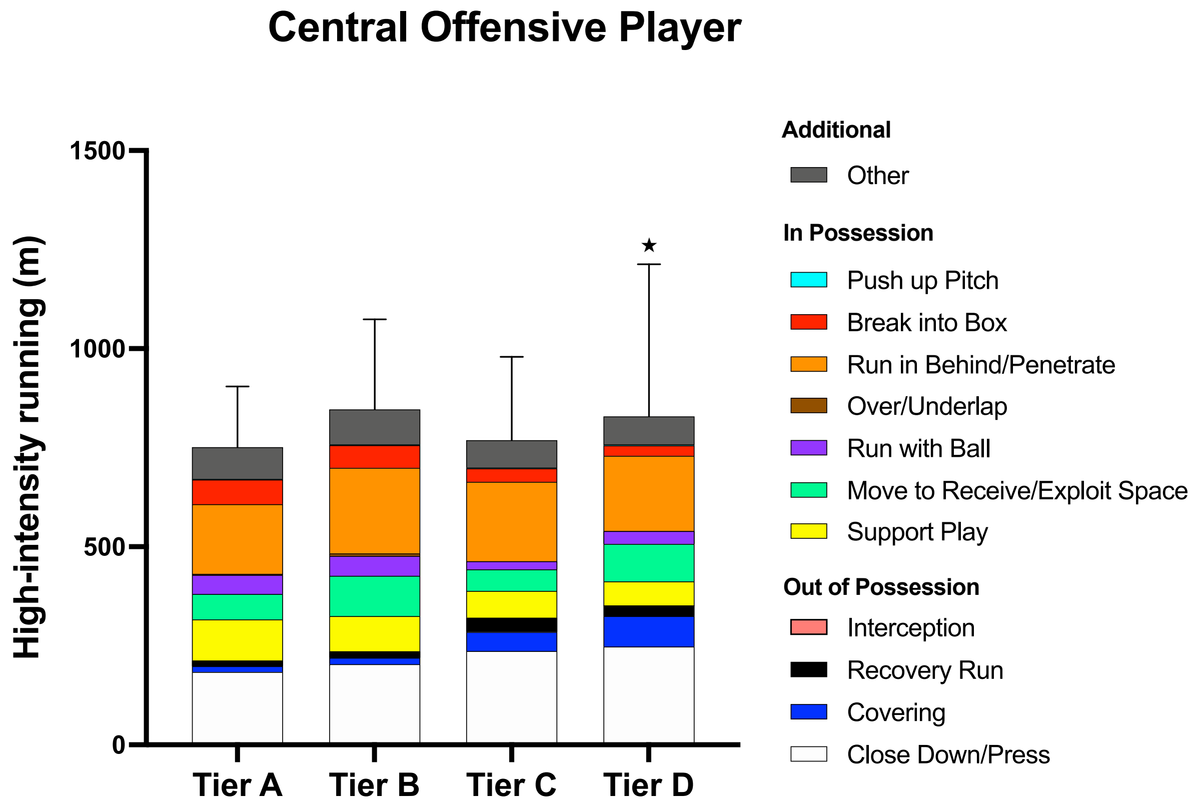


Figure 5.3. Contextualised high-intensity distances covered by (A) Central Defensive Players, (B) Wide Defensive Players, (C) Central Midfield Players, (D) Wide Offensive Players and (E) Central Offensive Players in different Tiers. *Greater distance covered for ‘Move to Receive/Exploit Space’ than Tier A, B and C (*P*<0.01). $^{\#}$Greater distance covered for ‘Push up Pitch’ than Tier C (*P*<0.05). $^{\diamond}$Greater distance covered for ‘Over/Underlap’ than Tier C (*P*<0.05). $^{\blacklozenge}$Greater distance covered for ‘Recovery Run’ than Tier B (*P*<0.05). $^{\Delta}$Greater distance covered for ‘Run with Ball’ than Tier B and C (*P*<0.05). $^{\bullet}$Greater distance covered for ‘Run in Behind/Penetrate’ than Tier B and C (*P*<0.01). $^{\circ}$Greater distance covered for ‘Break into Box’ than Tier C (*P*<0.01). *Greater distance covered for ‘Covering’ than Tier A (*P*<0.05). $^{\bigstar}$Greater distance covered for ‘Covering’ than Tier A and B (*P*<0.05). The volume of ‘Interception’ and ‘Push up Pitch’ distances was relatively small; thus, they are invisible on the figure.

Table 5.6. Differences in physical-tactical variables between ‘positions’ in different Tiers along with effect sizes.

Position	Action	Tier	Distance (m)	Difference and Effect Size			
				A	B	C	D
CDP (*n*=179)	SP	A (*n*=40)	3.5±16.1		*P*=0.530 (0.2)	*P*=0.337 (0.3)	*P*=0.316 (0.3)
		B (*n*=49)	1.1±4.9			*P*=0.983 (0.1)	*P*=0.975 (0.2)
		C (*n*=46)	0.5±3.4				*P*=1.000 (0.0)
		D (*n*=44)	0.4±2.6				
	MTR/ES	A (*n*=40)	30.3±36.1		*P*<0.001 (0.7)	*P*<0.001 (1.0)	*P*<0.001 (0.8)
		B (*n*=49)	11.0±19.8			*P*=0.493 (0.4)	*P*=0.937 (0.1)
		C (*n*=46)	4.7±11.1				*P*=0.854 (0.3)
		D (*n*=44)	8.4±14.1				
	OVL/UDL	A (*n*=40)	0.8±5.0		*P*=0.996 (0.1)	*P*=0.999 (0.0)	*P*=0.915 (0.1)
		B (*n*=49)	0.4±2.9			*P*=0.978 (0.1)	*P*=0.794 (0.2)
		C (*n*=46)	1.0±7.1				*P*=0.956 (0.1)
		D (*n*=44)	1.9±12.4				
	RWB	A (*n*=40)	26.0±28.8		*P*=0.863 (0.2)	*P*=0.400 (0.3)	*P*=0.175 (0.5)
		B (*n*=49)	21.2±29.0			*P*=0.835 (0.2)	*P*=0.531 (0.3)
		C (*n*=46)	16.2±33.5				*P*=0.956 (0.1)
		D (*n*=44)	13.1±23.0				
	RIB/PEN	A (*n*=40)	0.0±0.0		*P*=0.880 (0.3)	*P*=0.953 (0.2)	*P*=0.217 (0.4)
		B (*n*=49)	0.5±2.6			*P*=0.996 (0.0)	*P*=0.579 (0.2)
		C (*n*=46)	0.4±2.6				*P*=0.460 (0.2)
		D (*n*=44)	1.4±5.5				
	BIB	A (*n*=40)	1.9±5.6		*P*=0.999 (0.1)	*P*=0.868 (0.2)	*P*=0.161 (0.4)
		B (*n*=49)	1.6±4.0			*P*=0.765 (0.2)	*P*=0.090 (0.5)
		C (*n*=46)	3.0±7.9				*P*=0.518 (0.2)
		D (*n*=44)	5.1±9.7				
	PUP	A (*n*=40)	9.0±18.2		*P*=0.287 (0.3)	*P*=0.035 (0.5)	*P*=0.100 (0.4)
		B (*n*=49)	4.4±10.8			*P*=0.735 (0.3)	*P*=0.931 (0.1)
		C (*n*=46)	1.9±6.9				*P*=0.978 (0.1)
		D (*n*=44)	2.9±10.6				

Table 5.6. (continued)

Position	**Action**	**Tier**	**Distance (m)**	**Difference and Effect Size**			
				A	B	C	D
CDP (*n*=179)	CD/PRE	A (*n*=40)	9.2±14.4		*P*=0.919 (0.2)	*P*=0.807 (0.2)	*P*=0.465 (0.3)
		B (*n*=49)	7.1±11.9			*P*=0.992 (0.1)	*P*=0.130 (0.4)
		C (*n*=46)	6.2±10.8				*P*=0.075 (0.5)
		D (*n*=44)	14.1±22.5				
	COV	A (*n*=40)	264.9±72.0		*P*=0.105 (0.6)	*P*=0.459 (0.3)	*P*=0.791 (0.2)
		B (*n*=49)	221.9±81.7			*P*=0.842 (0.2)	*P*=0.519 (0.3)
		C (*n*=46)	236.8±87.5				*P*=0.948 (0.1)
		D (*n*=44)	247.0±107.6				
	RR	A (*n*=40)	123.0±73.9		*P*=0.381 (0.4)	*P*=0.998 (0.0)	*P*=0.999 (0.0)
		B (*n*=49)	96.3±70.7			*P*=0.250 (0.4)	*P*=0.425 (0.3)
		C (*n*=46)	126.2±88.6				*P*=0.990 (0.1)
		D (*n*=44)	121.1±78.3				
	INT	A (*n*=40)	3.9±10.4		*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.4)
		B (*n*=49)	2.8±7.6			*P*=1.000 (0.1)	*P*=1.000 (0.3)
		C (*n*=46)	2.4±6.3				*P*=1.000 (0.2)
		D (*n*=44)	1.2±3.9				
	OTH	A (*n*=40)	30.8±30.0		*P*=0.882 (0.0)	*P*=0.763 (0.1)	*P*=0.332 (0.0)
		B (*n*=49)	31.8±30.7			*P*=0.994 (0.2)	*P*=0.736 (0.0)
		C (*n*=46)	27.5±23.3				*P*=0.876 (0.1)
		D (*n*=44)	31.5±31.7				

Table 5.6. (continued)

Position	Action	Tier	Distance (m)	Difference and Effect Size			
				A	B	C	D
WDP (*n*=147)	SP	A (*n*=36)	105.0±74.8		*P*=1.000 (0.0)	*P*=0.600 (0.3)	*P*=0.999 (0.0)
		B (*n*=38)	105.8±82.3			*P*=0.557 (0.3)	*P*=1.000 (0.0)
		C (*n*=40)	83.9±57.1				*P*=0.518 (0.3)
		D (*n*=33)	107.7±79.8				
	MTR/ES	A (*n*=36)	90.2±67.7		*P*=0.023 (0.6)	*P*=0.003 (0.8)	*P*=0.007 (0.8)
		B (*n*=38)	54.7±58.4			*P*=0.933 (0.1)	*P*=0.958 (0.1)
		C (*n*=40)	47.6±44.0				*P*=1.000 (0.0)
		D (*n*=33)	48.4±33.8				
	OVL/UDL	A (*n*=36)	70.5±67.8		*P*=0.987 (0.1)	*P*=0.018 (0.7)	*P*=0.385 (0.3)
		B (*n*=38)	66.1±54.3			*P*=0.043 (0.7)	*P*=0.574 (0.3)
		C (*n*=40)	33.0±39.5				*P*=0.588 (0.3)
		D (*n*=33)	49.3±56.4				
	RWB	A (*n*=36)	56.0±45.6		*P*=0.988 (0.1)	*P*=0.137 (0.5)	*P*=0.543 (0.3)
		B (*n*=38)	53.0±44.5			*P*=0.249 (0.4)	*P*=0.732 (0.2)
		C (*n*=40)	36.1±33.4				*P*=0.876 (0.2)
		D (*n*=33)	43.1±35.4				
	RIB/PEN	A (*n*=36)	44.5±48.2		*P*=0.928 (0.1)	*P*=0.017 (0.7)	*P*=0.378 (0.3)
		B (*n*=38)	39.0±40.6			*P*=0.081 (0.6)	*P*=0.732 (0.2)
		C (*n*=40)	18.2±25.5				*P*=0.581 (0.4)
		D (*n*=33)	29.7±35.8				
	BIB	A (*n*=36)	12.8±23.1		*P*=0.265 (0.4)	*P*=0.700 (0.2)	*P*=0.956 (0.1)
		B (*n*=38)	5.1±9.6			*P*=0.864 (0.2)	*P*=0.586 (0.3)
		C (*n*=40)	8.3±15.6				*P*=0.951 (0.1)
		D (*n*=33)	10.6±22.6				
	PUP	A (*n*=36)	1.4±5.4		*P*=0.410 (0.3)	*P*=1.000 (0.0)	*P*=0.990 (0.1)
		B (*n*=38)	3.8±8.4			*P*=0.427 (0.3)	*P*=0.622 (0.2)
		C (*n*=40)	1.5±5.2				*P*=0.995 (0.1)
		D (*n*=33)	1.9±6.7				

Table 5.6. (continued)

Position	**Action**	**Tier**	**Distance (m)**	**Difference and Effect Size**			
				A	B	C	D
WDP (*n*=147)	CD/PRE	A (*n*=36)	58.5±40.0		*P*=0.272 (0.4)	*P*=0.223 (0.5)	*P*=0.914 (0.1)
		B (*n*=38)	42.1±38.8			*P*=1.000 (0.0)	*P*=0.685 (0.2)
		C (*n*=40)	41.3±27.8				*P*=0.623 (0.3)
		D (*n*=33)	52.4±48.8				
	COV	A (*n*=36)	211.4±90.3		*P*=1.000 (0.0)	*P*=0.919 (0.1)	*P*=0.733 (0.3)
		B (*n*=38)	210.7±97.7			*P*=0.904 (0.2)	*P*=0.706 (0.3)
		C (*n*=40)	225.3±95.9				*P*=0.973 (0.1)
		D (*n*=33)	234.9±93.5				
	RR	A (*n*=36)	227.4±108.3		*P*=0.009 (0.9)	*P*=0.231 (0.4)	*P*=0.388 (0.4)
		B (*n*=38)	146.0±73.8			*P*=0.519 (0.3)	*P*=0.420 (0.4)
		C (*n*=40)	179.8±125.5				*P*=0.996 (0.0)
		D (*n*=33)	185.7±121.1				
	INT	A (*n*=36)	4.2±8.4		*P*=0.998 (0.0)	*P*=0.531 (0.3)	*P*=0.553 (0.3)
		B (*n*=38)	4.5±10.7			*P*=0.405 (0.3)	*P*=0.432 (0.3)
		C (*n*=40)	1.8±5.1				*P*=1.000 (0.0)
		D (*n*=33)	1.8±5.0				
	OTH	A (*n*=36)	74.5±63.9		*P*=0.930 (0.1)	*P*=0.661 (0.2)	*P*=0.561 (0.3)
		B (*n*=38)	81.9±53.6			*P*=0.284 (0.4)	*P*=0.226 (0.5)
		C (*n*=40)	60.7±49.0				*P*=0.996 (0.1)
		D (*n*=33)	58.0±39.6				

Table 5.6. (continued)

Position	Action	Tier	Distance (m)	Difference and Effect Size			
				A	B	C	D
CMP (*n*=167)	SP	A (*n*=39)	76.2±88.2		*P*=0.997 (0.0)	*P*=1.000 (0.0)	*P*=0.992 (0.1)
		B (*n*=41)	80.3±124.0			*P*=0.996 (0.0)	*P*=0.962 (0.1)
		C (*n*=47)	75.7±79.5				*P*=0.993 (0.1)
		D (*n*=40)	70.2±71.4				
	MTR/ES	A (*n*=39)	49.3±43.6		*P*=0.799 (0.2)	*P*=0.968 (0.1)	*P*=0.913 (0.2)
		B (*n*=41)	39.1±63.2			*P*=0.962 (0.1)	*P*=0.994 (0.1)
		C (*n*=47)	44.3±47.1				*P*=0.996 (0.1)
		D (*n*=40)	41.9±44.2				
	OVL/UDL	A (*n*=39)	9.5±22.6		*P*=0.093 (0.4)	*P*=0.185 (0.4)	*P*=0.317 (0.3)
		B (*n*=41)	2.3±7.4			*P*=0.977 (0.1)	*P*=0.926 (0.2)
		C (*n*=47)	3.5±8.7				*P*=0.995 (0.1)
		D (*n*=40)	4.2±12.5				
	RWB	A (*n*=39)	59.1±56.0		*P*=0.031 (0.6)	*P*=0.004 (0.7)	*P*=0.290 (0.3)
		B (*n*=41)	33.2±34.8			*P*=0.935 (0.2)	*P*=0.748 (0.2)
		C (*n*=47)	27.9±29.6				*P*=0.369 (0.4)
		D (*n*=40)	42.4±44.0				
	RIB/PEN	A (*n*=39)	30.1±52.7		*P*=0.351 (0.3)	*P*=0.435 (0.3)	*P*=0.411 (0.3)
		B (*n*=41)	16.9±34.5			*P*=0.997 (0.0)	*P*=1.000 (0.0)
		C (*n*=47)	18.4±25.6				*P*=1.000 (0.0)
		D (*n*=40)	17.6±25.8				
	BIB	A (*n*=39)	12.7±18.2		*P*=0.879 (0.2)	*P*=0.974 (0.1)	*P*=0.328 (0.5)
		B (*n*=41)	9.6±20.7			*P*=0.986 (0.1)	*P*=0.767 (0.2)
		C (*n*=47)	11.0±20.5				*P*=0.534 (0.3)
		D (*n*=40)	5.7±11.0				
	PUP	A (*n*=39)	3.5±7.8		*P*=0.235 (0.5)	*P*=0.988 (0.1)	*P*=0.716 (0.2)
		B (*n*=41)	0.6±2.5			*P*=0.099 (0.6)	*P*=0.838 (0.2)
		C (*n*=47)	4.0±8.1				*P*=0.478 (0.3)
		D (*n*=40)	1.9±7.9				

Table 5.6. (continued)

Position	Action	Tier	Distance (m)	Difference and Effect Size			
				A	B	C	D
CMP (*n*=167)	CD/PRE	A (*n*=39)	65.9±50.5		*P*=0.904 (0.1)	*P*=0.996 (0.1)	*P*=0.852 (0.2)
		B (*n*=41)	75.8±88.5			*P*=0.962 (0.1)	*P*=0.999 (0.0)
		C (*n*=47)	69.0±61.1				*P*=0.927 (0.2)
		D (*n*=40)	77.7±54.1				
	COV	A (*n*=39)	160.5±111.2		*P*=0.856 (0.2)	*P*=0.898 (0.2)	*P*=0.706 (0.2)
		B (*n*=41)	179.3±93.7			*P*=0.999 (0.0)	*P*=0.992 (0.1)
		C (*n*=47)	176.4±94.1				*P*=0.975 (0.1)
		D (*n*=40)	186.0±123.3				
	RR	A (*n*=39)	156.2±94.7		*P*=0.779 (0.2)	*P*=0.079 (0.5)	*P*=0.490 (0.3)
		B (*n*=41)	176.5±88.1			*P*=0.467 (0.3)	*P*=0.963 (0.1)
		C (*n*=47)	206.3±95.9				*P*=0.780 (0.2)
		D (*n*=40)	186.8±104.5				
	INT	A (*n*=39)	3.1±6.8		*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.3)
		B (*n*=41)	2.5±5.9			*P*=1.000 (0.1)	*P*=1.000 (0.3)
		C (*n*=47)	2.0±4.5				*P*=1.000 (0.4)
		D (*n*=40)	5.7±12.3				
	OTH	A (*n*=39)	53.6±52.8		*P*=0.989 (0.0)	*P*=0.923 (0.2)	*P*=0.428 (0.2)
		B (*n*=41)	53.3±45.5			*P*=0.990 (0.2)	*P*=0.249 (0.2)
		C (*n*=47)	63.7±55.3				*P*=0.122 (0.0)
		D (*n*=40)	61.9±47.2				

Table 5.6. (continued)

Position	Action	Tier	Distance (m)	Difference and Effect Size			
				A	B	C	D
WOP (*n*=54)	SP	A (*n*=11)	107.7±93.7		*P*=0.871 (0.3)	*P*=1.000 (0.0)	*P*=0.983 (0.1)
		B (*n*=10)	132.9±58.0			*P*=0.774 (0.4)	*P*=0.664 (0.6)
		C (*n*=20)	104.8±79.7				*P*=0.990 (0.1)
		D (*n*=13)	96.5±62.8				
	MTR/ES	A (*n*=11)	139.8±66.9		*P*=0.995 (0.1)	*P*=0.074 (1.0)	*P*=0.758 (0.4)
		B (*n*=10)	133.0±84.3			*P*=0.156 (0.8)	*P*=0.894 (0.3)
		C (*n*=20)	80.3±56.7				*P*=0.453 (0.6)
		D (*n*=13)	114.1±52.9				
	OVL/UDL	A (*n*=11)	14.2±16.0		*P*=0.218 (1.0)	*P*=0.627 (0.5)	*P*=0.759 (0.3)
		B (*n*=10)	2.5±5.3			*P*=0.726 (0.6)	*P*=0.706 (0.4)
		C (*n*=20)	8.0±11.1				*P*=0.999 (0.0)
		D (*n*=13)	8.7±18.8				
	RWB	A (*n*=11)	88.1±42.7		*P*=0.937 (0.3)	*P*=0.928 (0.2)	*P*=0.725 (0.5)
		B (*n*=10)	102.0±56.8			*P*=0.597 (0.4)	*P*=0.375 (0.7)
		C (*n*=20)	75.6±63.8				*P*=0.945 (0.2)
		D (*n*=13)	64.8±44.9				
	RIB/PEN	A (*n*=11)	175.6±114.2		*P*=0.012 (1.1)	*P*=0.002 (1.3)	*P*=0.319 (0.6)
		B (*n*=10)	71.7±52.5			*P*=1.000 (0.0)	*P*=0.368 (0.8)
		C (*n*=20)	70.4±53.2				*P*=0.209 (0.8)
		D (*n*=13)	122.9±75.1				
	BIB	A (*n*=11)	47.5±32.5		*P*=0.519 (0.5)	*P*=0.002 (1.6)	*P*=0.313 (0.6)
		B (*n*=10)	32.8±29.7			*P*=0.143 (1.0)	*P*=0.993 (0.1)
		C (*n*=20)	12.2±13.4				*P*=0.183 (0.9)
		D (*n*=13)	30.0±25.6				
	PUP	A (*n*=11)	1.6±5.2		*P*=0.922 (0.4)	*P*=0.993 (0.1)	*P*=1.000 (0.0)
		B (*n*=10)	0.0±0.0			*P*=0.767 (0.3)	*P*=0.933 (0.4)
		C (*n*=20)	2.1±7.3				*P*=0.985 (0.1)
		D (*n*=13)	1.4±5.1				

Table 5.6. (continued)

Position	Action	Tier	Distance (m)	Difference and Effect Size			
				A	B	C	D
WOP (*n*=54)	CD/PRE	A (*n*=11)	99.4±59.9		*P*=0.986 (0.2)	*P*=0.866 (0.3)	*P*=0.818 (0.4)
		B (*n*=10)	110.3±75.5			*P*=0.984 (0.1)	*P*=0.960 (0.2)
		C (*n*=20)	120.6±74.0				*P*=0.997 (0.1)
		D (*n*=13)	125.6±80.0				
	COV	A (*n*=11)	55.7±58.7		*P*=0.150 (1.0)	*P*=0.247 (0.6)	*P*=0.020 (1.3)
		B (*n*=10)	114.2±56.8			*P*=0.931 (0.2)	*P*=0.896 (0.3)
		C (*n*=20)	99.7±67.7				*P*=0.455 (0.5)
		D (*n*=13)	132.5±59.4				
	RR	A (*n*=11)	90.7±71.2		*P*=0.981 (0.2)	*P*=0.104 (0.9)	*P*=0.157 (0.8)
		B (*n*=10)	104.2±61.9			*P*=0.271 (0.7)	*P*=0.346 (0.7)
		C (*n*=20)	161.4±84.7				*P*=1.000 (0.0)
		D (*n*=13)	161.1±92.8				
	INT	A (*n*=11)	1.1±3.6		*P*=0.994 (0.2)	*P*=0.490 (0.5)	*P*=0.975 (0.3)
		B (*n*=10)	1.9±6.0			*P*=0.691 (0.4)	*P*=0.999 (0.1)
		C (*n*=20)	5.0±9.8				*P*=0.739 (0.3)
		D (*n*=13)	2.4±5.8				
	OTH	A (*n*=11)	64.8±47.1		*P*=0.592 (0.6)	*P*=0.208 (0.7)	*P*=0.217 (0.8)
		B (*n*=10)	91.3±43.4			*P*=0.958 (0.2)	*P*=0.932 (0.3)
		C (*n*=20)	100.6±48.7				*P*=0.998 (0.1)
		D (*n*=13)	103.4±51.1				

Table 5.6. (continued)

Position	Action	Tier	Distance (m)	Difference and Effect Size			
				A	B	C	D
COP (*n*=36)	SP	A (*n*=8)	104.4±81.1		*P*=0.981 (0.1)	*P*=0.785 (0.6)	*P*=0.765 (0.6)
		B (*n*=9)	88.7±133.5			*P*=0.945 (0.2)	*P*=0.920 (0.3)
		C (*n*=12)	67.9±54.2				*P*=0.999 (0.1)
		D (*n*=7)	61.4±44.6				
	MTR/ES	A (*n*=8)	64.0±35.1		*P*=0.663 (0.5)	*P*=0.989 (0.2)	*P*=0.814 (0.5)
		B (*n*=9)	101.4±92.4			*P*=0.401 (0.7)	*P*=0.997 (0.1)
		C (*n*=12)	54.6±50.5				*P*=0.595 (0.6)
		D (*n*=7)	894.6±80.0				
	OVL/UDL	A (*n*=8)	2.4±6.7		*P*=0.695 (0.4)	*P*=0.867 (0.6)	*P*=0.904 (0.5)
		B (*n*=9)	5.9±11.9			*P*=0.207 (0.8)	*P*=0.313 (0.7)
		C (*n*=12)	0±0				*P*=1.000 (0.0)
		D (*n*=7)	0±0				
	RWB	A (*n*=8)	48.0±37.6		*P*=0.999 (0.1)	*P*=0.340 (0.9)	*P*=0.830 (0.4)
		B (*n*=9)	50.4±35.4			*P*=0.244 (1.0)	*P*=0.747 (0.4)
		C (*n*=12)	19.9±26.6				*P*=0.894 (0.3)
		D (*n*=7)	32.0±48.9				
	RIB/PEN	A (*n*=8)	175.8±71.0		*P*=0.817 (0.6)	*P*=0.938 (0.3)	*P*=0.992 (0.1)
		B (*n*=9)	216.6±57.6			*P*=0.983 (0.2)	*P*=0.946 (0.3)
		C (*n*=12)	201.1±97.7				*P*=0.995 (0.1)
		D (*n*=7)	190.0±145.6				
	BIB	A (*n*=8)	62.4±32.8		*P*=0.985 (0.2)	*P*=0.191 (1.0)	*P*=0.125 (1.3)
		B (*n*=9)	57.1±36.8			*P*=0.323 (0.7)	*P*=0.211 (1.0)
		C (*n*=12)	33.8±27.5				*P*=0.957 (0.3)
		D (*n*=7)	26.5±22.4				
	PUP	A (*n*=8)	1.5±4.1		*P*=0.998 (0.1)	*P*=0.998 (0.1)	*P*=0.988 (0.2)
		B (*n*=9)	2.0±5.9			*P*=1.000 (0.0)	*P*=0.998 (0.1)
		C (*n*=12)	1.9±6.7				*P*=0.998 (0.1)
		D (*n*=7)	2.5±6.5				

Table 5.6. (continued)

Position	**Action**	**Tier**	**Distance (m)**	**Difference and Effect Size**			
				A	B	C	D
COP (*n*=36)	CD/PRE	A (*n*=8)	183.5±97.3		*P*=0.985 (0.2)	*P*=0.767 (0.5)	*P*=0.728 (0.7)
		B (*n*=9)	204.0±154.7			*P*=0.925 (0.2)	*P*=0.884 (0.4)
		C (*n*=12)	236.9±125.9				*P*=0.997 (0.1)
		D (*n*=7)	248.3±73.8				
	COV	A (*n*=8)	15.0±2.8		*P*=1.000 (0.1)	*P*=0.344 (1.0)	*P*=0.043 (1.2)
		B (*n*=9)	16.0±20.7			*P*=0.340 (0.9)	*P*=0.041 (1.2)
		C (*n*=12)	48.1±40.9				*P*=0.514 (0.5)
		D (*n*=7)	76.4±74.5				
	RR	A (*n*=8)	14.0±21.7		*P*=0.996 (0.1)	*P*=0.152 (1.0)	*P*=0.780 (0.4)
		B (*n*=9)	16.4±16.7			*P*=0.208 (1.0)	*P*=0.873 (0.4)
		C (*n*=12)	35.8±22.6				*P*=0.717 (0.5)
		D (*n*=7)	24.7±26.7				
	INT	A (*n*=8)	0.0±0.0		*P*=1.000 (0.0)	*P*=1.000 (0.0)	*P*=0.347 (0.5)
		B (*n*=9)	0.0±0.0			*P*=1.000 (0.0)	*P*=0.324 (0.6)
		C (*n*=12)	0.0±0.0				*P*=0.276 (0.6)
		D (*n*=7)	1.7±4.6				
	OTH	A (*n*=8)	80.2±53.7		*P*=0.988 (0.1)	*P*=0.965 (0.2)	*P*=0.986 (0.2)
		B (*n*=9)	88.5±58.2			*P*=0.833 (0.4)	*P*=0.911 (0.3)
		C (*n*=12)	68.9±39.4				*P*=1.000 (0.0)
		D (*n*=7)	70.9±64.4				

CDP, Central Defensive Players; WDP, Wide Defensive Players; CMP, Central Midfield Players; WOP, Wide Offensive Players; COP, Central Offensive Players. SP: 'Support Play', MTR/ES: 'Move to Receive/Exploit Space', OVL/UDL: 'Overlap/Underlap', RWB: 'Run with Ball', RIB/PEN: 'Run in Behind/Penetrate', BIB: 'Break into Box', PUP: 'Push up Pitch', CD/PRE: 'Close Down/Press', COV: 'Covering', RR: 'Recovery Run', INT: 'Interception', OTH: 'Others'. P-values in green indicate differences with orange demonstrating no differences. Values in bracket represent effect size; trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006).

5.4.3 Team Data: Additional Options of Physical-Tactical Actions Across Tiers

In possession teams in Tier A performed 31% more high-intensity actions for 'Support Play' in the central zone compared to Tier D (26±10 vs 20±6, ES: 0.7, *P*<0.05). Tier A clubs executed 59% more high-intensity actions for 'Move to Receive/Exploit Space' in the central zone forwardly compared to Tier D (16±4 vs 10±4, ES: 1.5, *P*<0.01), 88-118% more in the central zone backwardly compared to Tier B, C and D (6±4 vs 3±2, ES: 1.0-1.1, *P*<0.01) and 44-69% more in a wide area compared to Tier C and D (9±4 vs 5±2 and 6±3, respectively, ES: 1.1, *P*<0.01).

Clubs in Tier A performed 73% more high-intensity activities for 'Over/Underlap' in a wide area compared to Tier C (5±3 vs 3±2, ES: 0.7, *P*<0.05); however, they executed 54-78% more actions for 'Run with Ball' in the central zone compared to Tier B, C and D (12±6 vs 8±5, 7±4 and 7±3, respectively, ES: 0.7-1.0, *P*<0.01).

Teams in Tier A performed 25-43% more high-intensity actions for 'Run in Behind/Penetrate' in the central zone than Tier B (22±5 vs 18±7, ES: 0.7, *P*<0.05) as well as Tier C and D (22±5 vs 16±5 and 15±5, respectively, ES: 1.2, *P*<0.01). In relation to 'Break into Box' Tier A executed 104-137% more high-intensity actions 'Within the box' compared to Tier B and C (4±3 vs 2±2, ES: 0.9-1.0, *P*<0.01). No differences were found for all of the additional options within 'Push up Pitch' actions between Tiers.

Out of possession no differences were found for all of the additional options within 'Close Down/Press', 'Covering', 'Recovery Run' and 'Interception' activities between Tiers. Figure 5.4 illustrates the comparison of additional options for in- (A, B and C) and out-of-possession (D and E) variables between Tiers.

(A)

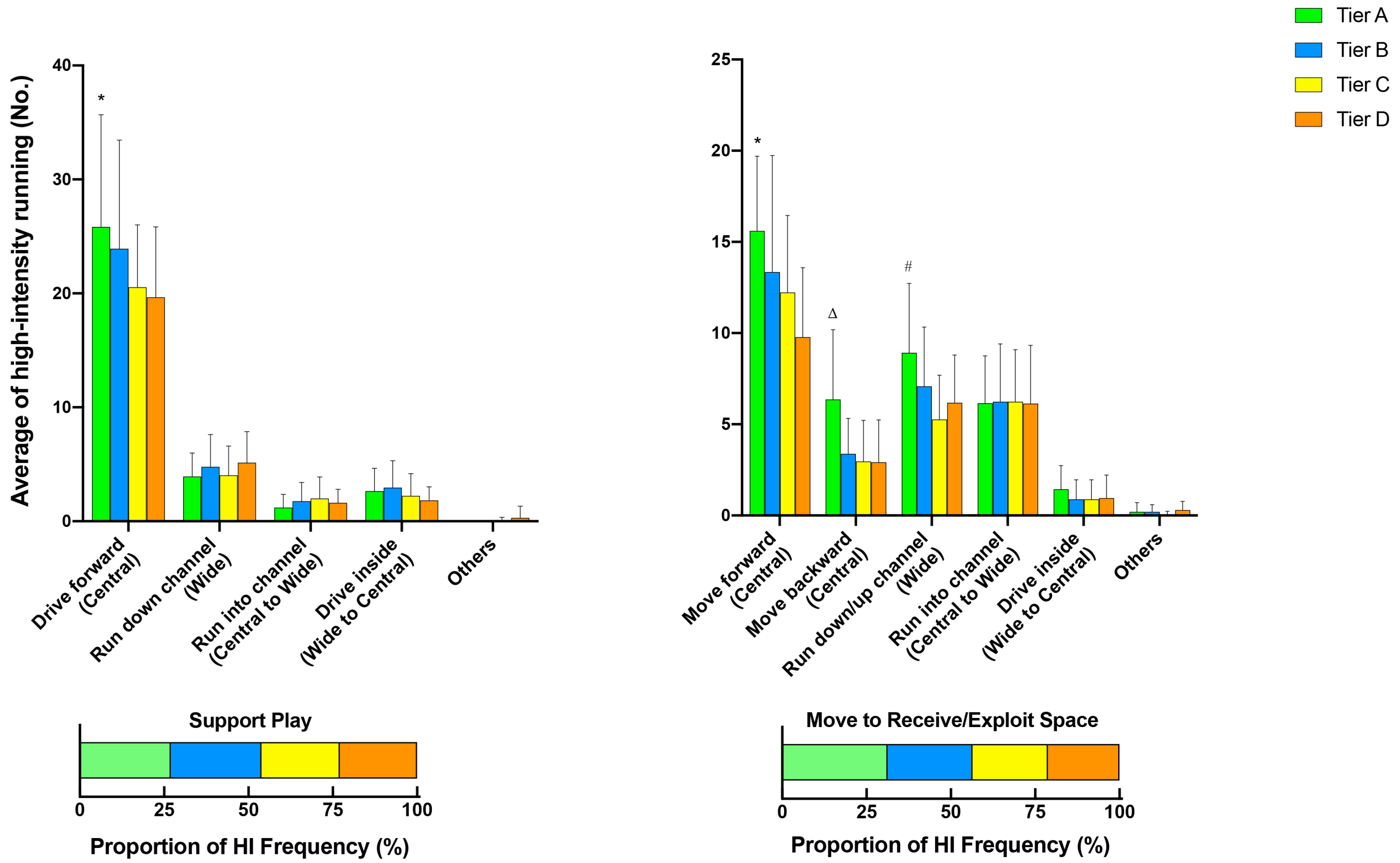


Figure 5.4. Comparison of additional options for in- (A, B and C) and out-of-possession (D and E) variables between Tiers. Symbols denote differences (P<0.05). $^{\Delta}$More actions performed than all other Tiers. *More actions performed than Tier D. $^{\#}$More actions performed than Tier C and D. $^{\bullet}$More actions performed than Tier C. $^{\blacklozenge}$More actions performed than Tier B and C. Values are average numbers of physical-tactical actions per match.

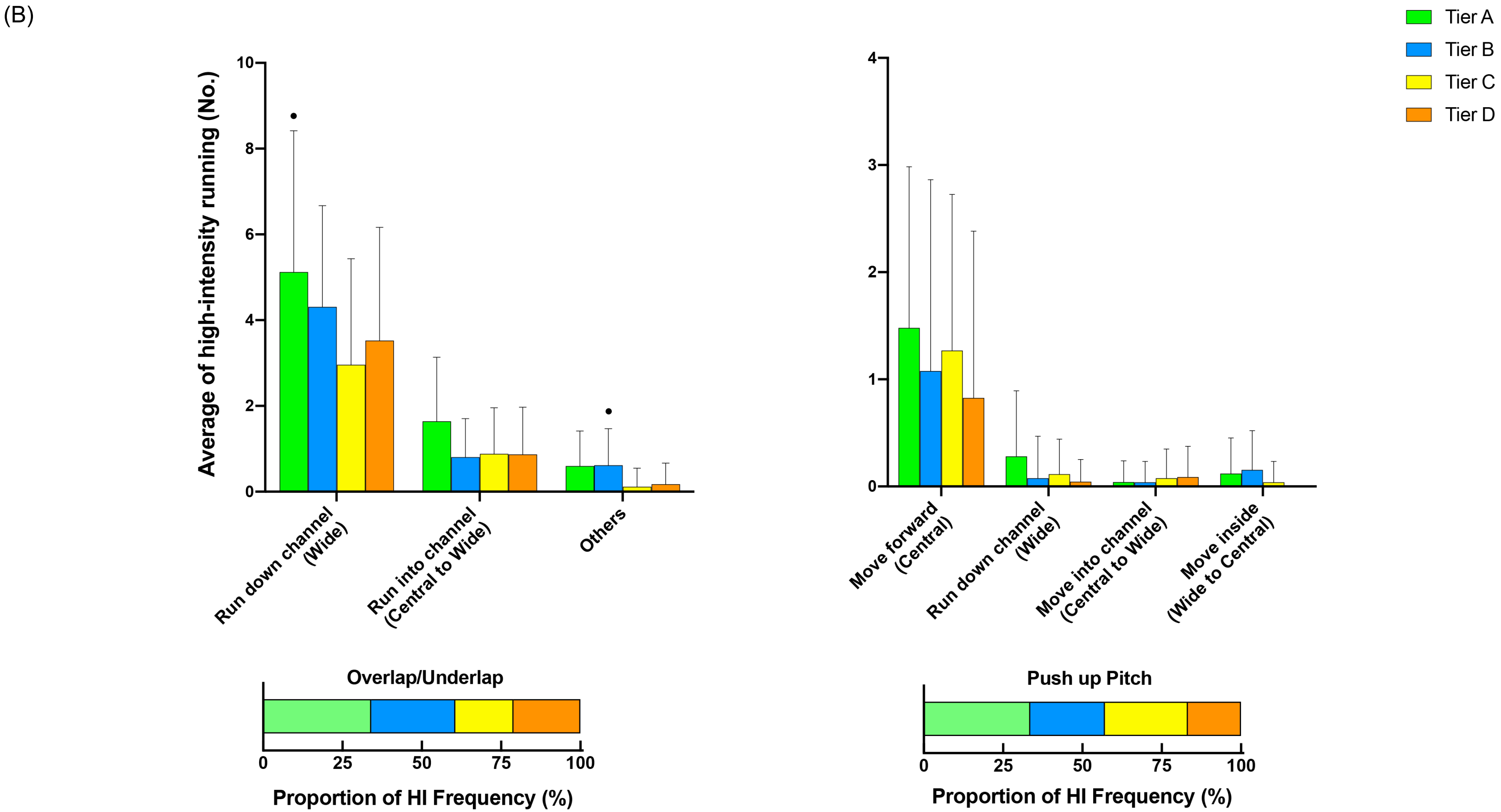


Figure 5.4. Comparison of additional options for in- (A, B and C) and out-of-possession (D and E) variables between Tiers. Symbols denote differences (P<0.05). $^{\Delta}$More actions performed than all other Tiers. *More actions performed than Tier D. $^{\#}$More actions performed than Tier C and D. $^{\bullet}$More actions performed than Tier C. $^{\blacklozenge}$More actions performed than Tier B and C. Values are average numbers of physical-tactical actions per match.

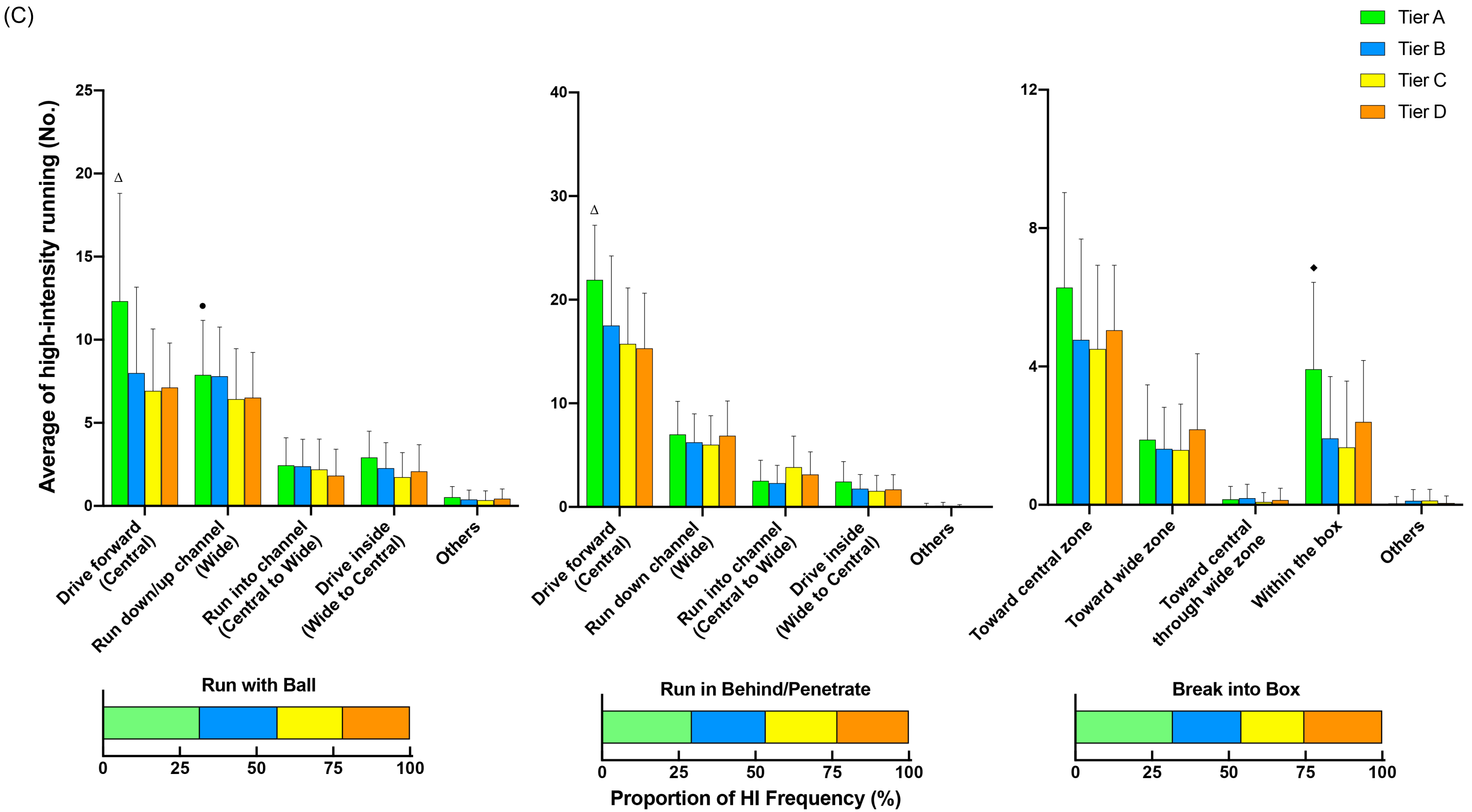


Figure 5.4. Comparison of additional options for in- (A, B and C) and out-of-possession (D and E) variables between Tiers. Symbols denote differences ($P<0.05$). $^{\Delta}$More actions performed than all other Tiers. *More actions performed than Tier D. $^{\#}$More actions performed than Tier C and D. $^{\bullet}$More actions performed than Tier C. $^{\blacklozenge}$More actions performed than Tier B and C. Values are average numbers of physical-tactical actions per match.

(D)

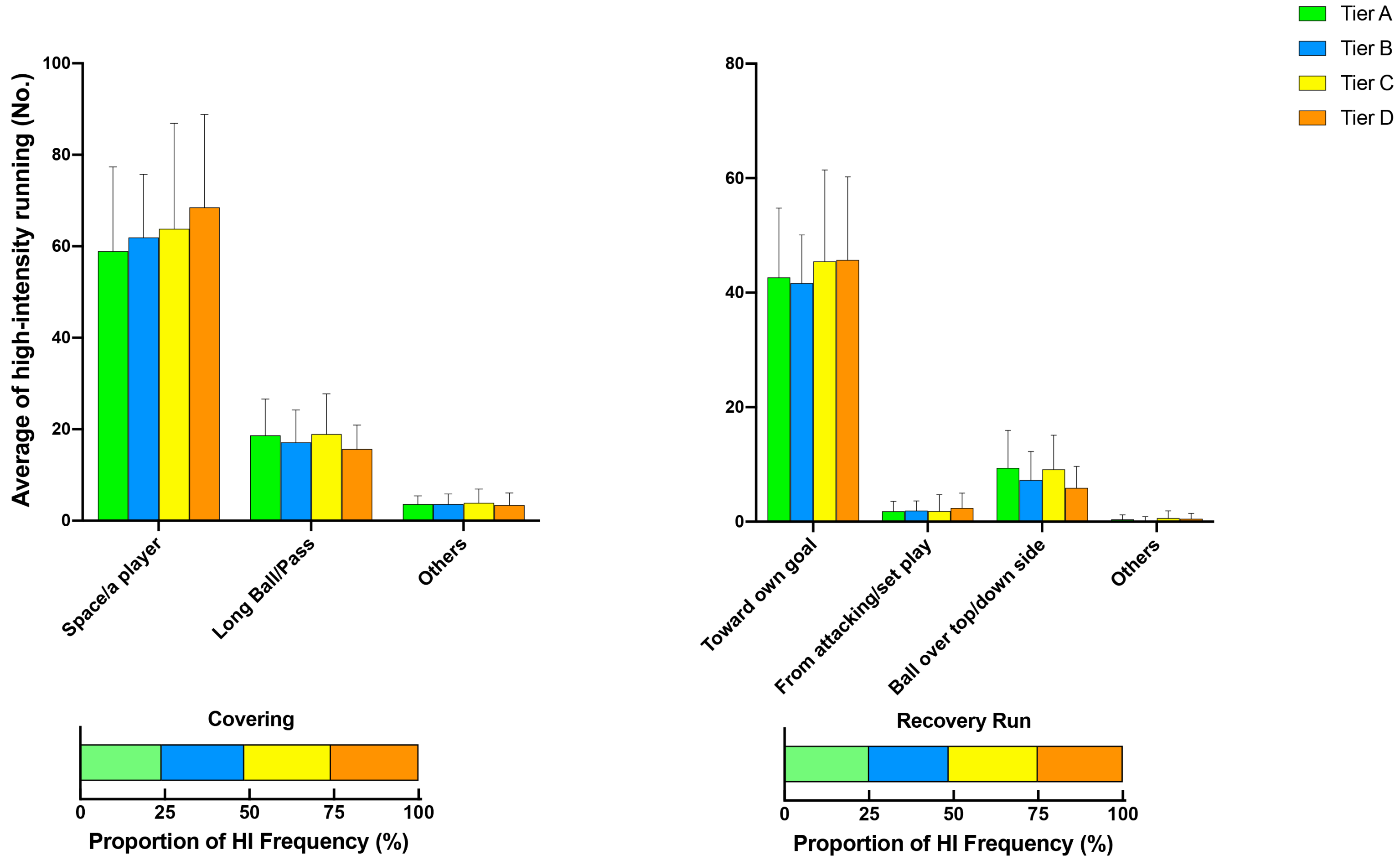


Figure 5.4. Comparison of additional options for in- (A, B and C) and out-of-possession (D and E) variables between Tiers. Symbols denote differences (*P*<0.05). $^{\Delta}$More actions performed than all other Tiers. *More actions performed than Tier D. $^{\#}$More actions performed than Tier C and D. $^{\bullet}$More actions performed than Tier C. $^{\blacklozenge}$More actions performed than Tier B and C. Values are average numbers of physical-tactical actions per match.

(E)

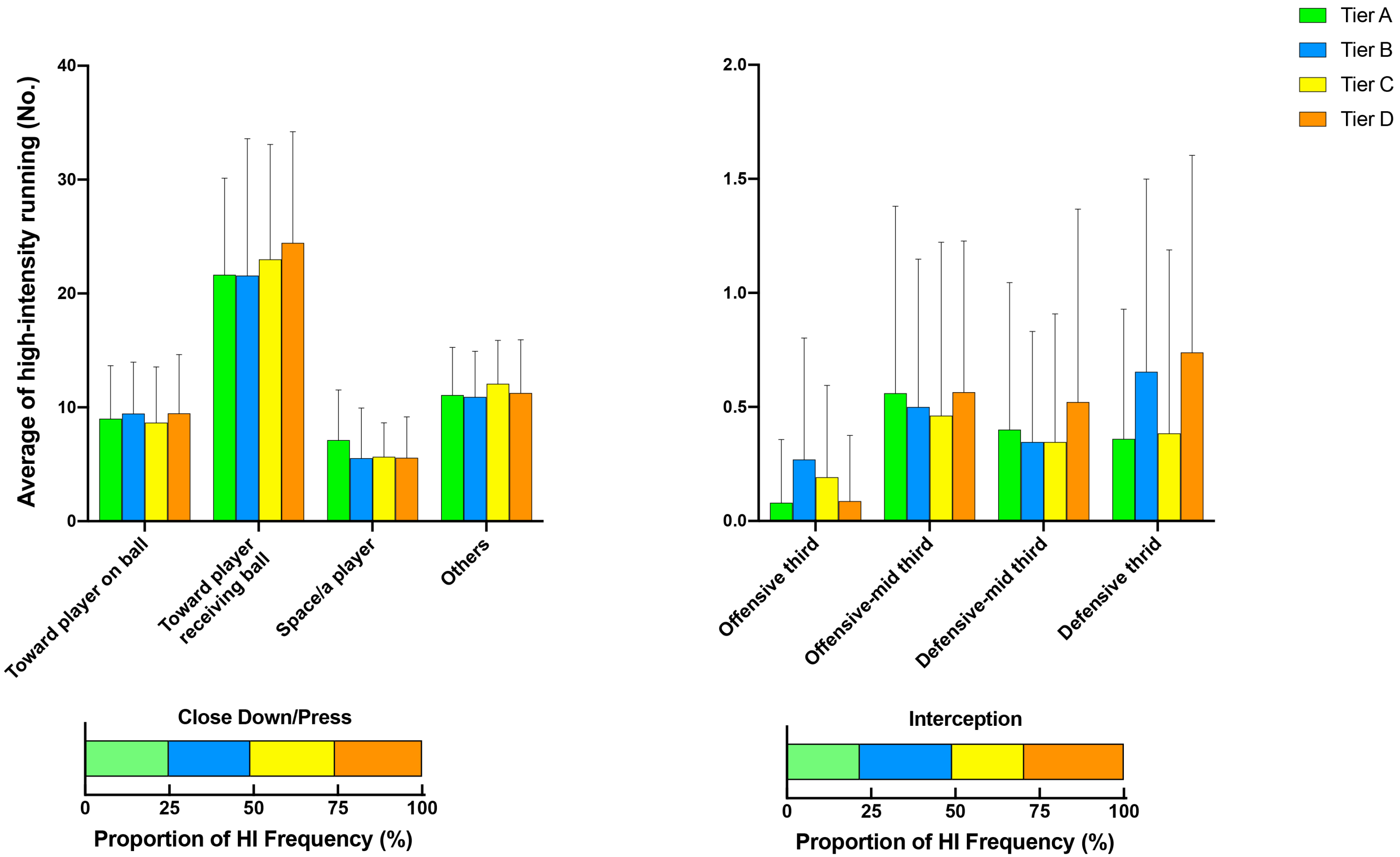


Figure 5.4. Comparison of additional options for in- (A, B and C) and out-of-possession (D and E) variables between Tiers. Symbols denote differences (*P*<0.05). $^{\Delta}$More actions performed than all other Tiers. *More actions performed than Tier D. $^{\#}$More actions performed than Tier C and D. $^{\bullet}$More actions performed than Tier C. $^{\blacklozenge}$More actions performed than Tier B and C. Values are average numbers of physical-tactical actions per match.

5.4.4 Team Data: Zonal Difference of Physical Tactical Actions Across Tiers

From the defensive third of the pitch Tier A clubs produced 56-133% more high-intensity actions for ‘Move to Receive/Exploit Space’ compared to Tier B, C and D (10±5 vs 6±4, 5±3 and 4±3, respectively, ES: 0.7-1.3; *P*<0.01) and 70% more for ‘Run with Ball’ compared to Tier D (5±3 vs 3±2, ES: 0.9, *P*<0.01). Teams in Tier B performed 83% more high-intensity actions for ‘Support Play’ from the defensive third than Tier D (7±6 vs 4±2, ES: 0.6, *P*<0.05).

From the middle third of the pitch clubs in Tier A executed 28% more high-intensity actions for ‘Move to Receive/Exploit Space’ compared to Tier C and D (21±4 vs 17±6 and 17±5, respectively, ES: 0.9-1.1, *P*<0.05) and 88% more for ‘Over/Underlap’ than Tier C (4±3 vs 2±2, ES: 0.8, *P*<0.01). In addition, Tier A completed 42-59% more high-intensity actions for ‘Run with Ball’ from the middle third compared to Tier C and D (14±6 vs 9±5 and 10±3, ES: 0.9-1.0, *P*<0.05).

From the final third of the pitch Tier A teams completed 45-62% more high-intensity actions for ‘Break into Box’ than Tier B and C (11±5 vs 8±4 and 7±3, respectively, ES: 0.8-1.0, *P*<0.05) and 49-56% more actions for ‘Run in Behind/Penetrate’ compared to Tier B, C and D (18±7 vs 12±6, 12±5 and 11±4, respectively, ES: 0.9-1.1, *P*<0.01). Tier A executed 50% more high-intensity actions for ‘Support Play’ from the final third than Tier C (6±3 vs 4±2, ES: 0.8, *P*<0.05), and 128-130% more for ‘Over/Underlap’ compared to Tier C and D (2±3 vs 1±1, ES: 0.7, *P*<0.05).

Out of possession, Tier C produced 26% more high-intensity actions for ‘Covering’ from the defensive third compared to Tier A (35±9 vs 30±9, ES: 0.7, *P*<0.05). Except for this, none of the tactical actions performed from the defensive, middle and final third exhibited differences. The average numbers of high-intensity actions in accordance with tactical actions produced by different Tiers across different areas (defensive, middle and final third) are illustrated in Figure 5.5A for in-possession and 5.5B for out-of-possession variables.

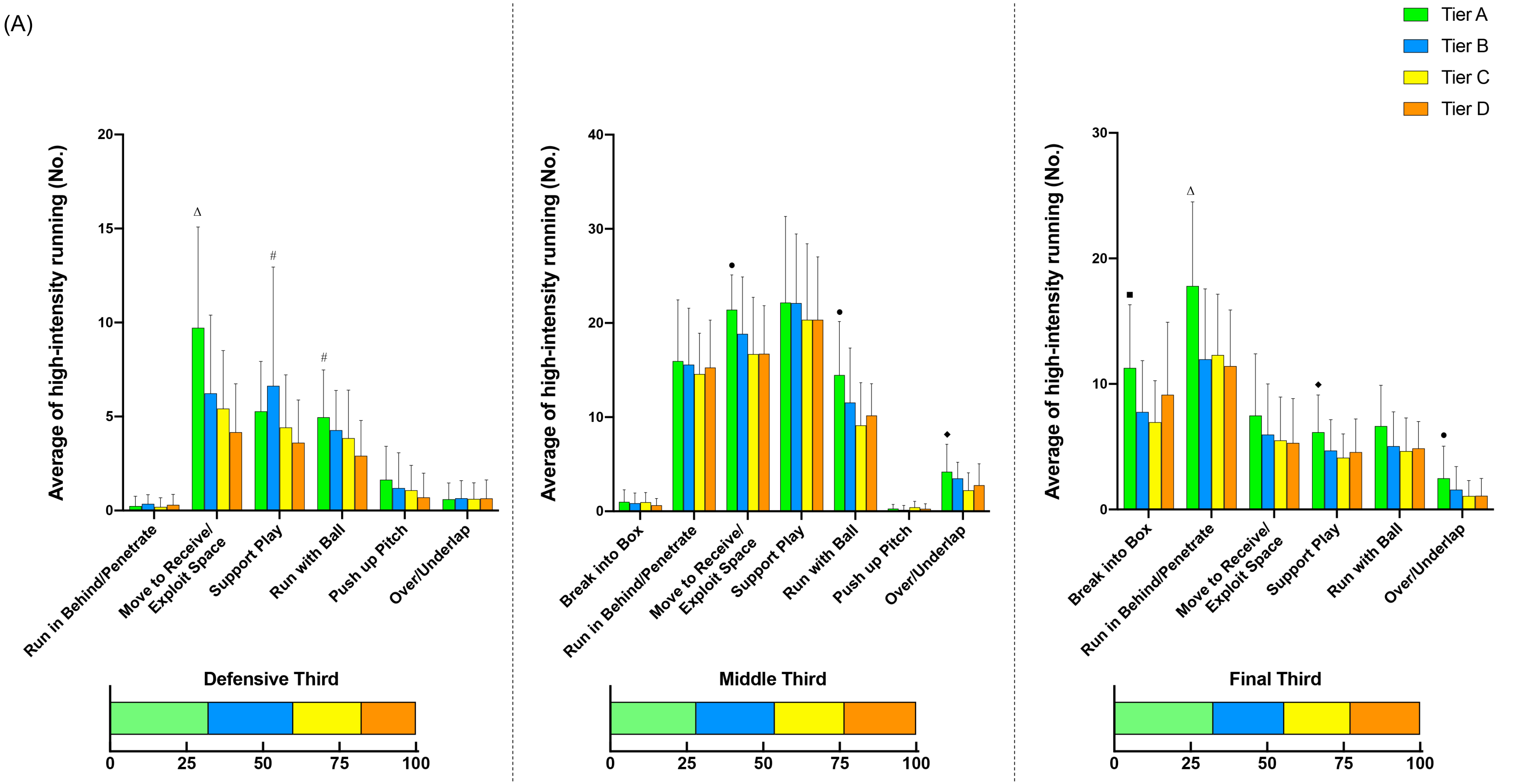


Figure 5.5. Frequency of high-intensity running in relation to (A) in-possession and (B) out-of-possession categories with special reference to different zones (defensive, middle and final third). Symbols denote differences (*P*<0.05). $^{\Delta}$More actions performed than other Tiers. $^{\#}$More actions performed than Tier D. *More actions performed than Tier A. $^{\bullet}$More actions performed than Tier C and D. $^{\blacklozenge}$More actions performed than Tier C. $^{\blacksquare}$More actions performed than Tier B and C. Values are average numbers of physical-tactical actions per match.

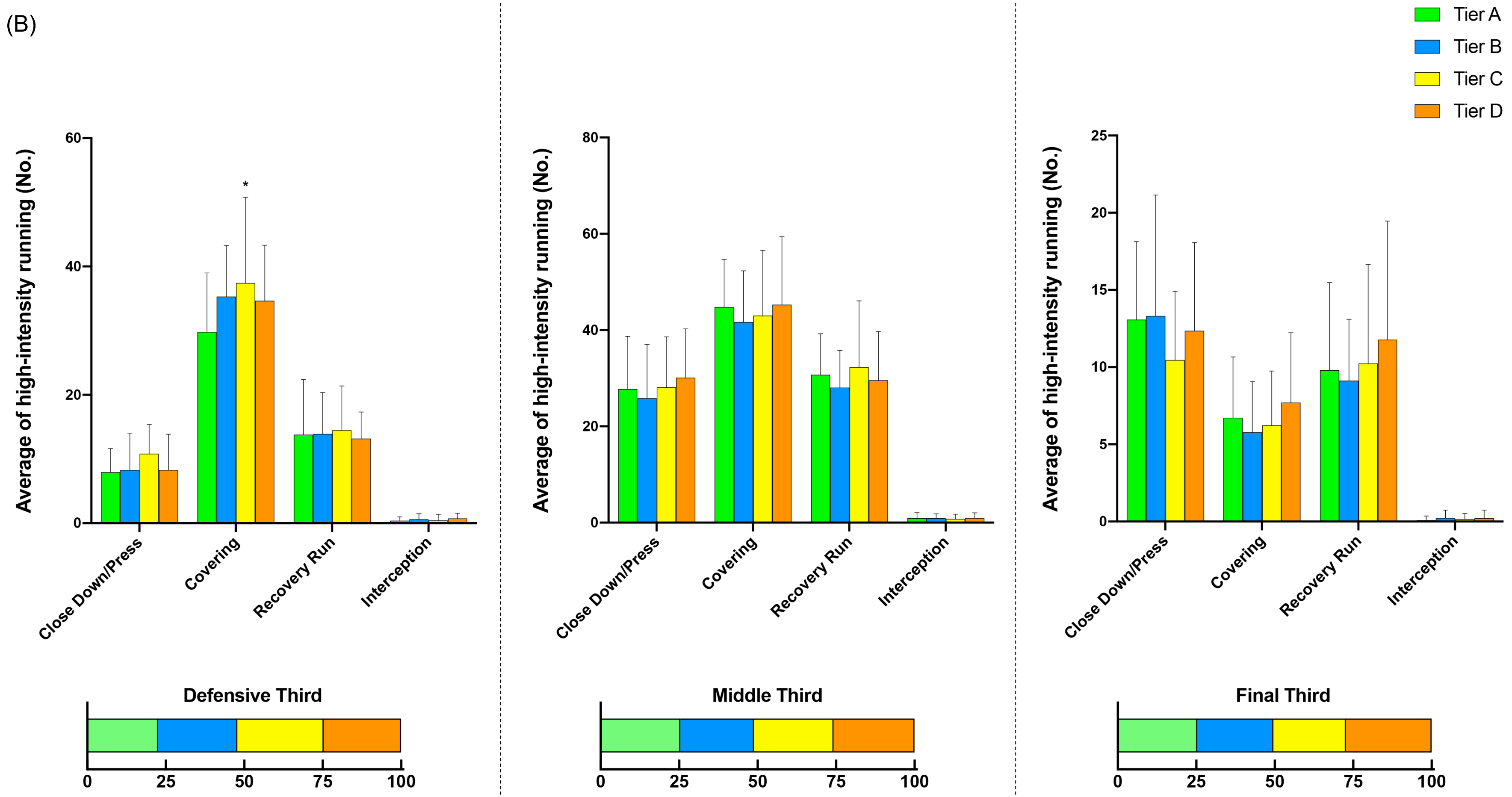


Figure 5.5. Frequency of high-intensity running in relation to (A) in-possession and (B) out-of-possession categories with special reference to different zones (defensive, middle and final third). Symbols denote differences (*P*<0.05). $^{\Delta}$More actions performed than other Tiers. $^{\#}$More actions performed than Tier D. *More actions performed than Tier A. $^{\bullet}$More actions performed than Tier C and D. $^{\blacklozenge}$More actions performed than Tier C. $^{\blacksquare}$More actions performed than Tier B and C. Values are average numbers of physical-tactical actions per match.

5.4.5 Team Data: Correlation Matrix within Physical-Tactical Actions

The correlations of ‘within dualities’ (teammates performing together) and ‘between dualities’ (Team A vs Team B) are presented in Table 5.7 and 5.8, respectively. For ‘within dualities’ producing high-intensity actions for ‘Run with Ball’ was highly associated with teammates performing ‘Move to Receive/Exploit Space’ (r=0.5, P<0.01). Producing high-intensity ‘Run in Behind/Penetrate’ actions was moderately related to ‘Move to Receive/Exploit Space’ and ‘Support Play’ (r=0.3, P<0.01). When out of possession, players performing high-intensity ‘Recovery Runs’ were moderately associated with teammates performing activities of ‘Covering’ and ‘Close Down/Press’ (r=0.3-0.4, P<0.01).

For ‘between dualities’, one team performing actions such as ‘Move to Receive/Exploit Space’ and ‘Run with Ball’ was largely correlated to the opposition team producing ‘Covering’ (r=0.5-0.6, P<0.01). Large to very large correlations were found between ‘Support Play’ and ‘Recovery Run’ (r=0.6-07, P<0.01). One team executing ‘Run in Behind/Penetrate’ activities was moderately associated with the other team producing activities of ‘Recovery Run’ (r=0.3, P<0.05), ‘Covering’ (r=0.4, P<0.01) and ‘Close Down/Press’ (r=0.03, P<0.05).

Table 5.7. The correlation matrix of ‘within dualities’ for physical-tactical actions.

IP	BIB	RIB	MTR	RWB	SP	OVL	PUP
BIB	1.0						
RIB	0.3	1.0					
MTR	0.2	0.3	1.0				
RWB	0.4	0.2	0.5	1.0			
SP	0.1	0.3	0.3	0.2	1.0		
OVL	0.3	0.1	0.3	0.4	0.2	1.0	
PUP	0.0	-0.1	0.1	0.0	0.0	0.0	1.0

OOP	RR	COV	CD/P	IOP
RR	1.0			
COV	0.4	1.0		
CD/P	0.3	0.2	1.0	
IOP	0.1	0.1	0.3	1.0

BIB: Break into Box; RIB: Run in Behind/Penetrate; MTR: Move to Receive/Exploit Space; RWB: Run with Ball; SP: Support Play; OVL: Over/Underlap; PUP: Push up Pitch; RR: Recovery Run; COV: Covering; CD/P: Close Down/Press; IOP: Interception. The magnitudes of the correlation coefficients were regarded as trivial (*r* ≤0.1), small (*r* >0.1–0.3), moderate (*r* >0.3–0.5), large (*r* >0.5–0.7), very large (*r* >0.7–0.9) and nearly perfect (*r* >0.9; Hopkins et al., 2009). Moderate to large correlations are highlighted in grey (*r* >0.3–0.5) and orange (*r* >0.5–0.7). IP: In Possession; OOP: Out of Possession.

Table 5.8. The correlation matrix of ‘between dualities’ for physical-tactical actions.

		Team A						
	IP vs OOP	**BIB**	**RIB**	**MTR**	**RWB**	**SP**	**OVL**	**PUP**
Team B	**RR**	0.1	0.3	0.0	0.0	0.7	0.1	-0.1
	COV	0.2	0.4	0.5	0.5	0.3	0.4	0.0
	CD/P	0.2	0.3	0.2	-0.2	0.4	-0.1	0.1
	IOP	0.0	-0.1	0.0	-0.3	0.0	-0.3	0.1

		Team B						
	IP vs OOP	**BIB**	**RIB**	**MTR**	**RWB**	**SP**	**OVL**	**PUP**
Team A	**RR**	0.2	0.3	0.3	0.3	0.6	0.1	0.1
	COV	0.4	0.4	0.5	0.6	0.6	0.3	0.0
	CD/P	0.1	0.3	0.5	0.4	0.3	0.2	0.0
	IOP	0.3	0.3	0.2	0.6	0.0	0.2	0.0

BIB: Break into Box; RIB: Run in Behind/Penetrate; MTR: Move to Receive/Exploit Space; RWB: Run with Ball; SP: Support Play; OVL: Over/Underlap; PUP: Push up Pitch; RR: Recovery Run; COV: Covering; CD/P: Close Down/Press; IOP: Interception. The magnitudes of the correlation coefficients were regarded as trivial (*r* ≤0.1), small (*r* >0.1–0.3), moderate (*r* >0.3–0.5), large (*r* >0.5–0.7), very large (*r* >0.7–0.9) and nearly perfect (*r* >0.9; Hopkins et al., 2009). Moderate to very large correlations are highlighted in grey (*r* >0.3–0.5) and orange (*r* >0.5–0.9). Team A: Home team; Team B: Away Team. IP: In Possession; OOP: Out of Possession.

5.4.6 Team Data: Technical Performances Across Tiers

Only Tier C teams took fewer shots when compared to Tier A (11±5 vs 15±5, ES: 0.9, *P*<0.01) whilst teams in Tier A had 36-57% more shots on target than Tier B, C and D (6±2 vs 4±2, ES: 0.7-1.2, *P*<0.05). Tier A teams completed 24-34% more ball touches than Tier B, C and D (739±124 vs 593±75, 551±117 and 550±90, respectively, ES: 1.4-1.7, *P*<0.01). Tier A clubs completed 38-55% more passes than Tier B, C and D (554±122 vs 402±76, 363±108, 356±94, respectively, ES: 1.5-1.8, *P*<0.01), and had a higher passing accuracy (82±5%) compared to Tier B (78±6%, ES: 0.8, *P*<0.05) and Tier C and D (74±5% and 73±7%, ES: 1.4, *P*<0.01). Teams in Tier A performed 36-38% more dribbles than Tier C and D (10±4 vs 7±3 and 7±2, respectively, ES: 0.8-0.9, *P*<0.05) but performed a lower number of interceptions compared to Tier D (10±5 vs 14±6, respectively, ES: 0.8, *P*<0.01). The correlations between physical-tactical and technical metrics are presented in Figure 5.6.

5.4.7 Team Data: Match-to-Match Variabilities Across Tiers

The mean percentage of CVs in high-intensity distances produced by Tiers was 13±4% (Tier A: 14±2%, Tier B: 13±3%, Tier C: 14±4% and Tier D: 13±6%). Match-to-match variabilities in contextualised actions varied across all variables. Regardless of physical-tactical variables, the mean percentage of CVs for the contextualised actions was 48±31%.

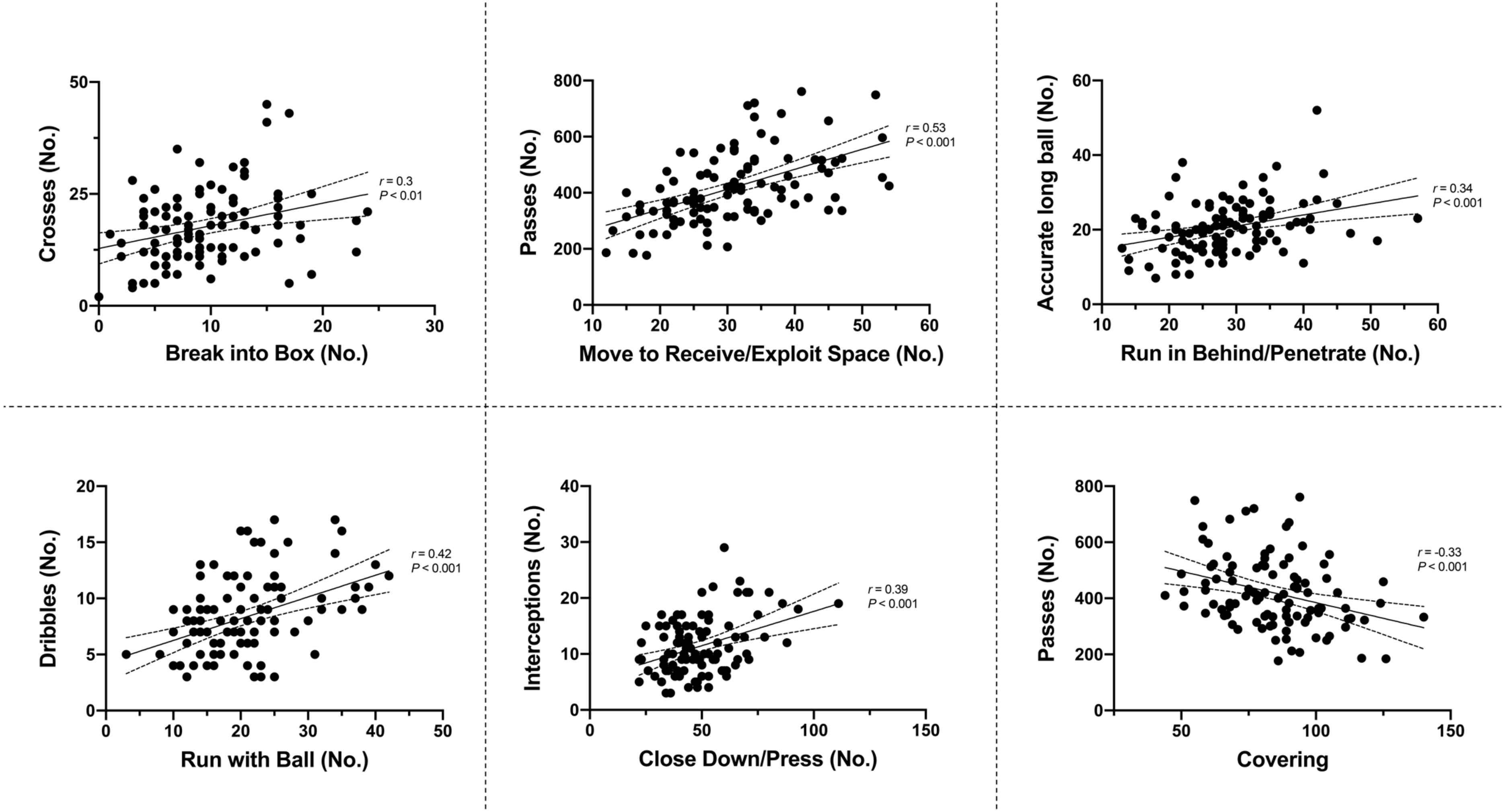


Figure 5.6. Correlation between physical-tactical (x axis) and technical (y axis) variables. Dashed lines indicate 95% confidence intervals.

5.5 Discussion

The present study is the first to evaluate the physical-tactical trends of elite football teams and players according to final league rankings. Tier A teams performed more contextualised actions (e.g., ‘Move to Receive/Exploit Space’, ‘Run with Ball’, etc.) as well as better technical skills (e.g., greater number of shots on target, passes, etc.) compared to those in lower Tiers. Regarding positional trends, CDP and WDP in Tier A ran ~65-550% more high-intensity ‘Move to Receive/Exploit Space’ distance than other Tiers. Moreover, the additional options within the physical-tactical actions and zonal differences (e.g., ‘HOW’ higher-standard teams outperformed opposition compared to lower-standard teams) exhibited more meaningful insights. These data trends aid our understanding of patterns of play according to final league ranking and the discriminatory factors between Tiers.

Data demonstrates that the total high-intensity distances covered by teams in various Tiers were comparable to others (~7100-7800 m vs 7500 m; FIFA, 2018), exhibiting no differences between Tiers. This contrasts previous studies where lower-ranked teams covered greater total distance in high-intensity running compared to higher-ranked teams (Di Salvo et al., 2009; Rampinini et al., 2009). This disparity could be due to the different methodological approach applied in the present study (i.e., team performance rather than individual players). Despite this, high-intensity distance covered in possession revealed meaningful differences, which is supported by previous findings (Di Salvo et al., 2009; Rampinini et al., 2009; Bradley et al., 2016). Tier A teams covered ~35% more high-intensity distance when they were in possession compared to those in Tier C and D with only ~5% difference for the distance covered when out of possession. Thus, high-intensity distance covered in possession seems to be an important differentiator between team standards in competitions such as the EPL.

Limited evidence exists in the scientific literature to understand ‘WHY’ and ‘HOW’ high-ranked teams cover greater high-intensity distance when in possession. Current findings indicate that although none of the out-of-possession physical-tactical actions displayed any differences between Tiers, meaningful differences were observed regarding in-possession physical-tactical movements. For instance, Teams in Tier A performed ~20-95% more high-intensity distance performing ‘Move to Receive/Exploit Space’, ‘Run with Ball’, ‘Over/Underlap’, ‘Run in Behind/Penetrate’ and ‘Break into Box’ activities compared to lower Tier teams. This clearly explains 'WHY' more high-intensity distance is covered by top-ranked teams when in possession than their lower-ranked counterparts. Such contextualised actions could be the actions that higher-standard teams perform more frequently whilst keeping the ball to exploit space whereby producing a viable attacking threat and ultimately scoring a goal (Bradley et al., 2014b; Bradley, 2020). Therefore, these contextualised actions could be key in discriminating between team standards. An important caveat is that this data is limited to the EPL. Therefore, verification of such trends across different competitive standards or other elite football leagues is necessary as different playing styles are expressed in each competition (Dellal et al., 2011; Bradley et al., 2013a).

Literature reports position-specific characteristics with attackers covering ~70-90% more distance at high-intensity in possession compared to out of possession whilst defenders performed ~60-160% greater distance out of possession compared to in possession (Di Salvo et al., 2009; Dellal et al., 2011). However, this provides only rudimentary insights, which may explain why such data are hardly used within the applied setting (Bradley and Ade, 2018). In contrast, the present study provides important insights into individual physical-tactical characteristics across Tiers. For instance, whilst in possession CDP and WDP in Tier A covered ~65-550% more high-intensity distance for 'Move to Receive/Exploit Space' than those in other Tiers whilst WDP in Tier A ran ~70-80% more distance for 'Over/Underlap' and 'Run in Behind/Penetrate' than those in Tier C. This agrees with previous findings where CDP and WDP from higher-ranked teams produced more attacking- and passing-related events than their counterparts from lower-ranked teams (Adams et al., 2013; Liu et al., 2016). This type of data provides clear insights into 'WHY' players within high-ranked teams cover more distance at high-intensity when in possession. However, when accounting for relative distance (m/min) covered for each tactical activity as a team using effective playing time (i.e., time of ball in play), which can be affected by team playing style as well as contextual factors (Lorenzo-Martinez et al., 2021; Castellano et al., 2022), no differences were observed between Tiers. This indicates that such trend appears to be simply due to the team having a higher percentage of ball possession during matches. Hence, it would be more beneficial if investigating how effective the physical-tactical actions are during match-play (e.g., did the action create or nullify a chance/threat?). Additionally, it would be of interest to examine how team physical-tactical performances change pertaining to match status and/or opponent standards since they impact match performance (Castellano, Blanco-Villasenor and Alvarez, 2011; Bradley and Noakes, 2013).

Data analysed from the additional options within the physical-tactical actions demonstrates that in possession Tier A teams noticeably dominated the central area, producing more high-intensity efforts for 'Support Play', 'Move to Receive/Exploit Space', 'Run with Ball' and 'Run in Behind/Penetrate' than other Tiers. Interestingly, Tier A clubs also performed more 'Move to Receive/Exploit Space' actions while moving backwards compared to other Tiers. For instance, forwards could move back towards their own goal to receive the ball (known as 'Coming Short') or defenders could move back and wide to receive the ball when the ball is played to the goalkeeper during build-up play (known as 'Splitting'). This seems to be due to high-ranked teams more likely adapting a build-up playing style while having a high percentage of ball possession (Adams et al., 2013; Bradley et al., 2016; Brito Souza et al., 2020). The analysis of technical data from this study also confirms this notion in which Tier A teams completed ~25-55% more ball touches and passes than other Tiers, which agrees with previous observations (Bradley et al., 2016; Liu et al., 2016). Although some studies indicate that the EPL teams tend to utilise a counter attack strategy with fast and direct attacks to transition (Mitrotasios et al., 2019; Cooper and Pulling, 2020), present data demonstrate that EPL teams in the top Tier are more likely to apply a more intricate build-up and possession-based style of play. Nevertheless, as the playing style of teams in top-class teams also differs (Paixão et al., 2015), individual team analysis is warranted to more precisely determine how each team physically and tactically plays during matches. Additionally, as this integrated approach can reveal teams' playing styles, performance analysts within the team could be benefited from using this approach, especially for opponent analyses, which takes a huge part of the match analysis in football (Plener, 2021).

Distinct differences in physical-tactical actions performed in different zones of the pitch by the diffferent Tiers were apparent. In possession Tier A teams produced ~30-130% more high-intensity 'Move to Receive/Exploit Space' actions from the defensive and middle third compared to lower Tier counterparts. Although previous reports noted that top-ranked teams dominated transition phases (Gollan, Ferrar and Norton, 2018), they failed to determine what types of tactical actions are critical during this phase of play. Since top-ranked clubs tend to achieve more width and length whilst increasing the offensive play-space than lower-ranked counterparts after regaining the ball (FIFA, 2018; Bradley and Scott, 2020), this seems to be 'Move to Receive/Exploit Space' actions that high-ranked teams perform more often during the defence-to-attack transition phase (e.g., from defensive and middle third) compared to lower-ranked teams. Furthermore, Tier A teams completed ~90-130% more high-intensity 'Over/Underlap' actions from the middle and final third than lower Tier teams whilst also performing ~45-60% more actions for 'Break into Box' and 'Run in Behind/Penetrate' in the final third. This clearly shows 'HOW' teams in the top Tier dominated opposition in the middle and final third of the pitch. However, since the present study did not include the phases of play, future research should condense such physical-tactical actions into phases of play to provide extra granularity to match analysis.

Out of possession, lower-ranked teams such as those in Tier C demonstrated ~25% more high-intensity activities for 'Covering' from the defensive third than higher-ranked teams such as those in Tier A. This action is essential for the team's defensive organisation whilst being goal side of the ball (Ade, Fitzpatrick and Bradley, 2016). Therefore, it seems that low-ranked teams tend to focus on the team's defensive stability in the defensive third while being goal side, rather than pressing higher up the pitch, which may explain why teams with a defensive formation (e.g., 4-5-1 formations) cover greater distance when out of possession (Bradley et al., 2011). In contrast, although there were no statistical differences in the frequency of 'Closing Down/Press' actions performed by each Tier in the final third, high-ranked teams executed ~20% more of these actions than low-ranked counterparts (13 vs 11). This could indicate that higher-ranked teams are more likely to try to regain the ball higher up the pitch and to counter press if they lose it. Since regaining ball possession in the opposition's half is important for a team's success (Jamil, 2019), this physical-tactical action seems very promising to evaluate team performance. However, contextual factors such as match status and match location could alter team playing style during match-play (Trewin et al., 2017).

This is the very first time that the relationships of 'within' (teammates performing together) and 'between' (Team A vs Team B) dualities have been quantified; thus, this provides novel insights into the interactional aspects of physical-tactical components.

Producing high-intensity actions for 'Run in Behind/Penetrate' was moderately related to teammates performing 'Support Play' with the opposition executing 'Recovery Run', 'Covering' and 'Close Down/Press'. Additionally, large to very large correlations were found between one team producing 'Support Play' and the other team performing 'Recovery Run' actions. This could be because when a fast transition occurs, for example, the ball is rapidly moved forward, teammates perform 'Support Play' to become involved in the transition or attacking phase with the opponent performing 'Recovery Run' actions (Bradley, 2020). Thus, it could be reasonably concluded that one team's collective behaviour influences the opposition team's performance and their own team's tactical behaviour. Nevertheless, further insight may be gained if investigating the individual antagonistic correlations between selected players (e.g., the actions performed by forwards vs those performed by centre backs of the opposition team). Therefore, future research should examine this aspect.

Tier A clubs produced better technical performance such as greater number of shots on target and passes as well as a higher pass accuracy than other Tiers, which agrees with previous findings (Rampinini et al., 2009; Castellano, Casamichana and Lago, 2012; Konefał et al., 2019a). This is possibly due to high-standard teams demonstrating higher levels of technical performance whilst also performing greater number of technical events compared to lower-standard teams (Rampinini et al., 2009; Bradley et al., 2016). Additionally, the present study found that some technical metrics (i.e., OPTA Sports data) were moderately associated with some physical-tactical actions. High-intensity 'Break into Box' and 'Run in Behind/Penetrate' actions were moderately associated with the number of technical skills such as crosses and accurate long passes, respectively. It may be due to players producing a high-intensity effort trying to enter the opposition box typically expecting a cross from a wide player or to run in behind/penetrate whilst an accurate long ball is being delivered from a deeper player (Ade, Fitzpatrick and Bradley, 2016). Moreover, the number of interception events (i.e., technical data) was moderately linked to high-intensity 'Close Down/Press' actions. Explanation may reside with the view point that aggressive pressing (e.g., closing down at high-intensity) is able to force the opposition to make mistakes such as inaccurate passes (Lucchesi, 2004). Collectively, the physical-tactical data appears to be associated with technical metrics available to professional football clubs; thus, this may be more practical for coaches as the context adds a narrative to the data trends. Practitioners are also moving towards an enhanced ability to quantify the impact of the physical work executed by the team on technical and tactical outcomes. Hence, this type of analysis is key to help drive forward physical requirement of the elite player. However, the complex nature of football where numerous contextual factors impact performance during match-play (Trewin et al., 2017), results in high levels of data variability of team performances (e.g., high-intensity distance and contextualised actions: 13% and 48%, respectively), thus practitioners should consider these variabilities when making decisions on the practical application of the data.

5.6 Limitations

Firstly, although the present study has integrated physical and tactical performances, this did not integrate ‘technical’ metrics but rather aggregated them within the result. As physical, tactical and technical parameters are fused to influence match performance, future research should amalgamate all these aspects to provide a comprehensive understanding of the true football match performance. Also, another limitation would be a lack of contextual variables included in the study. Therefore, the physical-tactical profiles with special reference to the standard of opposition or match status may be of interest since they have an influence on match performance (Castellano, Blanco-Villasenor and Alvarez, 2011; Bradley and Noakes, 2013).

5.7 Practical Recommendations

- The integrated approach is able to uncover playing styles of teams and players (e.g., Tier A teams executed more contextualised actions such as ‘Move to Receive/Exploit Space’ and ‘Run with Ball’). Therefore, within the applied setting this approach could be used to objectively analyse team/player physical-tactical performance during a match based on instructions given to the players (and then make quick tactical adjustments). Additionally, this information analysed could be used to give effective feedback to players with the aim of enhancing their tactical performance (e.g., game insights and decision making; Carling, Williams and Reilly, 2005).

- It may be advantageous for performance analysts to apply the integrated approach developed within the research programme since this can unveil the playing style of opposition teams/players (e.g., ‘HOW’ the opponent team physically and tactically play when playing against a weak team). With this type of data, coaches may be better informed of the strengths and weaknesses of the opposition team, thus giving more effective instructions to the players for the upcoming match (Plener, 2021).

5.8 Conclusion

The contextualised data can help improve the understanding of team playing style and could be used to better discriminate between team standards together with technical metrics. Additionally, players’ physical-tactical actions have an influence on not only their teammate but also opposition activities during match-play. However, it should be acknowledged that the match-to-match variabilities in high-intensity distance and contextualised actions are high.

5.9 Linkage to the next study

Physical-tactical profiles of teams and players during match-play have been provided in this study. However, the data limits the understanding of peak match demands since average match physical-tactical demands were analysed, which can underestimate the true match demands (Mernagh et al., 2021). Moreover, as physical metrics are now fused with tactical actions, ‘HOW’ players/teams modify their tactical behaviour after intense periods could be profiled in order to better understand ‘WHY’ transient decrements in performance occur in the next period immediately after the most intense period of play. Hence, the next study will determine the physical-tactical profiles of players/teams during the most intense 1-, 3- and 5-min periods of high-intensity running and the subsequent periods during match-play.

CHAPTER SIX

CONTEXTUALISED PEAK PERIODS OF PLAY IN ENGLISH PREMIER LEAGUE MATCHES

CONTEXTUALISED PEAK PERIODS OF PLAY IN ENGLISH PREMIER LEAGUE MATCHES

6.1 Abstract

Purpose: The present study aimed to determine the physical-tactical trends of elite players/teams during peak 1-, 3- and 5-min periods of match-play. **Method:** A total of 50 English Premier League matches (*n*=583 player observations and 100 match observations) were analysed by coding the players' physical-tactical activities through the synchronisation of tracking data and video. **Result:** The contextualised data showed that during the peak periods (i.e., the most demanding passage of play), players/teams covered the largest distance for 'Recovery Run' (28-37%) out of possession and 'Support Play' (9-13%) in possession. In the following periods, players covered less high-intensity distance versus the average with a more pronounced decline in the next 1-min period than longer duration 3- and 5-min periods (48% vs ~25-30%, ES: 0.4-0.5, *P*<0.01); team data showed similar trends with different relative patterns (31% vs 17-30%, ES: 0.5-0.8, *P*<0.01). After peak periods, players/teams performed 20-53% less high-intensity distances for 'Covering' and 'Recovery Run' (ES: 0.2-0.7, *P*<0.01) out of possession. However, players covered 28-91% less distance for 'Run with Ball' (ES: 0.1-0.5, *P*<0.05) when in possession. Some physical-tactical actions exhibited inconsistency in different time durations of the next periods; however, these physical-tactical data were position-specific. This may signify that each position has certain physical-tactical actions to execute even after the peak periods, especially when they are tactically required to do so. **Conclusion:** As the data demonstrates unique physical-tactical trends of players/teams during the peak and next periods of play, this can help practitioners prescribe position- or player-specific drills, and better understand transient decrements in high-intensity running after intense passages of play. Nonetheless, high match-to-match variabilities for high-intensity running distance (22%) and contextualised actions (57-63%) during the most intense period should be acknowledged.

6.2 Introduction

Time-motion analysis has been widely used for profiling the match performance of elite players using different technologies such as global positioning and optical tracking systems (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Di Mascio and Bradley, 2013; Oliva-Lozano et al., 2020). Practically, the activity profiles derived from match-play are used for designing training drills (Martín-García et al., 2019; Ade et al., 2021). However, previous studies have mainly analysed the average physical demands of play (Mohr, Krustrup and Bangsbo, 2003; Rampinini et al., 2007; Bradley et al., 2013a; Ade, Fitzpatrick and Bradley, 2016), which underestimates locomotive match demands of players (Mernagh et al., 2021). In light of this, recently greater attention has been paid to the physical demands during the peak periods (i.e., the most intense period of a match) or what some term the worst-case scenarios (Martín-García et al., 2018; Casamichana et al., 2019; Martín-García et al., 2019; Castellano, Martín-García and Casamichana, 2020; Oliva-Lozano et al., 2020; Riboli et al., 2021). As replicating intensified periods of match-play into training sessions facilitates players to be physically conditioned for the peak demands of competition, the peak performance data have been practically used as a benchmark to devise football-specific drills such as small-sided games and position-specific speed endurance exercises (Bradley et al., 2019; Martín-García et al., 2019; Riboli et al., 2020). However, issues exist when attempting to directly translate these into specific drills as the context of play is completely omitted from any of the studies that have quantified match-play peak periods (Carling et al., 2019; Bradley, 2020). Thus, tactical context should be fused with physical metrics to help coaches prescribe specific drills that mimic these intensified periods of matches more effectively.

Football (soccer) is a ‘team’ sport where physical, technical and tactical actions of players are influenced by both opponent and teammate actions (Bate and Jeffreys, 2015). Nevertheless, previous studies included only ‘player’ performances to understand individual patterns rather than actual team trends (Di Mascio and Bradley, 2013; Martín-García et al., 2018; Casamichana et al., 2019; Riboli et al., 2021). Quantifying individual players limits our understanding of a team’s collective performance during match-play. No research, to the best of our knowledge, has attempted to observe the peak physical demands for team performances. Therefore, analysing team collective physical-tactical performances could add insights into how teams collectively perform physical-tactical actions during intensified periods of play together with individual player data.

Several studies have investigated not only peak periods of play over different time durations (e.g., 1-, 3-, 5-min) but the 5-min periods after intense periods during match-play to examine transient decrements in high-intensity running compared to the match average (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017). The immediate declines in physical performance during the next 5-min periods have been ascribed to fatigue induced by the activities during peak periods. Although it is highly complex, there seems to be several contributing factors that cause fatigue (e.g., muscle acidosis and reduced muscle creatine phosphate) after intense periods (Mohr, Krustrup and Bangsbo, 2005). However, temporary declines in high-intensity running are not necessarily linked to fatigue but could be due to pacing strategies/tactical alterations (Bradley and Noakes, 2013) and/or fewer playing opportunities (Carling and Dupont, 2011). Few studies to date have attempted to provide tactical insights in the subsequent periods immediately after peak periods of play; thus, this is still questionable whether there are tactical adjustments as a team and/or individually after the most demanding passage. To potentially understand ‘HOW’ players/teams alter their tactical behaviour during the phases that follow intense periods of match-play, amalgamating physical and tactical performance data could be a solution (Chapter 3).

Previous research examining transient decrements in high-intensity running in the next period after the most demanding passage of a match had several limitations (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Carling and Dupont, 2011; Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017). Most studies used a predefined period (e.g., 0-5, 5-10 min etc.), which can under or overestimate the physical demands during the peak and the following periods of a match, respectively (Varley, Elias and Aughey, 2012; Oliva-Lozano et al., 2021). Thus, it is more advisable to use a rolling average technique (distance covered from every time point) to provide a more precise estimation of physical demands during such periods (Martín-García et al., 2018; Casamichana et al., 2019; Riboli et al., 2021). Moreover, studies investigating transient decrements used only a 5-min interval for the next period after the most intense period of play, which could omit brief changes immediately after intense actions (Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017). Hence, using shorter durations of the next period after the most intense passage of play may be more advantageous to understand short-term fluctuations. Therefore, the present study aimed to determine the physical-tactical profiles of elite players/teams during peak 1-, 3- and 5-min periods of high-intensity running and the subsequent periods of each time duration during match-play.

6.3 Method

6.3.1 Match Analysis and Player/Team Data

Match physical-tactical data were collated from the 2018-19 English Premier League season using an integrated approach and a new filter established for this research. Players' behaviours were captured by cameras situated at roof level during matches and their physical-tactical actions were manually coded using the integrated approach. The validity and reliability of the integrated approach and the novel filter used were verified within Chapter 3, from which additional methodological information can be found. The novel filter isolated high-intensity activities reaching speeds >19.8 $km \cdot h^{-1}$ for a minimal dwell time of 1 s (Carling, Le Gall and Dupont, 2012).

The researcher completed approximately 350 hours of coding to analyse 50 competitive matches. This consisted of the total number of 388 individual outfield players across 1,265 player observations (35,170 physical-tactical actions) within 20 different teams. For an individual player's analysis, only outfield players who had completed the entire match in the same position were included (583 player observations). This consisted of 179 Central Defensive Players (CDP), 147 Wide Defensive Players (WDP), 167 Central Midfield Players (CMP), 54 Wide Offensive Players (WOP) and 36 Central Offensive Players (COP). However, all of the contextualised performances of players for each match were summarised to analyse team performances (players who were subbed in or out were included; 100 match observations). All data were analysed for the duration of each half, including stoppage time. Prior to analysis, all original data were anonymised to ensure confidentiality. Research approval was given by the local Ethics Committee of the appropriate institution.

6.3.2 Match Control and Data Balance

In order to improve the scientific rigor of the research design, matches were arbitrarily selected while simultaneously controlling various situational factors. According to Barnes et al. (2014), the number of player observations largely varies across locations (Home/Away), phases of season and team or opponent standards based on final league ranking. Thus, the number of matches for each parameter was initially balanced. Matches were excluded if goal differential was >3 and a player dismissal occurred since these influence match running performances (Carling and Bloomfield, 2010; Bradley and Noakes, 2013).

6.3.3 The Integrated Approach of Match Performance

The descriptions of physical-tactical actions within the developed integrated approach are illustrated in Table 6.1. High-intensity actions isolated by the novel filter were synchronised with video footage of all players throughout matches to code the tactical purpose of each action. All coding occurred using QuickTime Player (Apple Inc, Cupertino, California) to watch video and then categorise tactical actions using Microsoft Excel with drop-down category lists.

The coding process was as follows: high-intensity actions with one tactical action were classified as a single action with dual tactical actions being coded as a hybrid action. High-intensity actions with more than three tactical actions were classified as ‘Other’. If the high-intensity action consisted of 70-90% of the primary and 10-30% of the secondary action, it was classified as a hybrid action. But if it was made up of 50-60% of the primary and 40-50% of the secondary action, then it was classified as ‘Other’. As hybrid actions are a combination of the primary and secondary actions (Bradley and Ade, 2018), single action events and the primary tactical movements of the hybrid actions were combined to simplify data outputs.

Table 6.1. The descriptions of the variables within the integrated approach.

Variables	**Description**
In Possession	
Push up Pitch	Player moves up the pitch to play offside and/or to squeeze to a higher line.
Break into Box	Player enters the opposition's penalty box to receive the ball. (typically receive ball from a cross - ball in front and wide)
Run in Behind /Penetrate	Player attacks space behind, overtakes and/or unbalances the opposition defence. (typically ball is behind)
Over/Underlap	Player runs from behind to in front of the player on the ball or receiving the ball.
Run with Ball	Player moves with the ball either dribbling with small touches or running at speed with fewer ball touches.
Move to Receive/ Exploit Space	Player moves to receive a pass from a teammate or to create/exploit space. (typically come short or move wide to receive ball)
Support Play	Player supports from behind/level by trying to engage in offensive/transition play. (typically during fast transitions)
Out of Possession	
Interception	Player cuts out pass.
Recovery Run	Player runs back towards their own goal to be goal side when out of position.
Covering	Player moves to cover space or an opposition player while remaining goal side.
Close Down/Press	Player runs directly towards opposition player on or receiving the ball, or towards space or players not on/receiving the ball.
Unclassifiable	
Other	All other variables that could not be categorised by the above.

6.3.4 Physical-Tactical Performance for the Peak Period

Physical-tactical data during peak periods of play were analysed using a customised Excel spreadsheet. Using a rolling average method, the peak periods of high-intensity running during matches for three different time durations (1-, 3- and 5-min) were determined (Martín-García et al., 2018). These durations were selected firstly, to facilitate a more detailed examination of temporal changes than using only a 5-min time interval (Varley, Elias and Aughey, 2012; Fransson, Krustrup and Mohr, 2017), and secondly to correspond with the typical duration of training drills (Casamichana et al., 2019). The next period after the peak of each time duration was used to evaluate physical performance decrements by comparing them with the average of the match that the period occurred in (Mohr, Krustrup and Bangsbo, 2003). In addition, this allowed exploration of how players/teams changed their tactical behaviour after intense periods of play. The mean distances of matches were calculated by averaging distances covered in all of the 1-, 3- and 5-min periods excluding stoppage time (Mohr, Krustrup and Bangsbo, 2003; Fransson, Krustrup and Mohr, 2017). Nevertheless, when the amount of the remaining time during the following intense period was not equivalent to the peak period, the related data were removed from analysis. This resulted in 556 player observations for 1-min period (167 for CDP, 143 for WDP, 158 for CMP, 53 for WOP and 35 for COP) with 93 match observations, 528 player observations for 3-min period (158 for CDP, 134 for WDP, 151 for CMP, 52 for WOP and 33 for COP) with 96 match observations, and 494 player observations for 5-min period (153 for CDP, 126 for WDP, 141 for CMP, 46 for WOP and 28 for COP) with 85 match observations.

6.3.5 Match-to-Match Variability for the Peak Periods

Match-to-Match variabilities for high-intensity distance and physical-tactical performance were calculated to appropriately identify fluctuations between matches using the coefficient of variation (Carling et al., 2016). A total of 143, 138 and 126 outfield players were included for the peak 1-, 3- and 5-min periods, respectively, and the respective match observations were 454, 428 and 389 with a median of three games per player (range: 2-7).

6.3.6 Statistical Analyses

Data are expressed as the mean ± standard deviation. All statistical analyses were conducted using IBM SPSS Statistics for Mac OS X, version 26 (IBM Corp., Armonk, N.Y., USA). Data normality was verified by Shapiro-Wilk and Kolmogorov-Smirnov tests. Differences between 1-, 3-, or 5-min periods within a game were determined using one-way analysis of variance (ANOVA) with repeated measures. Differences between playing positions were determined using one-way ANOVA. In the event of a significant difference, Bonferroni post hoc tests were used to identify any localised effects. Statistical significance was set at $P<0.05$. Effect sizes (Cohen's d) for the meaningfulness of the difference were determined as follows: trivial (≤ 0.2), small (> 0.2–0.6), moderate (> 0.6–1.2), large (> 1.2–2.0), very large (> 2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006). The coefficient of variation (CV) was determined by dividing the standard deviation by the mean and multiply by 100 for the analysis of the match-to-match variability during the peak 1-, 3- and 5-min periods (Carling et al., 2016; Novak et al., 2021).

6.4 Result

6.4.1 Contextualised Peak Periods – Individual Trends

During the peak 1-, 3- and 5-min periods, the players covered 64% of their high-intensity distances (67±19 m, 92±28 m and 113±36 m, respectively) when their team was not in possession of the ball, 27-28% in possession, and 8-9% for 'Other' regardless of playing positions. Out of possession, the players covered 28-34% and 22-25% of the high-intensity distance performing 'Recovery Run' and 'Covering' actions, respectively. In possession, the largest proportion of the high-intensity distance (11%) was covered for 'Support Play'.

In the next 1-, 3- and 5-min periods, the players experienced a deficit of 48%, 30% and 25%, respectively, in high-intensity distance compared to the match average (ES: 0.4-0.5, $P<0.01$). Out of possession the players covered 22-44%, 34-43% and 27-45% less high-intensity distance for 'Covering' (ES: 0.2-0.3, $P<0.01$), 'Recovery Run' (ES: 0.2-0.3, $P<0.01$) and 'Close Down/Press' (ES: 0.1-0.2, $P<0.05$), respectively, compared to the match average whilst also performing 28-91% less 'Run with Ball' distance when in possession (ES: 0.1-0.5, $P<0.05$).

The average distances per physical-tactical action during peak 1-, 3- and 5-min periods of a competitive match were 36±15, 31±9 and 23±7, respectively whilst the average numbers of contextualised actions during intensified periods per match were 2±1, 3±1 and 3±1, respectively (Table 6.2).

6.4.2 Contextualised Peak Periods – Team Trends

During the peak 1-, 3- and 5-min periods, the teams covered 57-63% of their high-intensity distances (420±82 m, 646±125 m and 842±154 m, respectively) out of possession, 32-35% in possession and 4-8% for ‘Other’. Out of possession, the teams covered 28-37% and 22-23% of the high-intensity distance, performing ‘Recovery Run’ and ‘Covering’ actions, respectively. However, they covered the largest proportion of their high-intensity distance for ‘Support Play’ (12-13%) in possession. In the next 1-, 3- and 5-min periods, the teams had a deficit of 31%, 30% and 17%, respectively, in high-intensity distance compared to the match average (ES: 0.5-0.8, $P<0.01$). The teams covered 20-41% and 32-53% less high-intensity distance for ‘Covering’ and ‘Recovery Run’, respectively, compared to the match average (ES: 0.4-0.7, $P<0.01$). Figure 6.1 shows the frequency of high-intensity actions and the numbers of players involved during the peak and next periods.

Table 6.2. Average distance (m) per physical-tactical action and average number of actions during the peak periods per game across positions.

Position	**Time**	**HIR Distance (m/min)**	**Average No. Actions [min-max]**	**In Possession**						**Out of Possession**			**Overall**
				SP	**MTR/ES**	**OVL/UDL**	**RWB**	**RIB/PEN**	**BIB**	**CD/PRE**	**COV**	**RR**	
CDP	1 min	55±17*	2±1 [1-4]	73 (1)	29±18 (6)	0 (0)	25±13 (19)	0 (0)	18±11 (5)	15±7 (7)	30±15 (119)	48±17 (95)	38±17 (273)
	3 min	24±7*	3±1 [1-5]	73 (1)	26±13 (9)	0 (0)	22±11 (29)	0 (0)	25±16 (3)	17±7 (15)	24±10 (209)	40±17 (119)	30±12 (417)
	5 min	17±5*	3±1 [1-7]	0 (0)	23±13 (12)	46 (1)	20±10 (25)	0 (0)	18±11 (5)	17±7 (15)	22±8 (272)	37±17 (141)	27±10 (518)
WDP	1 min	76±18$^{\#}$	2±1 [1-4]	38±18 (43)	30±17 (22)	47±18 (18)	28±13 (17)	21±9 (10)	23±7 (4)	16±6 (20)	30±14 (72)	41±17 (92)	36±12 (327)
	3 min	35±8$^{\#}$	4±1 [2-7]	31±17 (65)	29±14 (25)	34±16 (29)	23±14 (25)	23±12 (18)	23±8 (5)	15±5 (34)	26±12 (125)	36±16 (123)	30±9 (490)
	5 min	26±7$^{\#}$	5±1 [3-8]	30±15 (80)	22±10 (43)	32±15 (33)	25±12 (36)	21±10 (15)	18±7 (8)	15±4 (49)	24±10 (161)	34±14 (142)	28±8 (624)
CMP	1 min	68±17	2±1 [1-5]	41±20 (41)	22±13 (21)	54±33 (3)	31±13 (27)	30±13 (9)	22±11 (5)	21±10 (33)	31±17 (80)	39±19 (94)	37±18 (337)
	3 min	32±10	3±1 [1-7]	35±18 (57)	24±10 (25)	41±44 (3)	27±13 (29)	24±12 (18)	27±11 (13)	21±12 (57)	26±13 (120)	32±16 (140)	30±11 (514)
	5 min	23±7	4±1 [1-7]	34±17 (56)	24±10 (38)	33±39 (5)	25±11 (38)	22±10 (22)	22±12 (14)	19±10 (72)	25±11 (149)	31±15 (159)	28±9 (627)
WOP	1 min	76±16$^{\#}$	2±1 [1-4]	34±16 (15)	35±14 (22)	0 (0)	30±17 (16)	30±11 (12)	27±20 (2)	19±7 (12)	26±10 (10)	34±14 (28)	33±10 (129)
	3 min	36±7	4±1 [2-6]	30±17 (19)	29±15 (28)	0 (0)	29±17 (30)	28±10 (20)	27±11 (7)	22±10 (28)	28±14 (16)	32±17 (37)	29±9 (201)
	5 min	27±5$^{\#}$	5±2 [2-9]	29±16 (29)	29±15 (34)	19±9 (2)	22±10 (30)	24±9 (22)	24±12 (7)	18±8 (23)	24±10 (30)	31±17 (39)	27±9 (245)
COP	1 min	71±14	2±1 [1-4]	38±21 (8)	25±15 (13)	0 (0)	32±19 (4)	33±15 (16)	25±13 (6)	27±11 (22)	31±15 (7)	41±15 (4)	32±12 (84)
	3 min	32±7	4±1 [2-6]	44±17 (14)	23±12 (18)	0 (0)	26±15 (9)	24±12 (19)	25±12 (7)	27±10 (29)	36 (1)	32±17 (2)	29±11 (117)
	5 min	25±6	5±1 [2-8]	33±18 (21)	23±14 (11)	0 (0)	27±15 (10)	26±14 (25)	21±13 (8)	22±9 (42)	26±9 (4)	37±7 (3)	26±7 (141)
Overall	1 min	67±19	2±1 [1-5]	39±19 (108)	29±15 (84)	48±20 (21)	29±14 (83)	29±13 (47)	23±11 (22)	21±10 (94)	30±15 (288)	42±18 (313)	36±15 (1150)
	3 min	31±9	3±1 [1-7]	34±18 (156)	26±13 (105)	35±19 (32)	25±14 (122)	25±11 (75)	26±10 (35)	20±10 (163)	25±12 (471)	35±17 (421)	31±9 (1739)
	5 min	23±7	3±1 [1-9]	32±16 (186)	24±12 (138)	34±18 (41)	24±11 (139)	24±11 (84)	21±11 (42)	18±8 (201)	23±10 (616)	34±16 (484)	23±7 (2155)

CDP: Central Defensive Players; WDP: Wide Defensive Players; CMP: Central Midfield Players; WOP: Wide Offensive Players; COP: Central Offensive Players. HIR: High-intensity running. SP: 'Support Play', MTR/ES: 'Move to Receive/Exploit Space', OVL/UDL: 'Overlap/Underlap', RWB: 'Run with Ball', RIB/PEN: 'Run in Behind/Penetrate', BIB: 'Break into Box', CD/PRE: 'Close Down/Press', COV: 'Covering', RR: 'Recovery Run'. 'Push up Pitch' and 'Interception' were excluded due to the small number of actions. Physical-tactical average distances are reported as mean ± SD (m) and numeral in parenthesis indicates the total number of physical-tactical actions performed. *Less high-intensity running distance than other positions (*P*<0.01). $^{\#}$Greater high-intensity running distance than CMP (*P*<0.05).

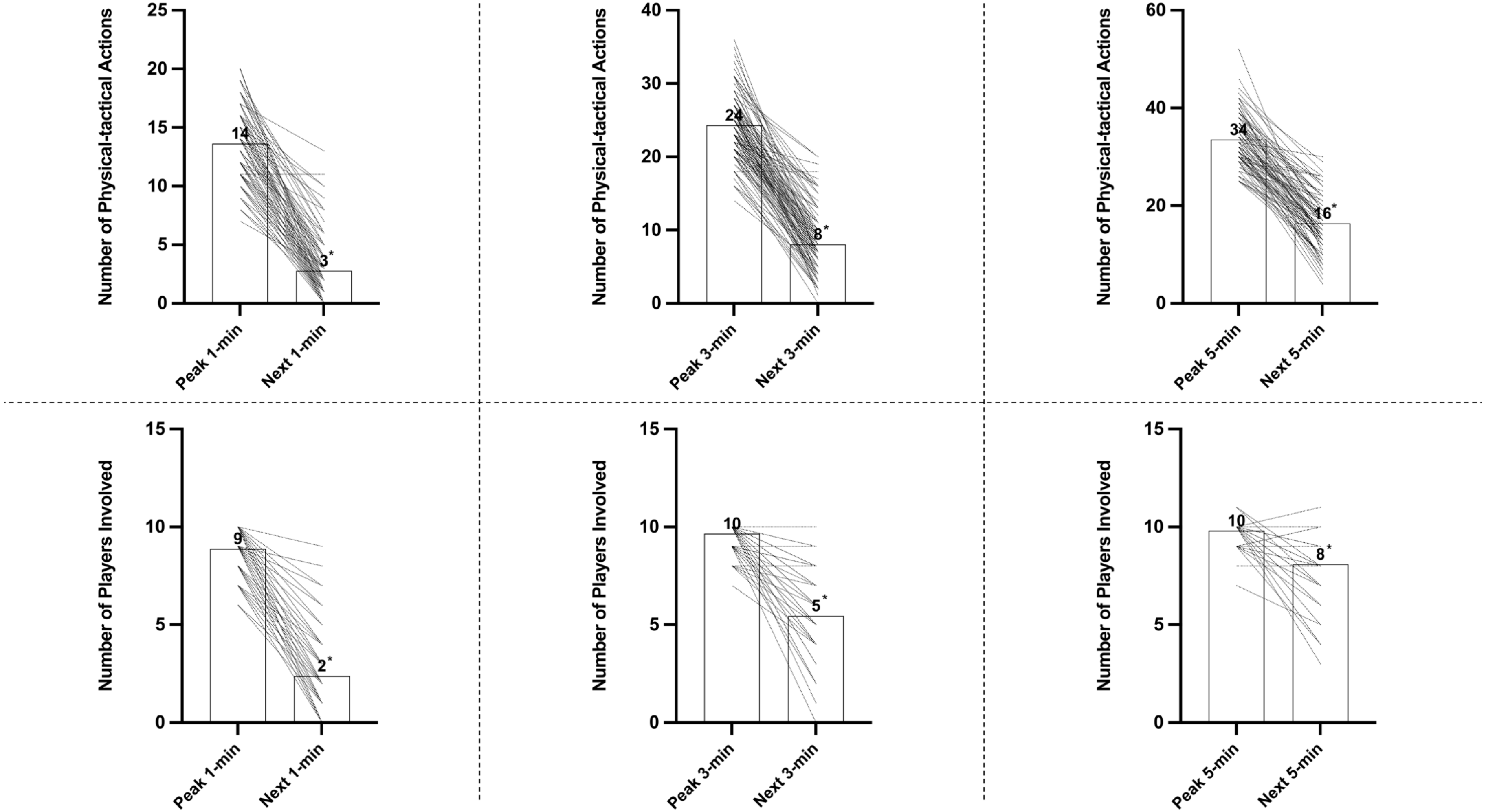


Figure 6.1. Team Performance; the numbers of physical-tactical actions and players involved during the peak and next 1-, 3- and 5-min periods. Numbers above the bars indicate mean values. Dotted lines indicate before-after values. *Difference from peak period (*P*<0.01).

6.4.3 Contextualised Peak Periods – Position-Specific Trends

6.4.3.1 Central Defensive Players

During the peak 1-, 3- and 5-min periods, CDP performed ~80% of their high-intensity distance (55±17 m, 72±22 m and 86±26 m, respectively) out of possession whilst covering 39-49% of the distance for 'Recovery Run' and 36-45% for 'Covering' (Figure 6.2). Although CDP covered 19-36% less distance at high-intensity than WDP, CMP, WOP and COP (ES: 0.8-1.8, *P*<0.01) during all of the peak periods, they covered greater high-intensity 'Covering' distance than WOP and COP (ES: 0.7-1.4, *P*<0.01) whilst also performing more 'Recovery Run' distance than COP (ES: 0.9-1.0, *P*<0.01). In the 1-, 3- and 5-min periods after the respective peak periods, CDP had a deficit of 49%, 30% and 30% in high-intensity running distance compared to the match average (ES: 0.4-0.5, *P*<0.01).

6.4.3.2 Wide Defensive Players

During the peak 1-, 3- and 5-min periods, WDP covered 28-34% and 20-23% of their high-intensity distance (76±18 m, 104±24 m and 132±35 m, respectively) for 'Recovery Run' and 'Covering', respectively whilst they covered 14% of the distance for 'Support Play' and 6-7% for 'Over/Underlap' (Figure 6.3). WDP covered 8-14% greater high-intensity distance during all of the peak periods than CMP (ES: 0.3-0.5, *P*<0.05) whilst performing more high-intensity 'Support Play' distance than CDP (ES: 0.7-1.0, *P*<0.01) and 'Over/Underlap' than other positions (ES: 0.4-0.7, *P*<0.01). In the 1-, 3- and 5-min periods after the respective peak periods, WDP had a deficit of 51%, 32% and 21% in high-intensity distance compared to the match average (ES: 0.4-0.6, *P*<0.01).

6.4.3.3 Central Midfield Players

During the intensified 1-, 3- and 5-min periods, CMP covered 29-33% and 21-22% of their high-intensity distance (68±17 m, 96±29 m and 116±34 m, respectively) for 'Recovery Run' and 'Covering', respectively, while they performed 12-15% of the distance for 'Support Play' (Figure 6.4). During all of the peak periods, CMP performed greater high-intensity 'Recovery Run' distance compared to COP (ES: 0.8-1.0, *P*<0.01) whilst also covering greater 'Support Play' distance than CDP (ES: 0.7-0.8, *P*<0.01). In the 1-, 3- and 5-min periods after the respective peak periods, CMP had a deficit of 46%, 29% and 25% in high-intensity distance compared to the match average (ES: 0.4-0.5, *P*<0.01).

6.4.3.4 Wide Offensive Players

During the peak 1-, 3- and 5-min periods WOP covered 19-23% of their high-intensity distance (76±16 m, 107±22 m and 134±26 m, respectively) for 'Recovery Run' whilst they performed 14-19% of their high-intensity distance for 'Move to Receive/Exploit Space', 10-14% for each 'Support Play' and 'Run with Ball', and 8-10% for 'Run in Behind/Penetrate' when in possession (Figure 6.5). WOP ran 11-16% greater high-intensity distance during the peak 1- and 5-min periods than CMP (ES: 0.5, *P*<0.05). Specifically, WOP performed more high-intensity distances for 'Run in Behind/Penetrate' and 'Move to Receive/Exploit Space' than CDP, WDP and CMP (ES: 0.5-1.6, *P*<0.01) whilst also covering greater 'Run with Ball' distance than CDP and WDP (ES: 0.4-0.8, *P*<0.05) during all of the peak periods. In the 1-, 3- and 5-min periods after the respective peak periods, WOP had a deficit of 42%, 36% and 23% in high-intensity distance compared to the match average (ES: 0.5-0.8, *P*<0.01).

6.4.3.5 Central Offensive Players

During the peak 1-, 3- and 5-min periods, COP covered 23-25% of their high-intensity distance (71±14 m, 96±21 m and 126±28 m, respectively) for 'Close Down/Press' whilst they ran 14-20% and 12-20% of the distance for 'Run in Behind/Penetrate' and 'Support Play', respectively (Figure 6.6). COP covered more high-intensity 'Close Down/Press' distance than other positions during all of the peak periods (ES: 0.4-2.5, *P*<0.05). In possession, COP performed greater high-intensity 'Run in Behind/Penetrate' distance during all of the peak periods compared to other positions (ES: 0.4-2.2, *P*<0.05) whilst also covering more distance for 'Break into Box' than CDP (ES: 0.7-0.9, *P*<0.01) and WDP (ES: 0.6, *P*<0.05). COP also experienced a deficit of 50% and 31% in distance covered at high-intensity during the next 1- and 5-min (ES: 0.6, *P*<0.05), respectively, whilst no difference was found for the next 3-min period. Table 6.3 illustrates detailed information (p-values and effect sizes) on the differences in the physical-tactical actions performed during peak periods of play between different positions.

Table 6.3. Differences in the physical-tactical variables performed during peak periods of play between positions along with effect sizes.

Duration	**Action**	**Position**	**Distance (m)**	**Difference and Effect Size**				
				CDP	WDP	CMP	WOP	COP
1 min	SP	CDP (*n*=167)	0.4±5.7		*P*<0.001 (0.7)	*P*<0.001 (0.7)	*P*<0.001 (0.9)	*P*=0.092 (0.9)
		WDP (*n*=143)	10.9±19.9			*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		CMP (*n*=158)	10.5±20.9				*P*=1.000 (0.0)	*P*=1.000 (0.1)
		WOP (*n*=53)	9.6±17.5					*P*=1.000 (0.1)
		COP (*n*=35)	8.7±18.7					
	MTR/ES	CDP (*n*=167)	1.0±6.3		*P*=0.076 (0.4)	*P*=1.000 (0.2)	*P*<0.001 (1.1)	*P*=0.009 (0.8)
		WDP (*n*=143)	4.6±13.1			*P*=1.000 (0.2)	*P*<0.001 (0.6)	*P*=-0.965 (0.3)
		CMP (*n*=158)	2.9±9.0				*P*<0.001 (0.8)	*P*=0.143 (0.5)
		WOP (*n*=53)	14.1±21.3					*P*=0.235 (0.3)
		COP (*n*=35)	8.3±16.0					
	OVL/UDL	CDP (*n*=167)	0.0±0.0		*P*<0.001 (0.5)	*P*=1.000 (0.2)	*P*=1.000 (0.0)	*P*=1.000 (0.0)
		WDP (*n*=143)	5.9±16.7			*P*<0.001 (0.4)	*P*<0.001 (0.4)	*P*=0.012 (0.4)
		CMP (*n*=158)	1.0±8.3				*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WOP (*n*=53)	0.0±0.0					*P*=1.000 (0.0)
		COP (*n*=35)	0.0±0.0					
	RWB	CDP (*n*=167)	2.8±9.0		*P*=1.000 (0.1)	*P*=0.569 (0.2)	*P*=0.010 (0.5)	*P*=1.000 (0.1)
		WDP (*n*=143)	3.4±11.7			*P*=1.000 (0.2)	*P*=0.037 (0.4)	*P*=1.000 (0.0)
		CMP (*n*=158)	5.3±12.8				*P*=0.531 (0.3)	*P*=1.000 (0.1)
		WOP (*n*=53)	9.0±17.0					*P*=0.405 (0.4)
		COP (*n*=35)	3.7±11.7					
	RIB/PEN	CDP (*n*=167)	0.0±0.0		*P*=1.000 (0.4)	*P*=0.801 (0.3)	*P*<0.001 (0.9)	*P*<0.001 (1.6)
		WDP (*n*=143)	1.5±5.9			*P*=1.000 (0.0)	*P*=0.002 (0.6)	*P*<0.001 (1.1)
		CMP (*n*=158)	1.7±7.6				*P*=0.002 (0.5)	*P*<0.001 (1.1)
		WOP (*n*=53)	6.9±15.4					*P*=0.002 (0.4)
		COP (*n*=35)	14.0±21.7					
	BIB	CDP (*n*=167)	0.5±3.6		*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*<0.001 (0.7)
		WDP (*n*=143)	0.7±4.0			*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*<0.001 (0.6)
		CMP (*n*=158)	0.7±4.2				*P*=1.000 (0.1)	*P*<0.001 (0.6)
		WOP (*n*=53)	1.0±5.8					*P*=0.021 (0.4)
		COP (*n*=35)	4.3±10.7					
	PUP	CDP (*n*=167)	0.2±2.3		*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WDP (*n*=143)	0.0±0.0			*P*=1.000 (0.1)	*P*=1.000 (0.0)	*P*=1.000 (0.0)
		CMP (*n*=158)	0.1±1.2				*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WOP (*n*=53)	0.0±0.0					*P*=1.000 (0.0)
		COP (*n*=35)	0.0±0.0					

Table 6.3. (continued)

Duration	Action	Position	Distance (m)	Difference and Effect Size				
				CDP	WDP	CMP	WOP	COP
1 min	CD/PRE	CDP (*n*=167)	0.6±3.5		*P*=1.000 (0.3)	*P*=0.012 (0.4)	*P*=0.112 (0.6)	*P*<0.001 (1.7)
		WDP (*n*=143)	2.5±8.1			*P*=1.000 (0.2)	*P*=1.000 (0.2)	*P*<0.001 (1.2)
		CMP (*n*=158)	4.4±11.8				*P*=1.000 (0.0)	*P*<0.001 (0.9)
		WOP (*n*=53)	4.8±14.2					*P*<0.001 (0.7)
		COP (*n*=35)	16.7±22.0					
	COV	CDP (*n*=167)	19.6±22.1		*P*=0.408 (0.2)	*P*=0.283 (0.2)	*P*<0.001 (0.7)	*P*=0.003 (0.7)
		WDP (*n*=143)	14.9±19.8			*P*=1.000 (0.0)	*P*=0.024 (0.6)	*P*=0.183 (0.5)
		CMP (*n*=158)	14.7±22.4				*P*=0.026 (0.5)	*P*=0.200 (0.4)
		WOP (*n*=53)	4.9±11.1					*P*=1.000 (0.1)
		COP (*n*=35)	5.8±13.9					
	RR	CDP (*n*=167)	26.7±27.2		*P*=1.000 (0.0)	*P*=1.000 (0.2)	*P*=0.239 (0.4)	*P*<0.001 (0.9)
		WDP (*n*=143)	25.7±26.3			*P*=1.000 (0.1)	*P*=0.505 (0.3)	*P*<0.001 (0.9)
		CMP (*n*=158)	22.7±25.5				*P*=1.000 (0.2)	*P*=0.002 (0.8)
		WOP (*n*=53)	17.7±20.1					*P*=0.184 (0.7)
		COP (*n*=35)	4.7±14.1					
	INT	CDP (*n*=167)	0.3±3.3		*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WDP (*n*=143)	0.0±0.0			*P*=1.000 (0.1)	*P*=1.000 (0.0)	*P*=1.000 (0.0)
		CMP (*n*=158)	0.1±1.3				*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WOP (*n*=53)	0.0±0.0					*P*=1.000 (0.0)
		COP (*n*=35)	0.0±0.0					
	OTH	CDP (*n*=167)	2.8±10.4		*P*=0.384 (0.2)	*P*=1.000 (0.1)	*P*=0.114 (0.4)	*P*=1.000 (0.2)
		WDP (*n*=143)	5.8±13.7			*P*=1.000 (0.2)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		CMP (*n*=158)	3.7±11.4				*P*=0.400 (0.3)	*P*=1.000 (0.1)
		WOP (*n*=53)	7.9±18.8					*P*=1.000 (0.2)
		COP (*n*=35)	4.7±15.5					

Table 6.3. (continued)

Duration	Action	Position	Distance (m)	Difference and Effect Size				
				CDP	WDP	CMP	WOP	COP
3 min	SP	CDP (*n*=158)	0.5±3.2		*P*<0.001 (0.9)	*P*<0.001 (0.7)	*P*=0.014 (1.0)	*P*<0.001 (1.4)
		WDP (*n*=134)	14.3±21.2			*P*=1.000 (0.0)	*P*=1.000 (0.2)	*P*=1.000 (0.2)
		CMP (*n*=151)	13.5±24.9				*P*=1.000 (0.1)	*P*=1.000 (0.2)
		WOP (*n*=52)	10.9±20.1					*P*=0.592 (0.3)
		COP (*n*=33)	19.4±33.0					
	MTR/ES	CDP (*n*=158)	1.5±6.7		*P*=0.057 (0.4)	*P*=0.669 (0.3)	*P*<0.001 (1.2)	*P*<0.001 (1.1)
		WDP (*n*=134)	5.4±14.0			*P*=1.000 (0.1)	*P*<0.001 (0.6)	*P*=0.058 (0.4)
		CMP (*n*=151)	4.0±10.1				*P*<0.001 (0.9)	*P*=0.007 (0.7)
		WOP (*n*=52)	15.0±18.6					*P*=1.000 (0.2)
		COP (*n*=33)	11.9±17.5					
	OVL/UDL	CDP (*n*=158)	0.0±0.0		*P*<0.001 (0.6)	*P*=1.000 (0.2)	*P*=1.000 (0.0)	*P*=1.000 (0.0)
		WDP (*n*=134)	7.4±17.0			*P*<0.001 (0.5)	*P*<0.001 (0.5)	*P*<0.001 (0.5)
		CMP (*n*=151)	0.8±7.6				*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WOP (*n*=52)	0.0±0.0					*P*=1.000 (0.0)
		COP (*n*=33)	0.0±0.0					
	RWB	CDP (*n*=158)	4.0±10.6		*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*<0.001 (0.8)	*P*=1.000 (0.2)
		WDP (*n*=134)	4.4±12.3			*P*=1.000 (0.1)	*P*<0.001 (0.7)	*P*=1.000 (0.2)
		CMP (*n*=151)	5.1±11.9				*P*<0.001 (0.7)	*P*=1.000 (0.1)
		WOP (*n*=52)	15.2±21.7					*P*=0.034 (0.4)
		COP (*n*=33)	6.6±14.3					
	RIB/PEN	CDP (*n*=158)	0.0±0.0		*P*=0.081 (0.5)	*P*=0.117 (0.5)	*P*<0.001 (1.2)	*P*<0.001 (1.9)
		WDP (*n*=134)	3.1±9.4			*P*=1.000 (0.0)	*P*<0.001 (0.6)	*P*<0.001 (0.9)
		CMP (*n*=151)	2.9±8.7				*P*<0.001 (0.7)	*P*<0.001 (1.0)
		WOP (*n*=52)	10.9±18.9					*P*=1.000 (0.1)
		COP (*n*=33)	13.6±17.8					
	BIB	CDP (*n*=158)	0.5±3.9		*P*=1.000 (0.1)	*P*=0.242 (0.3)	*P*=0.078 (0.5)	*P*=0.011 (0.8)
		WDP (*n*=134)	0.9±4.6			*P*=0.850 (0.2)	*P*=0.223 (0.4)	*P*=0.032 (0.6)
		CMP (*n*=151)	2.4±9.5				*P*=1.000 (0.1)	*P*=0.543 (0.3)
		WOP (*n*=52)	3.6±10.0					*P*=1.000 (0.1)
		COP (*n*=33)	5.1±12.0					
	PUP	CDP (*n*=158)	0.5±3.2		*P*=0.880 (0.2)	*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.2)
		WDP (*n*=134)	0.1±1.0			*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		CMP (*n*=151)	0.3±1.9				*P*=1.000 (0.2)	*P*=1.000 (0.2)
		WOP (*n*=52)	0.0±0.0					*P*=1.000 (0.0)
		COP (*n*=33)	0.0±0.0					

Table 6.3. (continued)

Duration	Action	Position	Distance (m)	Difference and Effect Size				
				CDP	WDP	CMP	WOP	COP
3 min	CD/PRE	CDP (*n*=158)	1.6±5.7		*P*=1.000 (0.3)	*P*<0.001 (0.5)	*P*<0.001 (0.9)	*P*<0.001 (1.8)
		WDP (*n*=134)	4.1±9.3			*P*=0.171 (0.3)	*P*<0.001 (0.6)	*P*<0.001 (1.3)
		CMP (*n*=151)	7.9±15.8				*P*=0.330 (0.3)	*P*<0.001 (0.8)
		WOP (*n*=52)	12.6±22.0					*P*=0.021 (0.4)
		COP (*n*=33)	21.9±23.8					
	COV	CDP (*n*=158)	30.2±23.3		*P*=0.084 (0.3)	*P*<0.001 (0.4)	*P*<0.001 (1.0)	*P*<0.001 (1.4)
		WDP (*n*=134)	23.3±24.4			*P*=1.000 (0.1)	*P*<0.001 (0.7)	*P*<0.001 (1.0)
		CMP (*n*=151)	20.5±22.9				*P*=0.009 (0.6)	*P*<0.001 (0.9)
		WOP (*n*=52)	8.6±15.1					*P*=1.000 (0.6)
		COP (*n*=33)	1.1±6.3					
	RR	CDP (*n*=158)	29.3±30.7		*P*=1.000 (0.1)	*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*<0.001 (1.0)
		WDP (*n*=134)	32.2±31.1			*P*=1.000 (0.1)	*P*=0.274 (0.4)	*P*<0.001 (1.1)
		CMP (*n*=151)	29.9±30.4				*P*=0.814 (0.3)	*P*<0.001 (1.0)
		WOP (*n*=52)	21.7±23.3					*P*=0.025 (1.0)
		COP (*n*=33)	1.9±8.3					
	INT	CDP (*n*=158)	0.2±1.6		*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WDP (*n*=134)	0.2±1.8			*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		CMP (*n*=151)	0.5±4.0				*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WOP (*n*=52)	0.0±0.0					*P*=1.000 (0.0)
		COP (*n*=33)	0.0±0.0					
	OTH	CDP (*n*=158)	3.6±10.8		*P*=0.022 (0.4)	*P*=0.086 (0.3)	*P*=0.486 (0.4)	*P*=0.002 (0.8)
		WDP (*n*=134)	9.1±17.0			*P*=1.000 (0.1)	*P*=1.000 (0.0)	*P*=0.660 (0.3)
		CMP (*n*=151)	8.2±15.3				*P*=1.000 (0.0)	*P*=0.296 (0.4)
		WOP (*n*=52)	8.4±17.2					*P*=0.704 (0.3)
		COP (*n*=33)	14.6±22.5					

Table 6.3. (continued)

Duration	Action	Position	Distance (m)	Difference and Effect Size				
				CDP	WDP	CMP	WOP	COP
5 min	SP	CDP (*n*=153)	0.0±0.0		*P*<0.001 (0.5)	*P*<0.001 (0.7)	*P*<0.001 (0.8)	*P*<0.001 (2.5)
		WDP (*n*=126)	19.0±27.3			*P*=0.449 (0.3)	*P*=1.000 (0.3)	*P*=1.000 (1.7)
		CMP (*n*=141)	13.6±24.9				*P*=1.000 (0.0)	*P*=0.095 (1.2)
		WOP (*n*=46)	18.2±23.0					*P*=1.000 (1.0)
		COP (*n*=28)	25.4±34.2					
	MTR/ES	CDP (*n*=153)	1.8±7.5		*P*=0.005 (0.5)	*P*=0.052 (0.4)	*P*<0.001 (1.6)	*P*=0.221 (0.7)
		WDP (*n*=126)	7.8±17.1			*P*=1.000 (0.1)	*P*<0.001 (0.7)	*P*=1.000 (0.0)
		CMP (*n*=141)	6.5±14.3				*P*<0.001 (0.9)	*P*=1.000 (0.1)
		WOP (*n*=46)	20.4±20.0					*P*=0.005 (0.6)
		COP (*n*=28)	8.5±15.2					
	OVL/UDL	CDP (*n*=153)	0.3±3.7		*P*<0.001 (0.7)	*P*=1.000 (0.1)	*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WDP (*n*=126)	8.4±17.5			*P*<0.001 (0.6)	*P*<0.001 (0.5)	*P*<0.001 (0.5)
		CMP (*n*=141)	1.0±8.2				*P*=1.000 (0.0)	*P*=1.000 (0.1)
		WOP (*n*=46)	0.8±4.1					*P*=1.000 (0.2)
		COP (*n*=28)	0.0±0.0					
	RWB	CDP (*n*=153)	3.4±11.1		*P*=0.302 (0.3)	*P*=0.362 (0.3)	*P*<0.001 (0.8)	*P*=0.349 (0.5)
		WDP (*n*=126)	6.9±14.0			*P*=1.000 (0.0)	*P*=0.028 (0.5)	*P*=1.000 (0.2)
		CMP (*n*=141)	6.7±13.1				*P*=0.018 (0.5)	*P*=1.000 (0.2)
		WOP (*n*=46)	13.9±18.1					*P*=1.000 (0.3)
		COP (*n*=28)	9.2±17.2					
	RIB/PEN	CDP (*n*=153)	0.0±0.0		*P*=0.409 (0.4)	*P*=0.037 (0.5)	*P*<0.001 (1.4)	*P*<0.001 (2.2)
		WDP (*n*=126)	2.6±8.9			*P*=1.000 (0.1)	*P*<0.001 (0.8)	*P*<0.001 (1.4)
		CMP (*n*=141)	3.6±10.0				*P*<0.001 (0.6)	*P*<0.001 (1.3)
		WOP (*n*=46)	11.2±16.5					*P*<0.001 (0.5)
		COP (*n*=28)	22.0±25.9					
	BIB	CDP (*n*=153)	0.6±3.7		*P*=1.000 (0.1)	*P*=0.582 (0.2)	*P*=0.121 (0.5)	*P*=0.003 (0.9)
		WDP (*n*=126)	1.1±5.8			*P*=1.000 (0.1)	*P*=0.420 (0.4)	*P*=0.012 (0.6)
		CMP (*n*=141)	2.2±8.7				*P*=1.000 (0.2)	*P*=0.103 (0.4)
		WOP (*n*=46)	3.7±9.8					*P*=1.000 (0.2)
		COP (*n*=28)	6.1±13.4					
	PUP	CDP (*n*=153)	0.7±3.5		*P*=1.000 (0.2)	*P*=1.000 (0.2)	*P*=1.000 (0.0)	*P*=1.000 (0.2)
		WDP (*n*=126)	0.2±1.8			*P*=1.000 (0.0)	*P*=1.000 (0.2)	*P*=1.000 (0.1)
		CMP (*n*=141)	0.2±1.7				*P*=1.000 (0.2)	*P*=1.000 (0.1)
		WOP (*n*=46)	0.7±4.6					*P*=1.000 (0.2)
		COP (*n*=28)	0.0±0.0					

Table 6.3. (continued)

Duration	**Action**	**Position**	**Distance (m)**	**Difference and Effect Size**				
				CDP	WDP	CMP	WOP	COP
5 min	CD/PRE	CDP (*n*=153)	1.6±5.6		*P*=0.084 (0.5)	*P*<0.001 (0.7)	*P*=0.009 (0.8)	*P*<0.001 (2.5)
		WDP (*n*=126)	5.9±10.8			*P*=0.132 (0.3)	*P*=1.000 (0.3)	*P*<0.001 (1.7)
		CMP (*n*=141)	10.0±15.8				*P*=1.000 (0.0)	*P*<0.001 (1.2)
		WOP (*n*=46)	9.2±17.5					*P*<0.001 (1.0)
		COP (*n*=28)	31.3±27.4					
	COV	CDP (*n*=153)	38.8±28.9		*P*=0.081 (0.3)	*P*<0.001 (0.5)	*P*<0.001 (0.9)	*P*<0.001 (1.3)
		WDP (*n*=126)	30.3±27.8			*P*=1.000 (0.2)	*P*=0.013 (0.6)	*P*<0.001 (1.0)
		CMP (*n*=141)	25.8±26.8				*P*=0.227 (0.4)	*P*<0.001 (0.9)
		WOP (*n*=46)	15.5±20.2					*P*=0.632 (0.7)
		COP (*n*=28)	3.7±11.6					
	RR	CDP (*n*=153)	33.5±34.2		*P*=1.000 (0.1)	*P*=1.000 (0.0)	*P*=1.000 (0.3)	*P*<0.001 (0.9)
		WDP (*n*=126)	37.5±35.5			*P*=1.000 (0.1)	*P*=0.236 (0.4)	*P*<0.001 (1.0)
		CMP (*n*=141)	34.1±32.2				*P*=0.913 (0.3)	*P*<0.001 (1.0)
		WOP (*n*=46)	24.9±23.0					*P*=0.071 (1.1)
		COP (*n*=28)	4.0±11.9					
	INT	CDP (*n*=153)	0.3±2.0		*P*=1.000 (0.2)	*P*=1.000 (0.1)	*P*=1.000 (0.2)	*P*=1.000 (0.2)
		WDP (*n*=126)	0.0±0.0			*P*=1.000 (0.2)	*P*=0.851 (0.4)	*P*=1.000 (0.0)
		CMP (*n*=141)	0.5±4.1				*P*=1.000 (0.1)	*P*=1.000 (0.1)
		WOP (*n*=46)	0.8±3.9					*P*=1.000 (0.3)
		COP (*n*=28)	0.0±0.0					
	OTH	CDP (*n*=153)	5.3±12.3		*P*=0.016 (0.4)	*P*=0.012 (0.4)	*P*=0.018 (0.6)	*P*=0.037 (0.7)
		WDP (*n*=126)	12.0±18.6			*P*=1.000 (0.0)	*P*=1.000 (0.1)	*P*=1.000 (0.2)
		CMP (*n*=141)	12.0±19.0				*P*=1.000 (0.1)	*P*=1.000 (0.2)
		WOP (*n*=46)	14.6±21.3					*P*=1.000 (0.1)
		COP (*n*=28)	15.8±23.0					

CDP, Central Defensive Players; WDP, Wide Defensive Players; CMP, Central Midfield Players; WOP, Wide Offensive Players; COP, Central Offensive Players. SP: 'Support Play', MTR/ES: 'Move to Receive/Exploit Space', OVL/UDL: 'Overlap/Underlap', RWB: 'Run with Ball', RIB/PEN: 'Run in Behind/Penetrate', BIB: 'Break into Box', PUP: 'Push up Pitch', CD/PRE: 'Close Down/Press', COV: 'Covering', RR: 'Recovery Run', INT: 'Interception', OTH: 'Others'. P-values in green indicate differences with orange demonstrating no differences. Values in bracket represent effect size; trivial (≤ 0.2), small (>0.2–0.6), moderate (>0.6–1.2), large (>1.2–2.0), very large (>2.0–4.0) and extremely large (>4.0; Batterham and Hopkins, 2006).

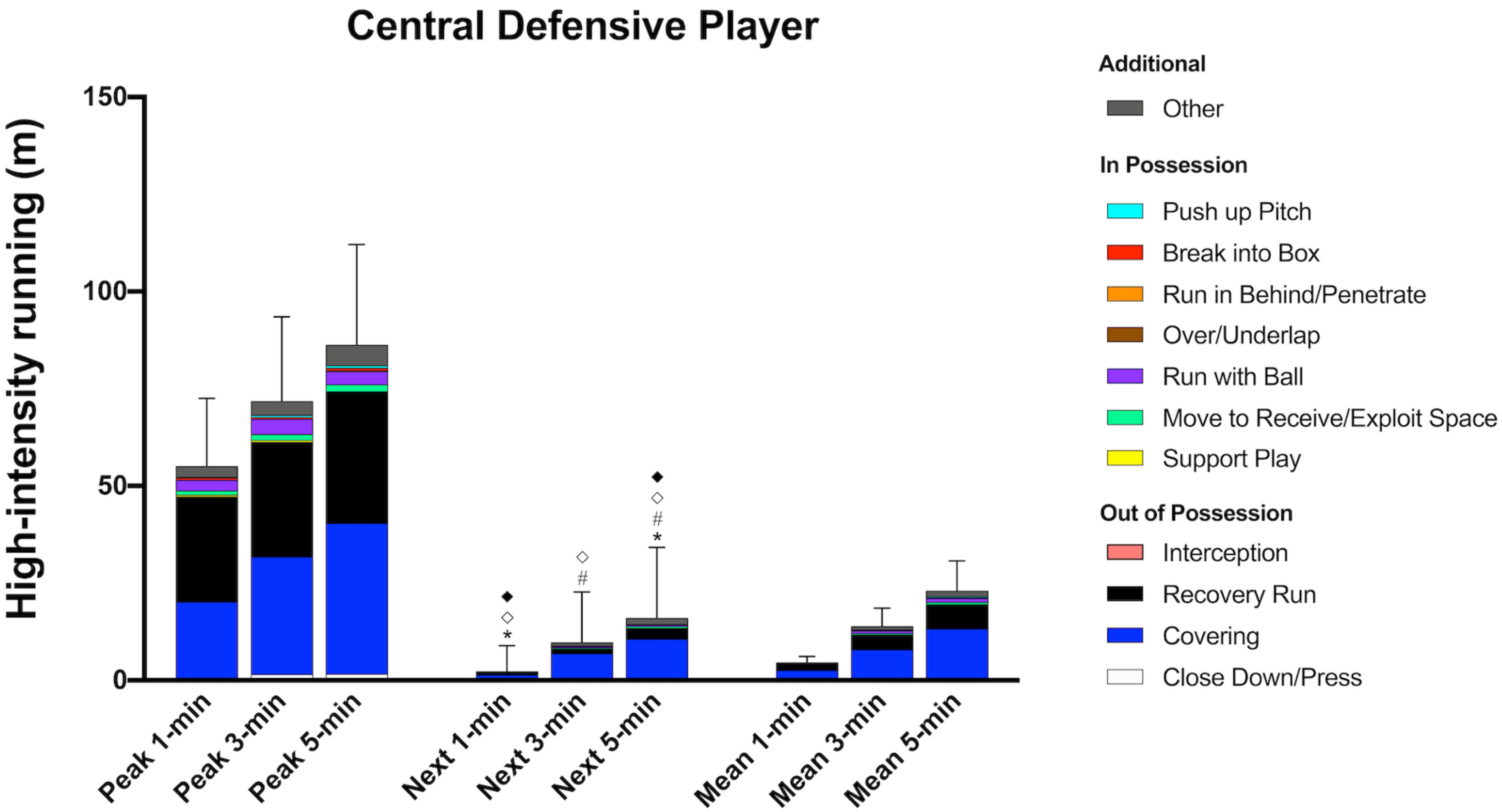


Figure 6.2. Central Defensive Players; contextualised distances at high-intensity in the peak 1-, 3- and 5-min periods during the match, the subsequent period (next) and the match average (mean). *Difference from match average for 'Covering' (P<0.05). $^{\#}$Difference from match average for 'Recovery Run' (P<0.01). $^{\diamond}$Difference from match average for 'Run in Behind/Penetrate' (P<0.01). $^{\blacklozenge}$Difference from match average for 'Break into Box' (P<0.01).

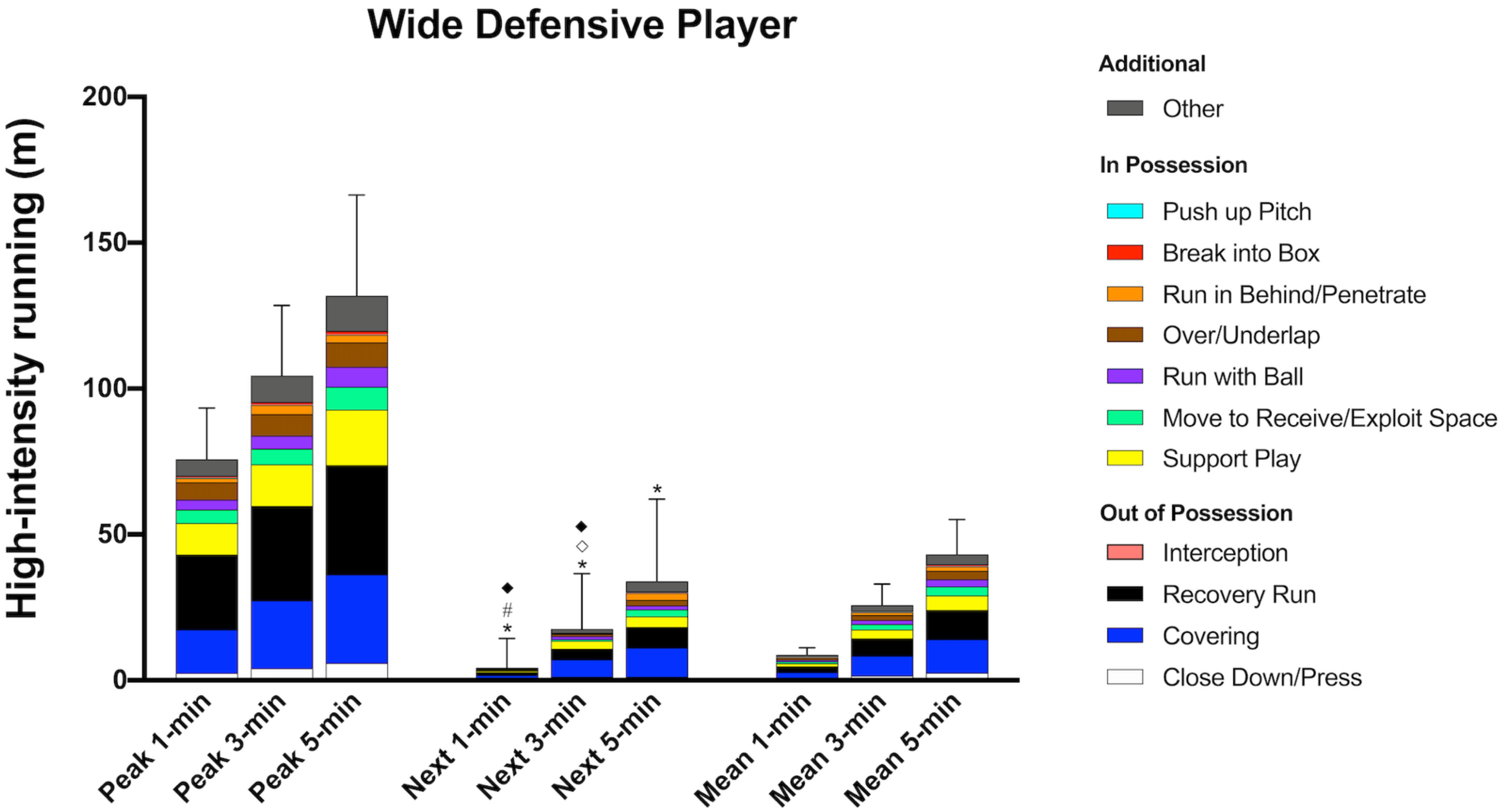


Figure 6.3. Wide Defensive Players; contextualised distances at high-intensity in the peak 1-, 3- and 5-min periods during the match, the subsequent period (next) and the match average (mean). *Difference from match average for 'Recovery Run' ($P<0.05$). #Difference from match average for 'Support Play' and 'Run with Ball' ($P<0.05$). ◇Difference from match average for 'Break into Box' and 'Run in Behind' ($P<0.01$). ◆Difference from match average for 'Move to Receive/Exploit Space' ($P<0.05$).

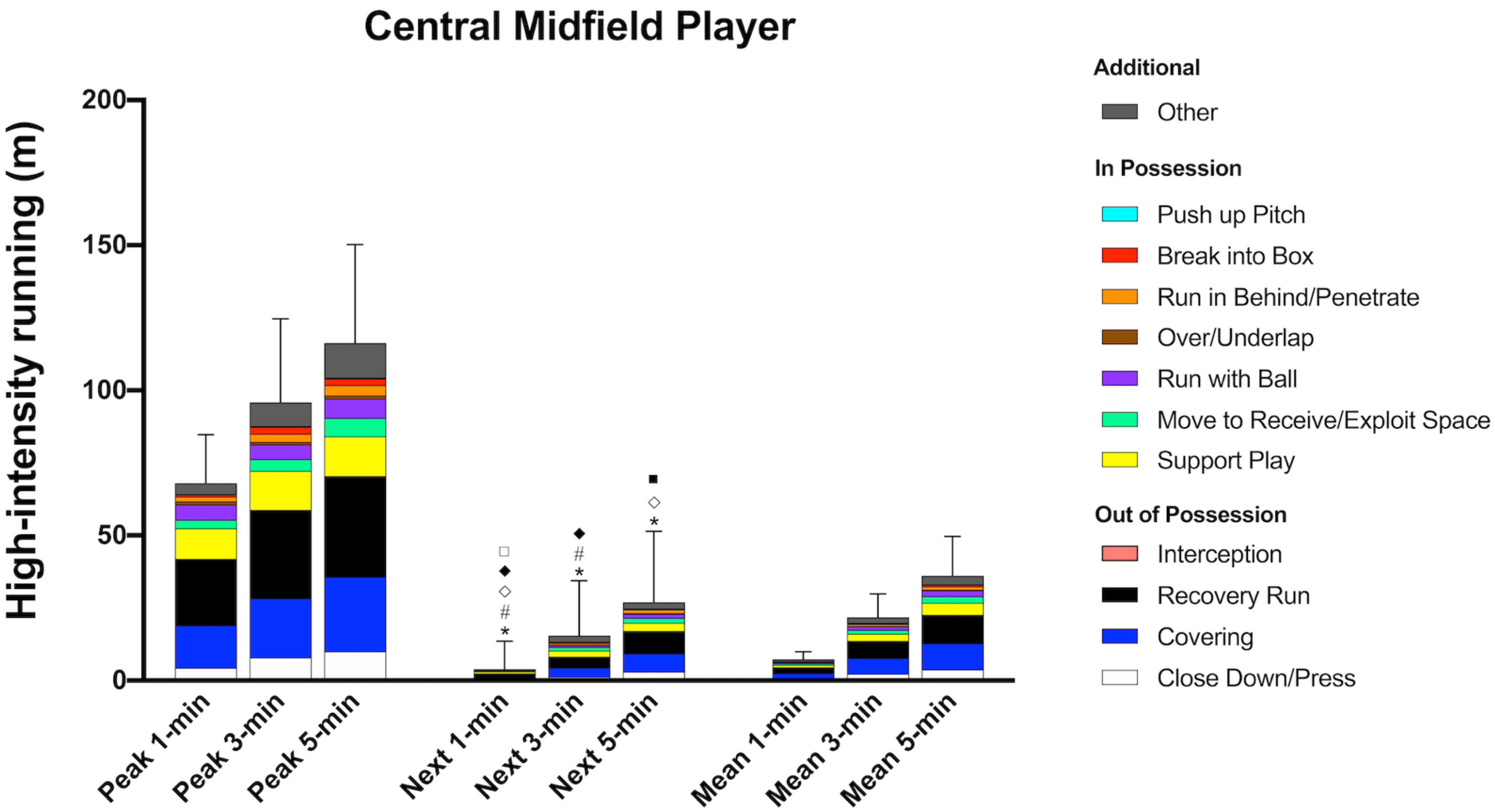


Figure 6.4. Central Midfield Players; contextualised distances at high-intensity in the peak 1-, 3- and 5-min periods during the match, the subsequent period (next) and the match average (mean). *Difference from match average for 'Covering' (P<0.01). $^{\#}$Difference from match average for 'Close Down/Press' (P<0.01). $^{\diamond}$Difference from match average for 'Break into Box' (P<0.01). $^{\blacklozenge}$Difference from match average for 'Run with Ball' (P<0.05). $^{\square}$Difference from match average for 'Move to Receive/Exploit Space' (P<0.01). $^{\blacksquare}$Difference from match average for 'Support Play' (P<0.05).

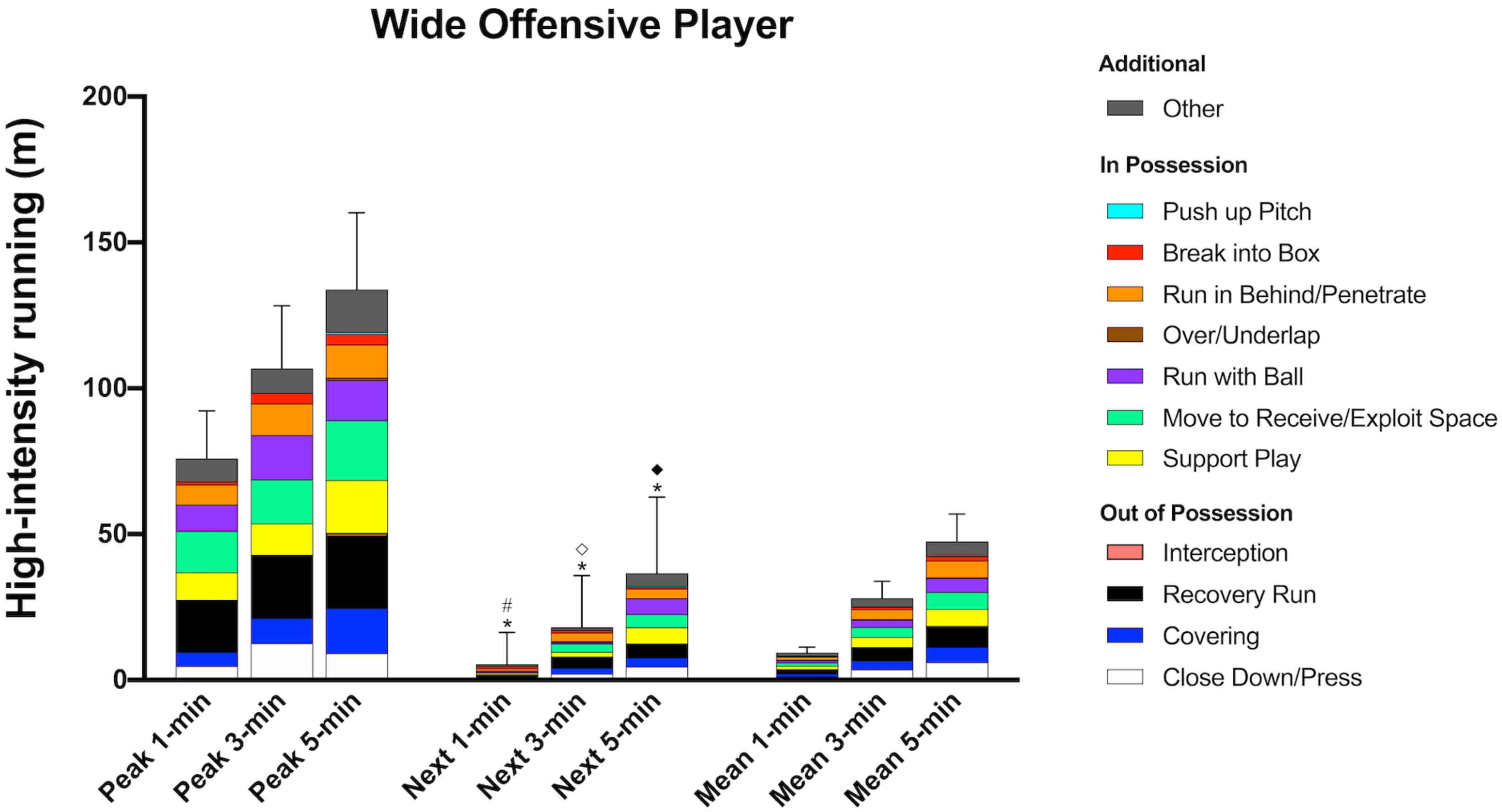


Figure 6.5. Wide Offensive Players; contextualised distances at high-intensity in the peak 1-, 3- and 5-min periods during the match, the subsequent period (next) and the match average (mean). *Difference from match average for ‘Interception’ ($P<0.01$). $^{\#}$Difference from match average for ‘Move to Receive/Exploit Space’ ($P<0.01$). $^{\diamond}$Difference from match average for ‘Support Play’ ($P<0.05$) and ‘Run with Ball’ ($P<0.01$). $^{\blacklozenge}$Difference from match average for ‘Run in Behind/Penetrate’ ($P<0.05$).

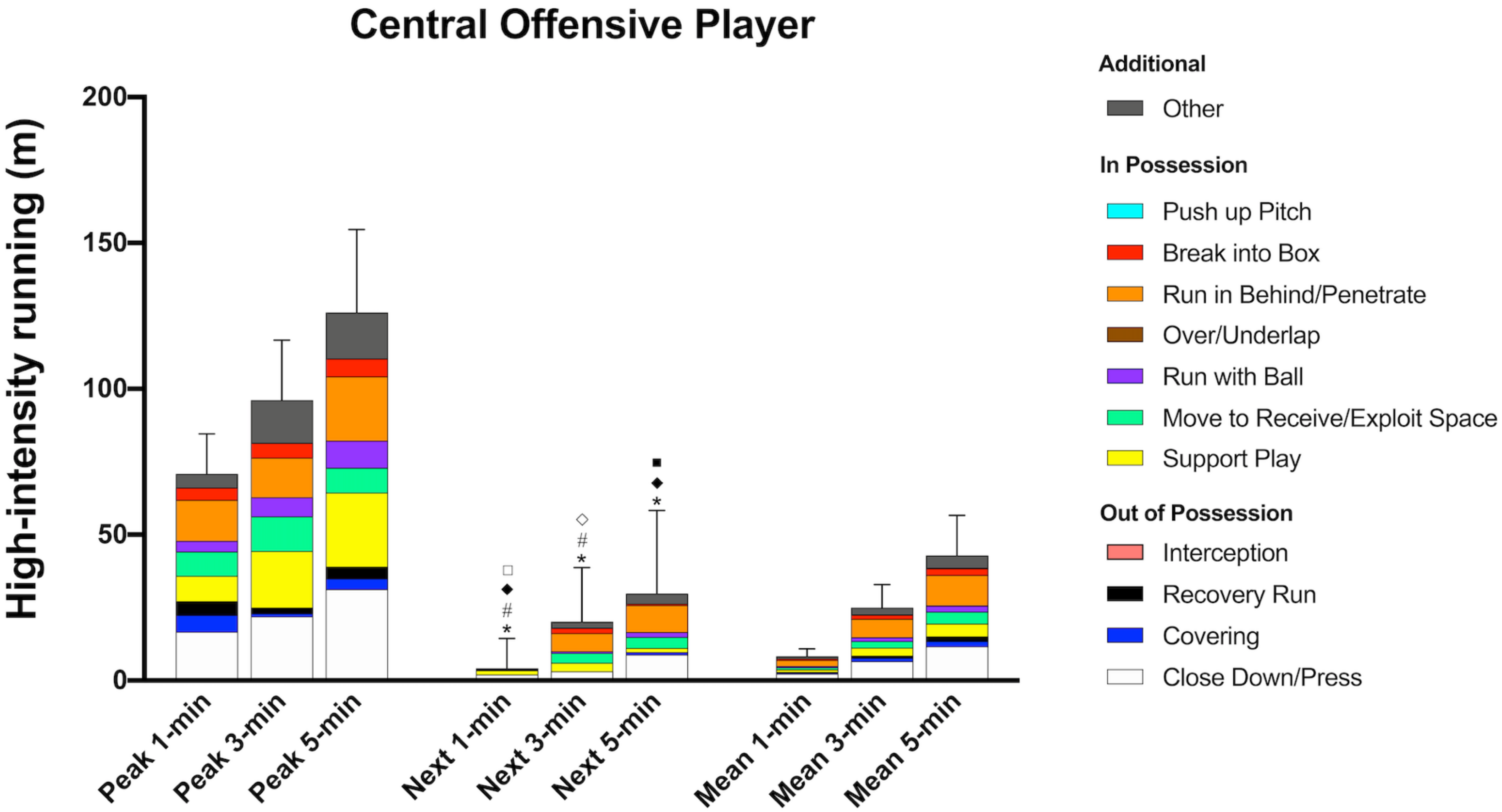


Figure 6.6. Central Offensive Players; contextualised distances at high-intensity in the peak 1-, 3- and 5-min periods during the match, the subsequent period (next) and the match average (mean). *Difference from match average for 'Recovery Run' (P<0.01). #Difference from match average for 'Covering' (P<0.01). ◇Difference from match average for 'Close Down/Press' (P<0.05). ◆Difference from match average for 'Break into Box' (P<0.01). □Difference from match average for 'Run in Behind/Penetrate', 'Move to Receive/Exploit Space' and 'Run with Ball' (P<0.01). ■Difference from match average for 'Support Play' (P<0.05).

6.4.4 Match-to-Match Variability

Regardless of playing positions, the mean percentages of CVs for high-intensity distance produced by players during the peak 1-, 3- and 5-min periods were 21±12%, 22±12% and 22±14%, respectively. CDP produced the largest CVs during the peak 1-min (29±12%), 3-min (27±14%) and 5-min (26±14%) periods. Whilst WOP generated the lowest CVs for the peak 3-min (15±11%) and 5-min (18±13%), it was CMP for the peak 1-min (17±8%). Regardless of physical-tactical variables except for 'Push up Pitch' and 'Interception', the mean percentage of CVs for the contextualised performance of players during the peak 1-, 3- and 5-min periods were 57±36%, 63±36% and 66±34%, respectively.

6.5 Discussion

The present study is the first to consider the contextualised high-intensity distance covered during peak 1-, 3- and 5-min periods of match-play and the following periods of each duration using a rolling average technique for individual and team performances. The contextualised data now provide important insights into 'HOW' players/teams tactically perform in relation to high-intensity efforts during peak periods and how they altered their physical-tactical behaviour during the following periods. However, high match-to-match variabilities for high-intensity running distance (22%) and physical-tactical actions (57-63%) performed during the most intense period should be acknowledged, which is supported by previous research (Ade, Fitzpatrick and Bradley, 2016; Carling et al., 2016; Novak et al., 2021). Additionally, some physical-tactical actions demonstrated inconsistency in different time durations of the next periods, and these physical-tactical data were position-specific. This may indicate that each position has certain physical-tactical actions to perform even after intensified periods of play, especially when tactically required to do so.

Numerous studies have examined match running performances in peak periods of play to provide an insight into intensified discrete periods (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2010; Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017; Martín-García et al., 2018; Oliva-Lozano et al., 2020; Riboli et al., 2021). Supported by previous studies (Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017; Martín-García et al., 2018; Oliva-Lozano et al., 2020), CDP demonstrated the lowest locomotive demands (e.g., high-intensity running distance) whilst WDP and WOP exhibited the largest during intense periods. Additionally, the present study for the first time analysed the peak periods for team performances. Data indicates that during the peak 1-, 3- and 5-min periods, almost all of the outfield players in different playing positions (9-10 players) were involved collectively covering high-intensity distances of ~400 m, ~650 m and ~850 m, respectively (Figure 6.1). This indicates that all outfield players must collectively perform some bouts of high-intensity actions during intensified periods of competition as a team. Nevertheless, such data provide only a rudimentary insight on physical performance.

The contextualised data revealed that out of possession ~20-35% of the high-intensity distance was covered by players for each 'Recovery Run' and 'Covering' whilst in possession ~10% was covered for 'Support Play'. This may indicate that peak periods occur during a fast transition phase since such actions as 'Recovery Run' and 'Support Play' are commonly performed when the ball is quickly moved defensively or offensively during a quick transition (Bradley, 2020). This could also be supported with the team performance data where teams produced high-intensity 'Recovery Run' and 'Support Play' actions the most out of possession and in possession, respectively. This could be due to players/teams executing more high-intensity actions during decisive phases of play than normal situations (Faude, Koch and Meyer, 2012; Martínez-Hernández, Quinn and Jones, 2022). Nevertheless, since the present study did not analyse phases of play (e.g., attack-to-defence transition phases), it is difficult to fully conclude whether intensified periods take place during fast transition phases. Thus, future studies should attempt to condense contextualised actions into the phases of play to provide additional granularity.

However, the contextualised data during the peak periods were position specific. For instance, the key high-intensity tactical actions during the peak periods for CDP were 'Covering' and 'Recovery Run'. This is possibly due to one of their main defensive duties, which is to defend the space left behind particularly when a turnover in possession occurs (Modric, Versic and Sekulic, 2020). In addition to these, 'Support Play' was another main physical-tactical action for WDP and CMP, but also there was a bespoke action for WDP ('Over/Underlap'). This clearly demonstrates their attacking responsibilities during the peak periods. For instance, WDP and CMP should perform 'Support Play' to become involved in the attacking/defence-to-attack transition phase to produce a promising attacking threat (Ade, Fitzpatrick and Bradley, 2016; Bradley, 2020). Furthermore, the key high-intensity tactical activities for WOP were ‘Move to Receive/Exploit Space’, ‘Run in Behind/Penetrate’, ‘Support Play’ and ‘Run with Ball’ when in possession, and ‘Recovery Run’ when out of possession. By contrast, ‘Close Down/Press’, ‘Run in Behind/Penetrate’ and ‘Support Play’ were the main high-intensity tactical activities for COP. The data clearly exhibit their specific tactical roles during intensified periods. For example, COP should aggressively close down/press the opponent to make it hard for them to advance their attacking play or regain possession when out of possession (Lucchesi, 2004) whilst they should also perform attacking actions (e.g., ‘Run in Behind/Penetrate’) to create promising chances when in possession (Ade, Fitzpatrick and Bradley, 2016). Such position-specific tasks could be used to replicate intensified periods during training matches as the 11v11 training matches could offer the players resources to train the most demanding episodes of match-play (Martín-García et al., 2019); however, it should be acknowledged that it is unlikely to provide the necessary ‘overload’ desired at times. Additionally, these position-specific trends could be easily translated into training sessions using the average distance per physical-tactical action and average number of actions during the peak periods (Table 6.2). For example, whilst CMP is driving through the middle running with the ball at high-intensity (~20 m), WDP could perform a high-intensity over/underlapping action (~35 m) in a wide area from the middle to the final third. Once CMP pass the ball to WDP, they could produce a ‘Break into Box’ action (~20 m) and WDP could cross the ball at the end of the action. Both then produce ‘Recovery Run’ actions (~30-40 m) to get goal side of the ball to replicate fast transition phases of the peak periods. Although this type of work has been previously attempted to replicate physical demands of players whilst simultaneously reflecting position-specific game situations (Bradley et al., 2019; Ade et al., 2021), they used average physical demands, which may underestimate the true match demands (Mernagh et al., 2021). Thus, these contextualised peak distance data could help practitioners better prescribe not only position- but player-specific drills with the true peak demands.

Decrements that follow the peak periods have been previously examined alongside analysing intensified periods of play (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017). However, most studies used a predefined technique (e.g., 0-5, 5-10 min etc.), which can under or overestimate the true physical demands of the peak period and the subsequent period, respectively (Varley, Elias and Aughey, 2012). Moreover, different speed thresholds for high-intensity running during the peak periods have been used (>14.0-19.8 km·h^{-1}), which makes it difficult to compare across studies. Despite these shortcomings, the general consensus from previous research was that the transient decrements in high-intensity running occur after intense periods, which agrees with the findings of the present study. Additionally, the present study analysed shorter durations of the next periods to evaluate more detailed temporal changes after the peak periods of match-play. Data demonstrated that players experienced more pronounced reductions in high-intensity running in the next 1-min period (~50%) compared to the next 3- and 5-min period (~25-30%) after the peak periods of play. This prominent short-term fluctuation during the next 1-min period seems likely due to less energy available from creatine phosphate hydrolysis since creatine phosphate concentrations could be significantly diminished after some bouts of high-intensity actions (Haff and Triplett, 2015). That said, similar trends for team performances were observed during the subsequent periods to individual performances. This might indicate that teams briefly modify their collective tactical behaviour after intensified periods during matches, which could also be supported by the number of high-intensity actions and players involved in the following periods (Figure 6.1). Yet, it could be due to reduced playing time (e.g., ball out of play); thus, it is difficult to fully determine without context whether transient decrements are down to fatigue or tactical alterations/pacing strategies or reduced playing opportunities.

The present study for the first time provides important insights on how players/teams alter their tactical behaviour during the next 1-, 3- and 5-min periods through integrating the physical-tactical metrics. Players/teams changed their tactical performances by covering ~20-55% less high-intensity distances for ‘Covering’ and ‘Recovery Run’ during all the subsequent periods compared to the match average. Since both players and teams consistently ran less high-intensity distance for such variables, this may denote that they tend to be defensively in a good tactical position/formation when out of possession after intense periods whilst covering less high-intensity distance. This could be due to the defensive phases of play being more physically taxing (Castellano et al., 2022). In possession, players performed ~30-90% less

‘Run with Ball’ distance in the next periods compared to the match average, which may be due to such actions (e.g., dribbling) causing an increased energy cost when compared to running without the ball (Reilly, 2003) or due to player time running with the ball being small (Carling, 2010). However, even with such context it is still challenging to fully explain why transient decrements occur in subsequent periods. Thus, the systematic use of video to check each player and to add more layers of information together with effective playing time (e.g., only in-play time) may provide clearer insights into how players/teams alter their physical-tactical actions after intense periods (Castellano et al., 2022).

Data demonstrates that physical-tactical trends during the subsequent periods were also position-specific. For instance, WDP covered ~30-50% less high-intensity distance for ‘Recovery Run’ in all of the next periods compared to the match average. ‘Recovery Run’ is when players run back toward own goal to get goal side of the ball when out of position (Bradley and Ade, 2018), thus this might specify that WDP modulates their physical-tactical performances by being less involved in the attacking/transition phase during the next periods. That said, it would be of greater interest if measuring the ability of the player to be involved in the subsequent attack after the tactical modulation to evaluate the effectiveness of the player. However, certain physical-tactical actions exhibited inconsistency in different time durations of the next periods. For instance, COP covered ~80-100% less high-intensity distance for ‘Break into Box’ in the next 1- and 5-min periods compared to the match average; however, they covered ~20% more distance for this action during the next 3-min period. This may indicate that players selectively produce high-intensity running particularly when tactically required to do so. Yet, it is still difficult to draw conclusions since performances are influenced by context (e.g., no need to perform or choosing not to perform physical-tactical actions). Thus, more context should be provided to better understand ‘WHY’ players perform less physical-tactical distance during the subsequent period after the peak passage.

6.6 Limitations

Firstly, the present study did not quantify acceleration/deceleration efforts during matches. Although most of these efforts do not reach high-intensity speed thresholds, they are very frequent during matches and are extremely taxing mechanically (Varley and Aughey, 2013). Thus, these actions should be incorporated and contextualised to have a comprehensive understanding of the true physical demands with tactical purposes. Moreover, although contextualised data include high-intensity running activities with a single (~75%) and hybrid tactical (~15%) actions with unclassified movements as 'Other' (~10%), the present study combined the singular actions and the primary action of the hybrid actions to simplify data output. Thus, future research should evaluate hybrid actions to provide more transparency and insight to practitioners. Furthermore, since the present study analysed general positional data (e.g., WDP and CMP) and these were derived from different formations (e.g., 4-3-3, 3-5-2, etc.), this could have impacted data due to formations/player playing style influencing match performance (Bradley et al., 2011; Dellal et al., 2011).

6.7 Practical Recommendations

- When designing training programmes such as speed endurance training (Ade et al., 2021) and small-sided games (Riboli et al., 2020) while duplicating the peak demands of players, fast transition phases (e.g., defence to attack phase or vice versa) should be included as peak periods of play are likely to occur during fast transition phases.
- It may be helpful for coaches and practitioners to use the average distance per physical-tactical action and average number of the actions performed during intensified periods of play for devising position-specific training drills (Table 6.2). As the analysis of average physical demands during a 90-min game can underestimate the true match demands (Mernagh et al., 2021). However, since it is unlikely to provide the necessary 'overload' desired to players from time to time during training sessions, especially when training as a team, it seems to be more advantageous to use physical-tactical profiles of each player for separate drills such as an isolated drill or rehabilitation session (Ade et al., 2021).

6.8 Conclusion

The contextualised distance data can help coaches and/or practitioners better prescribe position- or player-specific training drills, and this also helps improve the understanding of transient decrements in high-intensity running during the subsequent periods. That said, since it is still complex due to numerous influencing factors, additional context should be provided to have a better understanding of the transient decrements in high-intensity running. Finally, the high match-to-match variabilities for high-intensity distance and contextualised data during intensified periods of play should be acknowledged.

CHAPTER SEVEN

SYNTHESIS OF FINDINGS

7.1 Synthesis

In this following chapter, the present findings will be considered in connection with the original aims and objectives of this research project before joining up the dots. Following the general discussion, the limitations of the studies conducted during the research will be acknowledged and then recommendations for future research will be made considering the current findings and the advancement of technologies in the last few years. Finally, practical recommendations will be provided in accordance with a synthesis of the key findings.

7.2 Accomplishment of Aims and Objectives

The research programme aimed to firstly develop the integrated approach for quantifying match physical-tactical actions, and secondly amalgamate physical-tactical actions to provide more informative insights to coaches and practitioners to help them better understand physical metrics with tactical information. The present research analysed the individual/team profiles of physical-tactical performances in the English Premier League (EPL) in accordance with various playing positions (General Positions: Central Defensive Players = CDP, Wide Defensive Players = WDP, Central Midfield Players = CMP, Wide Offensive Players = WOP, Central Offensive Players = COP; Specialised Positions: Centre Backs (CB) = two at the back: CB^2 or three at the back: CB^3, Full-Backs = FB, Wing-Backs = WB, Box-to-Box Midfielders = B2BM, Central Defensive Midfielders = CDM, Central Attacking Midfielders = CAM, Wide Midfielders = WM, Wide Forwards = WF, Centre Forwards (CF) = one centre forward: CF^1 or two centre forwards: CF^2), final league rankings (Tier A = 1st–5th ranking, Tier B = 6th–10th ranking, Tier C = 11th–15th ranking and Tier D = 16th–20th ranking), and specific periods of play (e.g., the most intensified 1-, 3- and 5-min period and the next 1-, 3- and 5-min period). The findings will possibly help coaches and practitioners translate data into training more effectively. These aims were achieved throughout the completion of the four studies (Table 7.1).

Table 7.1. A synthesis of the individual studies from the present research programme investigating various objectives.

Objective 1	To modify methodological issues and verify the validity and reliability of the integrated approach (Chapter 3).
Method	Initially, the original integrated approach was developed by modifying the identified methodological problems and the validity and reliability of the developed integrated approach were tested. Both UEFA qualified coaches and performance analysts (*n*=30) participated to verify the scientific robustness of this novel approach.
Main Findings	The integrated approach demonstrated a high degree of validity as evidenced by the mean percentage of correct responses by all participants (~90%) whilst inter- and intra-observer reliability were found to be strong (κ=0.81) to almost perfect (κ=0.94), respectively.
Conclusion	It is now possible to produce valid and reliable data in relation to physical-tactical profiles of players/teams during a match.
Evaluation	The objective 1 was achieved within Chapter 3. ✓

Table 7.1. (continued)

Objective 2	To identify physical-tactical trends of general and specialised positions and examine differences between them (Chapter 4).
Method	English Premier League players' high-intensity running efforts (583 observations) were contextualised using the developed integrated approach (Chapter 3). Data were analysed across 5 general (central defensive players, wide defensive players, central midfield players, wide offensive players, central offensive players) and 11 specialised tactical roles (centre backs: two or three at the back, full-backs, wing-backs, box-to-box midfielders, central defensive midfielders, central attacking midfielders, wide midfielders, wide forwards, centre forwards: one centre forward or two centre forwards).
Main Findings	The investigation revealed position-specific patterns of play in and out of possession with more meaningful differences being apparent for specialised positions compared to general positions. In addition, match physical-tactical demands of players can be under or overestimated if using a general positional analysis (e.g., wide defensive players and central midfield players).
Conclusion	It is suggested to use specialised tactical roles when analysing not only physical but also contextualised performances. This study allows coaches and practitioners to understand the physical-tactical demands of various playing positions during a competitive match. Coaches and practitioners could use the data to design position- or even -player-specific training drills. However, it should be acknowledged that match-to-match variabilities for high-intensity running distance and contextualised actions were high across various tactical roles (21-22% and 62-67%, respectively).
Evaluation	The objective 2 was achieved within Chapter 4. ✓

Table 7.1. (continued)

Objective 3	To determine physical-tactical differences between teams based on their final league ranking (Chapter 5).
Method	Physical-tactical differences between teams in English Premier League based on their final league ranking (Tier A: 1st–5th ranking, *n*=25; Tier B: 6th–10th ranking, *n*=26; Tier C: 11th–15th ranking, *n*=26; Tier D: 16th–20th ranking, *n*=23) were examined using the developed integrated approach (Chapter 3).
Main Findings	The investigation revealed that teams in Tier A performed more in-possession physical-tactical actions than those in lower Tiers. Moreover, central and wide defensive players in Tier A performed more in-possession physical-tactical actions (e.g., 'Move to Receive/Exploit Space') compared to those in lower Tier clubs whilst central offensive players in Tier D executed more out-of-possession physical-tactical activities (e.g., 'Covering') than those in higher Tier clubs.
Conclusion	High-intensity in-possession tactical actions would differentiate team standards or final league rankings. Also, the amalgamated data can help improve our understanding of a team's playing style according to their competitive standard. Nevertheless, it should be acknowledged that match-to-match variabilities produced by teams were high for high-intensity running distance (13%) and physical-tactical actions (48%).
Evaluation	The objective 3 was achieved within Chapter 5. ✓

Table 7.1. (continued)

Objective 4	To investigate physical-tactical performances during the most intense period of play and the following period (Chapter 6).
Method	Using the developed integrated approach (Chapter 3), physical-tactical actions performed by English Premier League players and teams (*n*=583 player observation and 100 match observations) during the most demanding 1-, 3- and 5-min periods and the subsequent 1-, 3- and 5-min periods of competitive matches were determined.
Main Findings	Players and teams covered the largest distance for 'Recovery Run' when out of possession and 'Support Play' when in possession during peak periods of play. Moreover, players and teams performed less high-intensity distance in the next period that follows the most intense passage of play compared to match average, especially when out of possession (e.g., less 'Covering' and 'Recovery Run' distance). However, some physical-tactical actions exhibited inconsistency in different time durations of the next periods with these contextualised data being position-specific.
Conclusion	Intensified periods may occur during fast transition phases of play. Each position seems to have certain physical-tactical actions to perform even after the peak periods, especially when tactically required to do so. This can help practitioners not only prescribe position- or player-specific drills with peak demands of play whilst simultaneously reflecting position-specific game situations, but also have a better understanding of transient decrements in high-intensity running after intense periods of play. However, it should be acknowledged that match-to-match variabilities during the peak periods were high (~20% for high-intensity running distance; ~55-65% for contextualised performances).
Evaluation	The objective 4 was achieved within Chapter 6. ✓

7.3 Joining Up the Dots

7.3.1 Out-of-Possession Variables

7.3.1.1 Closing Down/Press

High-intensity 'Closing Down/Pressing' actions are typically performed by COP over the course of a match and also during intensified periods of play. COP covered 89-2,307% greater high-intensity 'Close Down/Press' distance than other positions whilst performing such actions both toward the opposition player on the ball and receiving the ball. Regardless of tactical roles the players showed 27-45% reductions in high-intensity 'Close Down/Press' distance in the periods that follow intensified periods of play compared to the match average whilst COP did not exhibit decrements in such physical-tactical performance apart from the next 3-min periods. Given specialised tactical roles, CF^1 ran 43-3,621% greater high-intensity 'Close Down/Press' distance than other positions. Whilst the average number of high-intensity actions in relation to 'Close Down/Press' per match was greater for CAM (*n*=9) compared to their generalist position (CMP, *n*=5), that was lower for CDM (*n*=2). When considering team standards, higher-ranked clubs like Tier A and B teams completed ~20% more of 'Close Down/Press' activities in the final third of the pitch than lower-ranked clubs such as those in Tier C and D (13 vs 11) albeit no statistical differences between different Tiers.

7.3.1.2 Covering

During match-play high-intensity 'Covering' activities are normally performed by players with defensive roles such as CDP and WDP covering 25-532% more distance than other positions with the former performing more 'Covering–long ball/pass' activities. During intensified periods of play, both the players and teams covered 22-25% of the high-intensity distance performing 'Covering' actions. CDP covered greater high-intensity 'Covering' distance than WOP and COP whilst they demonstrated 20-44% decrements in high-intensity 'Covering' distance in the next periods after intense periods compared to the match average. When considering specialised tactical roles, the average number of high-intensity 'Covering' actions per match was lower for CAM compared to their general position, CMP (*n*=3 vs 9, respectively). Considering team standards, lower-ranked teams (e.g., Tier C) produced 26% more high-intensity 'Covering' actions from the defensive third compared to higher-ranked teams (e.g., Tier A) with offensive players in Tier D (WOP and COP) covering 138-410% greater distance than their counterparts in high-ranked teams (e.g., Tier A and B).

7.3.1.3 Recovery Run

WDP and CMP frequently performed ‘Recovery Run’ actions at high-intensity covering 34-670% greater distance than other positions during a 90-min match whilst CDP and WDP performed more ‘Recovery Run–Ball passed over top/downside’ actions than CMP, WOP and COP. During intensified periods of play, both the players and teams covered 28-37% of the high-intensity distance performing ‘Recovery Run’ actions, especially for CDP and CMP covering greater distance than COP. Also, CDP and CMP demonstrated 32-53% decrements in high-intensity ‘Recovery Run’ distance in the following periods after intensified periods compared to the match average. Specialised tactical role data demonstrated that WB and B2BM covered 48-1,125% more high-intensity distance producing ‘Recovery Run’ actions compared to CB^2, CB^3, FB, CAM, WF, CF^1 and CF^2 whilst no differences were witnessed when compared to CDM. In addition, the average number of high-intensity ‘Recovery Run’ activities per match was found to be lower for FB (*n*=5) and CAM (*n*=4) when compared to their general position (WDP and CMP, *n*=7 and 8, respectively).

7.3.2 In-Possession Variables

7.3.2.1 Break into Box

High-intensity ‘Break into Box’ actions are typically executed by COP covering 62-1,434% greater distance during match-play compared to other positions whilst they ran more distance for the action than CDP and WDP during intensified periods of play. Although COP completed a greater number of ‘Break into Box’ actions toward the central zone in the box than other positions, wide players (WOP and WDP) performed more running toward a wide zone in the box compared to CDP and CMP. Specialised tactical role data demonstrated that a greater number of high-intensity ‘Break into Box’ activities per game was witnessed for CAM (*n*=2) compared to their general tactical role (CMP, *n*=1) whilst an opposite trend was observed for CDM (*n*=0). Considering team standards, teams in the top Tier (i.e., Tier A) not only covered more high-intensity distance for ‘Break into Box’ compared to those in lower Tiers (e.g., Tier

C), especially for WOP in Tier A covering 290% more distance than those in Tier C, but also completed 45-62% greater high-intensity actions for the action from the final third of the pitch compared to teams in lower Tiers such as those in Tier B and C.

7.3.2.2 Run in Behind/Penetrate

High-intensity ‘Run in Behind/Penetrate’ actions are another action that is typically performed by COP where they covered 88-32,767% greater high-intensity distance for the action than other positions during a match. During the most intense 1-, 3- and 5-min periods, COP covered more high-intensity distance for ‘Run in Behind/Penetrate’ than other positions whilst WOP ran more than CDP, WDP and CMP. As far as specialised tactical roles are concerned, a greater number of high-intensity runs for ‘Run in Behind/Penetrate’ per game was observed for WB (*n*=3) compared to their general tactical role (WDP, *n*=2); however, lower values were evident for FB (*n*=1). A similar trend was found for CAM who performed a greater number of high-intensity actions for the action per match (*n*=5) with CDM showing lower values (*n*=0) compared to their general tactical role (CMP, *n*=1). Given the standard of teams, teams in the top Tier (i.e., Tier A) covered greater high-intensity ‘Run in Behind/Penetrate’ distance compared to Tier C whilst also completing 49-56% more for the action from the final third of the pitch compared to other Tiers. Especially, wide players (WDP and WOP) in Tier A covered more high-intensity distance for the action compared to Tier B and/or C.

7.3.2.3 Run with Ball

WOP performed 71-323% more ‘Run with Ball’ distance than other positions during match-play whilst they covered greater distance than CDP and WDP during the peak 1-, 3- and 5-min periods. WDP and WOP completed more high-intensity activities for the action in a wide area than CDP, CMP and COP while WOP executed more these actions from a wide to the central zone compared to other positions. However, the players experienced 28-91% of decrements in high-intensity ‘Run with Ball’ distance compared to the match average during the subsequent periods that follow intense periods. Considering the level of teams, Tier A teams covered 35-44% more high-intensity ‘Run with Ball’ distance compared to those in lower Tiers (e.g., Tier C and D), especially for CMP in Tier A running 78-112% more distance for the action than those in Tier B and C. Tier A teams also executed 70% more high-intensity actions for the action from the defensive third of the pitch compared to Tier D whilst also completing 42-59% more from the middle third compared to Tier C and D.

7.3.2.4 Support Play

During a match WDP and WOP ran 35-8,254% greater high-intensity 'Support Play' distance than CDP and CMP whilst WDP and CMP covered more distance for the action than CDP during the peak 1-, 3- and 5-min periods. High-intensity 'Support Play' actions are one of the actions that are typically performed both 'individually' and as a 'team' during intense periods of play, accounting for 11-13% of the high-intensity running distance. CMP and WOP completed more high-intensity 'Support Play' actions in the central zone than WDP and CDP; however, WDP executed more actions in a wide area compared to other positions with WOP performing more from a wide to the central zone. Given specialised tactical roles, WB, B2BM, CAM and WM covered 535-51,567% greater high-intensity 'Support Play' distance than CB^2, CB^3 and CDM. Whilst a greater number of high-intensity runs for 'Support Play' per match was observed for WB (*n*=5) compared to their generalised tactical role (WDP, *n*=4), lower values were evident for FB (*n*=3). Likewise, CAM showed a greater number of high-intensity efforts for the action per game (*n*=7) compared to their general tactical role (CMP, *n*=3) whilst CDM exhibited lower values (*n*=1). Considering team standards, clubs in Tier B completed 83% more high-intensity 'Support Play' actions from the defensive third than those in Tier D.

7.3.2.5 Move to Receive/Exploit Space

Wide players such as WDP and WOP ran 38-748% greater high-intensity 'Move to Receive/Exploit Space' distance than CDP and CMP during a match whilst WOP covered more distance for the action during the peak 1-, 3- and 5-min periods compared to CDP, WDP and CMP. Specialised tactical role data demonstrated that WB, CAM, WM and WF covered 210-828% more distance for 'Move to Receive/Exploit Space' than CB^2, CB^3, FB and CDM. The average number of high-intensity 'Move to Receive/Exploit Space' actions per match was greater for WB (*n*=4) compared to their general tactical role (WDP, *n*=3) whilst FB demonstrated lower values (*n*=1). Similarly, CAM showed a greater number of high-intensity actions for the action per game (*n*=6) compared to their generalist tactical role (CMP, *n*=2) while CDM demonstrated lower values (*n*=1). As far as team standards are concerned, Tier A teams covered 39-51% more distance at high-intensity for ‘Move to Receive/Exploit Space’ than those in lower Tiers (e.g., Tier C and D), especially for CDP and WDP running 176-551% and 65-90% greater distance for the action, respectively, compared to those in Tier B, C and D. Additionally, Tier A clubs produced 56-133% more high-intensity ‘Move to Receive/Exploit Space’ actions compared to those in Tier B, C and D from the defensive third of the pitch whilst also executing 28% more actions from the middle third of the pitch compared to those in Tier C and D.

7.3.2.6 Over/Underlap

High-intensity ‘Over/Underlap’ actions are a bespoke action that is typically performed by WDP where they covered far greater distance compared to other positions during not only an entire match but also the peak 1-, 3- and 5-min periods. Specialised tactical role data demonstrated that WB performed 103-16,925% more ‘Over/Underlap’ distance at high-intensity than other tactical roles, including FB. Given team standards, teams in the top Tier (i.e., Tier A), especially for WDP, covered more high-intensity ‘Over/Underlap’ distance compared to Tier C whilst also completing 88% more actions for the action from the middle third of the pitch.

7.4 General Discussion

The present research project initially developed the original integrated approach of quantifying match physical-tactical performance (Ade, Fitzpatrick and Bradley, 2016; Bradley and Ade, 2018) whereby addressing methodological issues and then comprehensively verifying the validity and reliability of the developed integrated approach (Chapter 3). This is the first research programme to analyse the individual/team trends of physical-tactical performances in the EPL with a large sample size in accordance with various playing positions, final league rankings and specific periods of play (e.g., intense periods and the following periods). These contextualised data clearly show 'WHY' (e.g., tactical info) and 'HOW' (e.g., directions and/or locations) players and teams perform high-intensity running actions during matches. Since tactical contexts are tagged alongside physical metrics, coaches and practitioners will understand physical data more clearly. It is hoped for the contextualised data to be used by coaches and practitioners more practically when designing training sessions. This advanced integrated approach could be adopted within the applied setting for the purpose of recruiting players as this is sensitive enough to detect specific playing styles of players with the unique physical-tactical signatures of the team. Furthermore, performance analysts may be benefited from using this approach, particularly for opponent analyses by providing coaches with objective data pertaining to the playing style of the opposition team for an upcoming match. This developed integrated approach could be a game changer within the area of match performance analysis in football given the fact that the reductionist and traditional approach, which provides rudimentary insights into physical data, has been adopted for ~45 years since the pioneering paper by Reilly and Thomas (1976).

A plethora of research has analysed match physical performance to figure out the optimal external load for conditioning fitness of individual players during training sessions whilst mitigating injury risks (Reilly and Thomas, 1976; Bangsbo, Nørregaard and Thorsoe, 1991; Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Di Salvo et al., 2009; Martín-García et al., 2019; Oliva-Lozano et al., 2020). That said, the major concern of these previous studies is a lack of tactical context in relation to physical data although tactical scenarios during a match are the modulatory factors of physical activities in football (Schuth et al., 2016). Existing studies revealed that the high-intensity distance covered by WDP (~900-1000 m) is similar to that covered by COP (Bradley et al., 2009; Di Salvo et al., 2009; Andrzejewski et al., 2016; Carling et al., 2016). Thus, measuring physical metrics in isolation as a reductionist approach, one may argue that their performances are comparable. Yet, the present research (Chapter 4) demonstrated that the components of the high-intensity distance covered by each position are completely different, supported by Ade, Fitzpatrick and Bradley (2016). For instance, the components of the high-intensity distance covered by WDP were very dynamic, demonstrating that they cover 27% and 22% of the distance for ‘Covering’ and ‘Recovery Run’ actions, respectively, when out of possession whilst also performing 12% and 7% of the distance for ‘Support Play’ and ‘Over/Underlap’ activities, respectively, when in possession. In contrast, COP covered 25% of their high-intensity distance for ‘Run in Behind/Penetrate’ when their team was in possession of the ball, but 28% of the distance was covered for ‘Closing Down/Press’ when out of possession. These contextualised data clearly show unique tactical responsibilities of positions when performing high-intensity running actions although physical-tactical performances are influenced by team standard (Chapter 5) and certain periods of play such as the most intense passage during a match (Chapter 6).

The majority of studies in the literature used positional roles from very generic classifications such as defenders, midfielders and attackers (Bloomfield, Polman and O'Donoghue, 2007; Felipe et al., 2019; Sausaman et al., 2019) to general positions such as centre backs, full-backs, central midfielders, wide midfielders and forwards (Bradley et al., 2009; Di Salvo et al., 2009; Abbott, Brickley and Smeeton, 2018; Andrzejewski et al., 2019). However, this limits our understanding of the true demands of players with more specialised tactical roles (e.g., FB, WB, CDM and CAM). Also, although a typical way of differentiating positions is to use team formations (Baptista et al., 2019; Modric, Versic and Sekulic, 2020), this simplistic way is somewhat problematic given that a player’s tactical role can change even during a match due to numerous contextual factors such as the standard of opposition (Rampinini et al., 2007) and match status (Castellano, Blanco-Villasenor and Alvarez, 2011). For instance, if a team plays in a 3-4-3 formation, the WDP are typically labelled as WB; however, they may play very defensively due to the opponent dominating the match. Thus, the player playing style could be seen as a traditional FB considering their main tactical duty of the match is defending. By contrast, if a team plays in a 4-3-3 formation, the WDP are normally classified as FB; however, they could play like WB while being involved in attacking and transition phases frequently. Such methodological issues have been addressed within Chapter 4 by observing the entire match of players in addition to other analytical modalities (heat maps, average position and etc.) to identify their specialised tactical role. This enabled the understanding of not only how players with a specific tactical role play during a match but how modern football plyers play both physically and tactically.

Over the past decade the physical demands of WDP in the EPL, particularly in high-intensity running and sprinting, have significantly increased by 36% and 63%, respectively (Bush et al., 2015b). Yet, it had not been able to understand 'WHY' such physical demands of modern WDP have increased until this present research programme (Chapter 4) was carried out. Such increased physical demands of modern WDP seem to be due to them actively being involved in attacking and transition phases covering high-intensity distance for 'Support Play' and 'Over/Underlap' activities when in possession, and 'Recovery Run' actions when dispossessed. This notion can be further supported by the proportion in the sample of FB and WB in Chapter 4 (35% vs 65%, respectively). That said, Chapter 5 showed that the physical-tactical actions performed by WDP were influenced by the playing style of the team (e.g., top-class teams demonstrating more build-up playing styles). For instance, WDP in Tier A covered 16-30% greater total high-intensity distance than those in lower Tiers with more high-intensity 'Move to Receive/Exploit Space' actions whilst moving backwards (known as 'Splitting'). Moreover, WDP in Tier A ran 114-144% more high-intensity distance for 'Over/Underlap' and 'Run in Behind/Penetrate' compared to those in lower Tier. Therefore, coaches and practitioners should carefully consider what the specific playing style of their WDP is within the team (e.g., traditional FB vs WB playing style) when attempting to condition players with optimal external loads of individual players.

In the scientific literature, only a few studies have analysed the match-play physical demands of CDM and CAM (Dellal et al., 2011; Scott, Haigh and Lovell, 2020). Despite this, the studies revealed that the high-intensity distances covered by CAM were greater than those covered by CDM (~400-600 m vs ~300-550 m, respectively). These findings were in accordance with the data within Chapter 4, revealing that 65% greater high-intensity distance was covered by CAM compared to CDM. Unlike previous research, the present research programme (Chapter 4) unveiled meaningful in-possession and out-of-possession differences of contextualised actions between CDM and CAM, which clearly explains different tactical duties of each specialised position whilst performing high-intensity efforts during a game. CDM covered greater high-intensity distance when out of possession compared to CAM (~430 m vs ~310 m) whilst performing more 'Covering' distance (~220 m vs ~55 m). This agrees with the main responsibility of CDM during a match ensuring defensive coverage whilst blocking space in front of the defensive line (Aalbers and Van Haaren, 2019). By contrast, out of possession CAM covered ~325% greater high-intensity 'Close Down/Press' distance than CDM (~170 m vs ~40 m) whilst performing ~150% more high-intensity distance in possession (e.g., Support Play, Run in Behind/Penetrate etc.). Collectively, when attempting to translate physical-tactical data into training drills, caution should be taken whilst considering the different physical-tactical match-play demands in accordance with specialised tactical roles as well as the team style of play. However, since this data is limited to the EPL, more research is warranted to confirm such trends across different competitive standards or other elite leagues since various styles of play are apparent in each competition (Dellal et al., 2011; Bradley et al., 2013a).

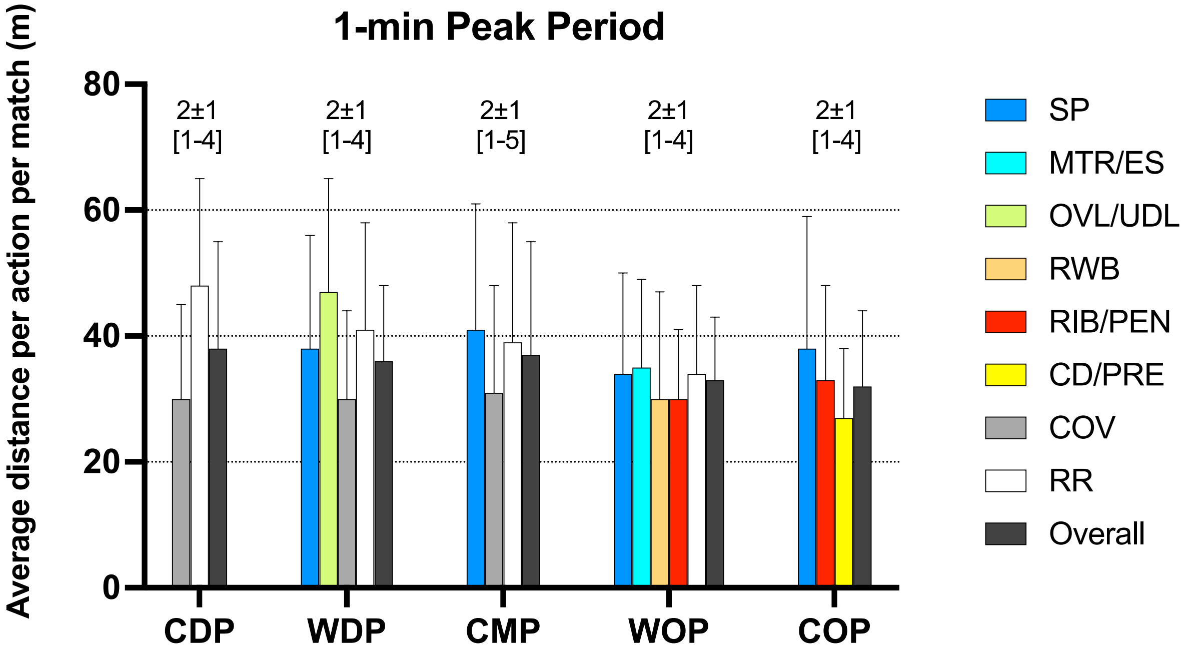
Furthermore, another finding from Chapter 4 was that the number of players up front as CF does not seem to impact their overall high-intensity running distance since the total high-intensity running demands between CF^1 and CF^2 were not different (~800 m), which is in accordance with Baptista et al. (2019). That said, Bradley et al. (2011) discovered that forwards in a 4-5-1 formation tend to cover ~20% greater high-intensity distance when out of possession compared to other formations such as 4-4-2 formations whilst covering ~30% less when in possession, which appears to be due to the 4-5-1 formation being one of the defensive formations typically used by low-standard teams (Bradley et al., 2011). Although there were no differences in the high-intensity distances covered when in possession and out of possession between CF^1 and CF^2 within Chapter 4, formations appear to impact high-intensity running performance given the possessional status (e.g., in- and out-of-possession). This disparity between Chapter 4 and previous studies is possibly due to Chapter 4 not differentiating formations but players depending on the number of players up front as central attackers (one player up front: CF^1 and two players up front: CF^2). Interestingly, contextualised data uncovered that the only difference between CF^1 and CF^2 was ‘Closing down/Pressing’ activities where the former covered ~40% greater high-intensity distance for such actions compared to the latter (~270 m vs ~190 m, respectively). This may explain ‘WHY’ a forward in a 4-5-1 formation cover greater high-intensity distance when out of possession (Bradley et al., 2011). Likewise, the number of players at the defensive line (e.g., three CB or two CB at the defensive line) seems to influence their physical demands during matches with the latter covering 31% greater high-intensity distance than the former (529 vs 404 m, respectively; Modric, Versic and Sekulic, 2020). Having said that, Chapter 4 did not support this notion as evidenced by the high-intensity running distances covered by CB^2 and CB^3 being comparable (433 vs 465 m, respectively). As limited research exists regarding the influence of formations or the number of players up front as CF or at the defensive line on match physical demands of players, more research is required to provide clearer insights into this. Despite this, based on the findings from Chapter 5, physical-tactical actions seem to be influenced by styles of play that are adopted by various teams (e.g., build-up playing style or counter-attack style). For instance, higher-ranked clubs completed ~20% more of ‘Close Down/Press’ activities in the final third of the pitch than lower-ranked clubs (13 vs 11) albeit no statistical differences between different Tiers whilst lower-ranked teams performed 26% more of high-intensity ‘Covering’ actions in the defensive third compared to those in Tier A. This implies that the team’s style of play impacts physical-tactical profiles of both teams and players. Nevertheless, as each team has their own tactics and philosophy performing different playing styles during matches (Paixão et al., 2015), physical-tactical demands of players will vary across teams, thus an individual team analysis therefore seems to be very much warranted to evaluate their own player’s performance. Additionally, as the integrated approach developed within this research project can uncover unique playing styles of teams, performance analysts within the team could be benefited from applying this approach, especially for opponent analyses, which takes a great part of the match analysis in football (Plener, 2021). Yet, given the complex nature of football and very high match-to-match variabilities of the physical-tactical data produced by players (CV: 62-67%) and teams (CV: 48%), coaches and practitioners should be cautious when making decisions, and thus analysing match-to-match variations within the team is warranted to decipher the signal from the noise of the data more effectively (Bush et al., 2015a; Carling et al., 2016).

Previous research has endeavoured to understand associations between success in football and match running metrics, particularly high-intensity running, or physical capacities of players; however, limited findings exist (Mohr, Krustrup and Bangsbo, 2003; Rampinini et al., 2007; Bradley et al., 2013a). This ambiguity seems to be due to limited consideration of the tactical context pertaining to physical data since tactical scenarios during matches are the modulatory factors of physical actions in football (Schuth et al., 2016) The contextualised data analysed within Chapter 5 revealed that compared to lower Tier teams, Tier A teams covered more high-intensity distance when in possession performing 'Move to Receive/Exploit Space', 'Run with Ball', 'Over/Underlap', 'Run in Behind/Penetrate' and 'Break into Box' actions, which clearly shows 'WHY' higher-standard teams cover more high-intensity distance when in possession of the ball, unlike existing studies in the literature (Di Salvo et al., 2009; Rampinini et al., 2009; Bradley et al., 2016). These in-possession physical-tactical activities could be differentiators between team standards in competitions such as the EPL. However, when accounting for relative distance (m/min) performed for each tactical action as a team using effective playing time (i.e., time of ball in play) that can be impacted by team playing style as well as contextual factors (Lorenzo-Martinez et al., 2021), no differences were observed between Tiers. This indicates that such trend appears to be simply due to the team having a higher percentage of ball possession during matches. Hence, it would be more beneficial if investigating how effective the physical-tactical actions are during matches (e.g., did the action create or nullify a chance/threat?). Additionally, it would be of interest to examine how team physical-tactical performances change pertaining to match status and/or opponent standards since they impact match performance (Castellano, Blanco-Villasenor and Alvarez, 2011; Bradley and Noakes, 2013).

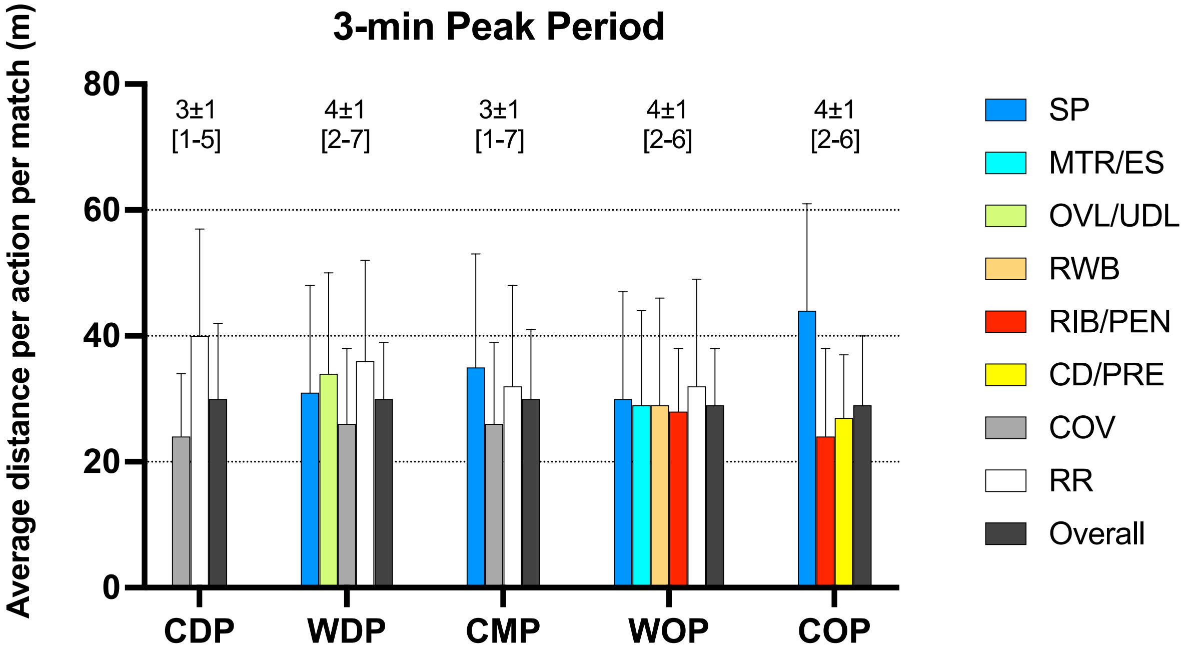
Technical performances (e.g., greater number of shots on target and pass accuracy), rather than match running metrics, seem to be a better indicator to predict a team's success (Rampinini et al., 2009; Castellano, Casamichana and Lago, 2012; Konefał et al., 2019a), which agrees with Chapter 5. However, it is still one dimensional to link technical metrics in isolation with success considering the complex nature of football with technical performances demonstrating high match-to-match variations (Bush et al., 2015a). Additionally, Bush et al. (2015a) for the first time investigated the correlation between physical and technical parameters, demonstrating that only small correlations (*r* <0.3) were found between overall physical and technical performance during a match. In contrast, higher correlations (*r*=0.3-0.5) were observed within Chapter 5 when comparing the 'physical-tactical' match performance data to technical metrics that are available to professional football clubs. Chapter 5 also demonstrated that there were some correlations of 'within dualities' (teammates performing together) and 'between dualities' (Team A vs Team B). For instance, producing high-intensity 'Run with Ball' activities was highly associated with teammates performing high-intensity 'Move to Receive/Exploit Space' actions (*r*=0.5). Moreover, one team producing high-intensity 'Support Play' actions was largely correlated with the opposition team performing 'Recovery Run' activities (*r*=0.6-07). It could be therefore concluded that technical metrics are more associated with physical efforts executed due to 'tactical' scenarios rather than 'isolated physical' performance during a match, which means players produce high-intensity running activities in relation to tactical purposes. Nonetheless, Chapter 5 did not integrate technical performance data properly but rather aggregated alongside the contextualised data; thus, a comprehensive understanding of the true football performance will be achieved if fusing all the physical, tactical and technical match performances. That said, this type of analysis will help drive forward physical requirement of the elite player within the team as the context adds a narrative to the data trends, and also practitioners are moving towards an enhanced ability to quantify the impact of the physical work executed by the team on technical and tactical outcomes.

Recently, the physical demands during peak periods of play (also referred to as the most intense period during a match) have been extensively studied (Martín-García et al., 2018; Casamichana et al., 2019; Martín-García et al., 2019; Castellano, Martín-García and Casamichana, 2020; Oliva-Lozano et al., 2020; Riboli et al., 2021); however, issues exist when trying to directly translate such metrics into specific drills as the context of play is entirely neglected from any of these aforementioned studies (Carling et al., 2019; Bradley, 2020). Chapter 6 demonstrated that players and teams covered the largest distance for 'Recovery Run' (28-37%) out of possession and 'Support Play' (9-13%) in possession during the most demanding passage of play, which may mean that peak periods occur during a fast transition phase (Bradley, 2020). This could be due to the one team performing high-intensity 'Support Play' actions likely causing the opposition team to produce high-intensity 'Recovery Run' activities (Chapter 5). Additionally, data were position-specific with the main high-intensity tactical actions for CDP being 'Covering' and 'Recovery Run' whilst 'Support Play' was another key physical-tactical action for WDP (also 'Over/Underlap') and CMP in addition to such actions. Furthermore, the key high-intensity tactical activities for WOP were 'Recovery Run' when out of possession, and 'Move to Receive/Exploit Space', 'Run in Behind/Penetrate', 'Support Play' and 'Run with Ball' when in possession. By contrast, the main high-intensity tactical actions for COP were 'Close Down/Press' when out of possession, but 'Run in Behind/Penetrate' and 'Support Play' when in possession. Additionally, supported by a previous finding (Ade, Fitzpatrick and Bradley, 2016), when comparing the average distance per action during a whole match (Chapter 4) to that during the peak 1-min periods (Chapter 6), the latter is almost double than the former (e.g., ~30-40 m vs ~20 m). These key position-specific tasks during intense periods of play may be more effectively translated with the use of the average distance per action and average number of the actions performed during intensified periods during a game (Figure 7.1). For example, coaches and practitioners could use them to devise individual and team training drills such as speed endurance training (Ade et al., 2021), small-sided games (Riboli et al., 2020) and team tactical circuits (Bradley et al., 2019) whilst trying to replicate peak external loads of each position (Figure 7.2). It should be acknowledged that it is unlikely to provide the necessary 'overload' desired to players at times during training sessions, especially when training as a team. Therefore, it seems to be more advantageous to use physical-tactical profiles of each player for separate drills such as an isolated drill or rehabilitation session. Moreover, it would be more beneficial to investigate peak demands of specialised positions during a match as match physical-tactical demands of players can be over or underestimated if using the general positional analysis (Chapter 4). This would ultimately help design specific training drills that can be tailored to a specific 'player' rather than a 'position'. Nonetheless, it should be noted that understanding the dose-response effect (i.e., the internal load or response that will arise due to a certain training stimulus) is still challenging (Fitzpatrick, Hicks and Hayes, 2018; Scott and Lovell, 2018), thus future research should investigate this in order to better condition players whilst mitigating injury risks.

(A)



(B)



(C)

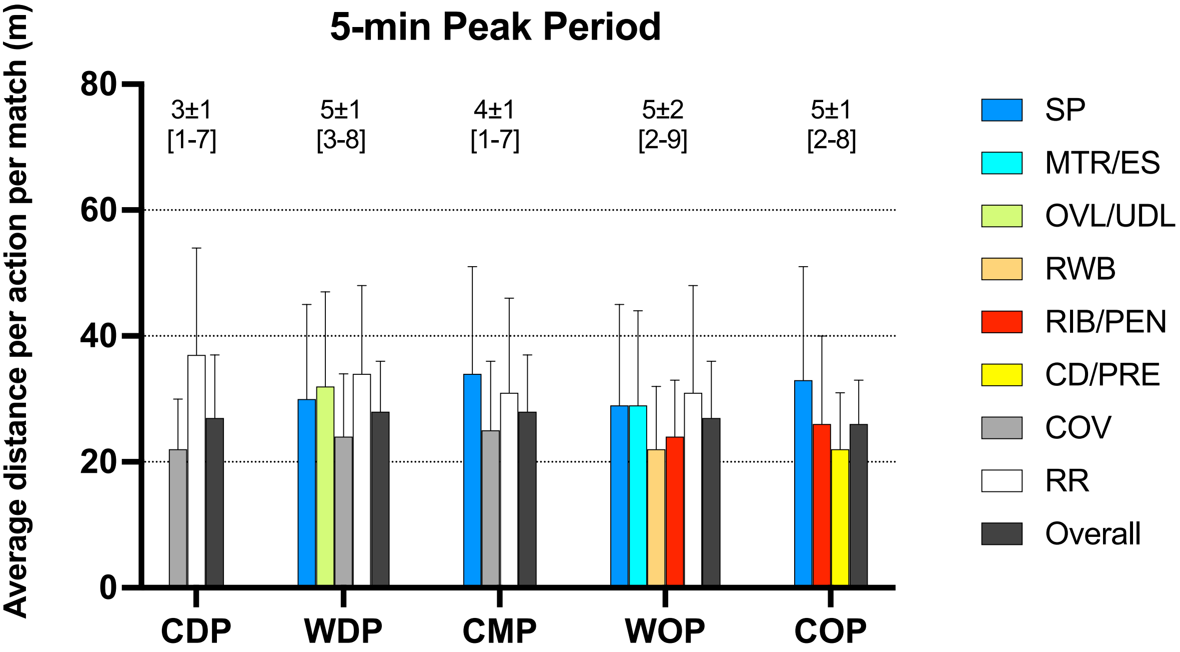


Figure 7.1. Average distance (m) per key contextualised action during the peak (A) 1-min, (B) 3-min, and (C) 5-min periods of play per match across positions. CDP: Central Defensive Players, WDP: Wide Defensive Players, CMP: Central Midfield Players, WOP: Wide Offensive Players, COP: Central Offensive Players. SP: Support Play, MTR/ES: Move to Receive/Exploit Space, OVL/UDL: Over/Underlap, RWB: Run with Ball, RIB/PEN: Run in Behind/Penetrate, CD/PRE: Closing Down/Press, COV: Covering, RR: Recovery Run. Values above the bars indicate the average number of physical-tactical actions performed per match [min-max].

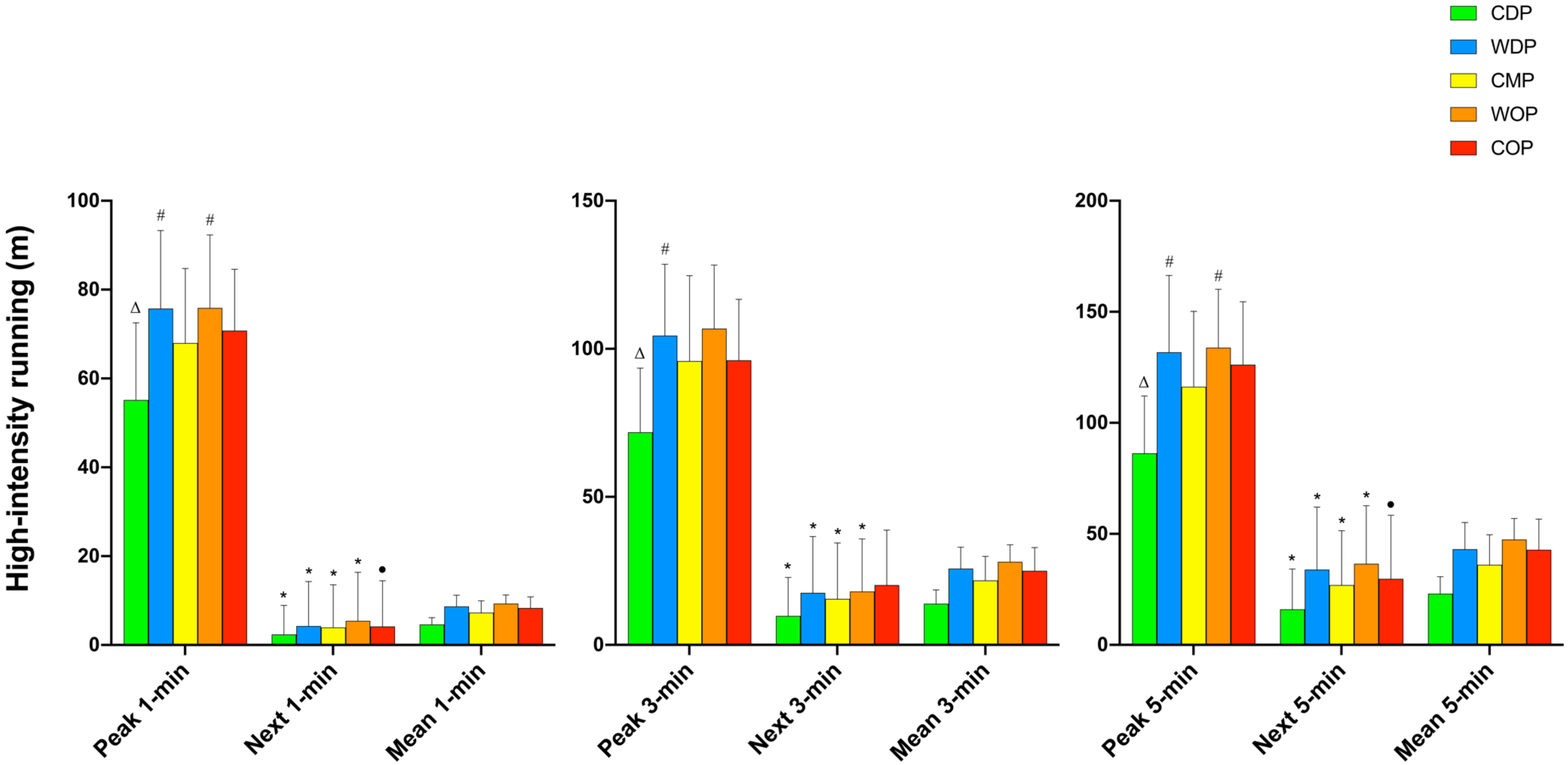


Figure 7.2. High-intensity running distances in the most intense 1-, 3- and 5-min periods, the subsequent period (next) and the match average (mean) during the match for elite football players in different positions. CDP: Central Defensive Players, WDP: Wide Defensive Players, CMP: Central Midfield Players, WOP: Wide Offensive Players, COP: Central Offensive Players. $^{\Delta}$Less distance covered in high-intensity running than other positions ($P<0.01$). $^{\#}$Greater distance covered in high-intensity running than CMP ($P<0.05$). *Differences from match average ($P<0.01$). $^{\bullet}$Differences from match average ($P<0.05$).

Lastly, understanding transient decrements in high-intensity running after the most intense period of play has been limited due to a lack of context being provided within the scientific literature (Mohr, Krustrup and Bangsbo, 2003; Bradley et al., 2009; Bradley et al., 2010; Di Mascio and Bradley, 2013; Fransson, Krustrup and Mohr, 2017). The general consensus from previous studies was that the transient declines in high-intensity running occur after intense periods, which agrees with the findings of Chapter 6 (Figure 7.2). Players can be temporarily fatigued after intense actions during a match due to a result of metabolic and ionic perturbations in which excitation-contraction coupling of muscles are impaired, leading to reduced muscle force (Mohr, Krustrup and Bangsbo, 2005; McKenna, Bangsbo and Renaud, 2008). In addition to this, such transient drops may also be ascribed to the depletion of phosphocreatine (PCr) stored in the muscle due to the muscular store of PCr being almost totally depleted after intensive actions (Baker, McCormick and Robergs, 2010). That said, this is not necessarily due to fatigue but may be linked to tactical alterations/pacing strategies (Bradley and Noakes, 2013), as such transient physical decrements do not always occur (Carling and Dupont, 2011). Chapter 6 support this notion since some tactical actions exhibited inconsistency in different time durations of the next periods. For example, COP covered ~80-100% less high-intensity 'Break into Box' distance during the subsequent 1- and 5-min periods compared to the match average, but they covered ~20% greater distance for this action during the subsequent 3-min period. This may indicate that players selectively produce high-intensity running actions, especially when they are tactically required to do so. Additionally, both players and teams consistently covered less high-intensity distance for 'Covering' and 'Recovery Run' during all of the next periods compared to the match average. This may indicate that there are tactical adjustments after intensified periods, particularly when out of possession. For example, after intense periods, players and teams may want to have time to tactically adjust their formation to become in shape whilst covering less high-intensity distance. However, even with context, it is still challenging to understand why transient decrements in high-intensity running occur after intense periods since numerous contextual factors such as reduced playing time (Carling and Dupont, 2011) can impact these. Hence, future research should systematically use video to check players and add extra layers of context with effective playing time (e.g., in-play time only), which would provide a better understanding of the transient physical decrements.

7.5 Conclusion

The contextualised data clearly display ‘WHY’ (e.g., tactical information) and ‘HOW’ (e.g., directions and/or locations) players and teams perform high-intensity running actions during a competitive football match. The physical-tactical performance profiles of players help differentiate specialised tactical roles as there are distinctive physical-tactical requirements of each role (e.g., FB vs WB and CDM vs CAM). It is suggested to use a specialised positional analysis as this appears to be more sensitive in identifying the true physical-tactical demands of players compared to a general positional analysis. Moreover, contextualised actions performed by players and teams are affected by the team’s style of play; however, it is unclear whether the number of players up front as CF or at the back line as CB impacts match performance. Thus, more research is required to provide more evidence regarding the influence of different formations or how players are arranged within their formation (e.g., two CB vs three CB) on match-play physical-tactical performance. Top-ranked teams dominate the opposition, especially in possession, whilst performing high-intensity Move to Receive/Exploit Space’, ‘Run with Ball’, ‘Over/Underlap’, ‘Run in Behind/Penetrate’ and ‘Break into Box’ actions compared to lower-ranked teams. These in-possession high-intensity activities may be differentiators between team standards in competitions. Nonetheless, as the data analysed within this present research programme is limited to the EPL, more research is warranted to confirm such trends across different competitive standards or other elite leagues. The key position-specific physical-tactical actions of each position during the most intense period could be effectively translated when devising individual/team training drills if using the average distance per action and average number of actions performed during intensified periods during a match (Figure 7.1) whilst replicating peak physical demands of each position (Figure 7.2). Therefore, it is hoped that the data from the present research programme can help not only coaches and practitioners with their drill preparation but also researchers to conduct future research trying to contextualise match performance data by using the developed integrated approach.

7.6 Research Limitations and Recommendations for Future Direction

The present research programme initially developed the original integrated approach of quantifying physical-tactical match performances to generate valid and reliable data, and then examined the physical-tactical trends of players and teams according to various playing positions, final league rankings and selected periods of play (e.g., intense periods and the following periods). Although the aim to develop the integrated approach and investigate match performance in elite football by using the developed methodology has been achieved, some limitations have been acknowledged.

Although the original integrated approach has been developed by addressing some methodological issues of the original integrated approach, this approach itself has some limitations. Firstly, it requires extensive manual work (350 hours for coding 50 competitive games), which is labour intensive. Therefore, it would be advantageous to use machine learning techniques to automatically categorise physical-tactical actions during a match to overcome such limitation (Bradley and Ade, 2018). This would allow investigating the evolution of match physical-tactical analysis in a football league such as the EPL whereby uncovering 'HOW' match performances have evolved physically and tactically. Also, this method does not include metabolically taxing movements such as accelerations and directional changes. This is mainly due to their high frequency during a match, which requires much more time to manually contextualise such actions. Having said that, future research should include and contextualise such activities to provide a comprehensive insight into physical-tactical match performance. In addition, it would be of more interest to amalgamate all the physical, tactical and technical match performances to have a complete understanding of the true football performance of competitions.

Chapter 4 used a systematically agreed method of differentiating various tactical roles of players to not only evaluate physical-tactical trends of general and specialised tactical roles but also compare a general positional analysis to a specialised one in order to determine the differences between them. Although meaningful differences have been identified, it requires extensive manual work to observe the entire match of players to determine their hyper-niche position whereby one could argue that this could be subjectively viewed. Hence, it would be more advantageous to use machine learning techniques to automatically categorise specialised tactical roles in the future (Aalbers and Van Haaren, 2019).

Another limitation of this research project was that the analysis of specialised tactical roles was not applied in relation to final league rankings (Chapter 5) and certain periods of play such as peak periods and the following periods (Chapter 6). Thus, it is not known if any differences of specialised positions exist between final league rankings or how they physically and tactically perform during the most demanding passage and the periods that follows. This was due to the samples of certain positions (e.g., CAM, WF, CF^1 and CF^2) being relatively small compared to other positions due to the stringent game selection criteria for balancing and controlling data within the research programme. It would be beneficial to investigate such trends with a greater number of samples for specialised positions although the reader should be aware that it is challenging if applying stringent game selection conditions since such positions are more likely replaced with substitutions (Carling et al., 2014).

Although numerous contextual factors such as the standard of opposition (Rampinini et al., 2007) have an influence on match performance, the research project did not investigate the influence of contextual factors on physical-tactical performances during match-play. As a result, it is unknown if contextual factors influence physical-tactical performances. Since the nature of football is reactionary where an intense action of a player produces not only a supportive action from teammates but also a counting intense action from the opponent (Chapter 5), it would be of greater interest to investigate how the standard of opposition team impacts physical-tactical performances of an individual and team level. Collectively, an automated solution appears to be the next iteration for researchers to tackle the limitations of the integrated approach and future research should consider other variables for multifactorial analysis or developing machine learning techniques since match performances of players/teams are influenced by numerous factors (Figure 7.3).

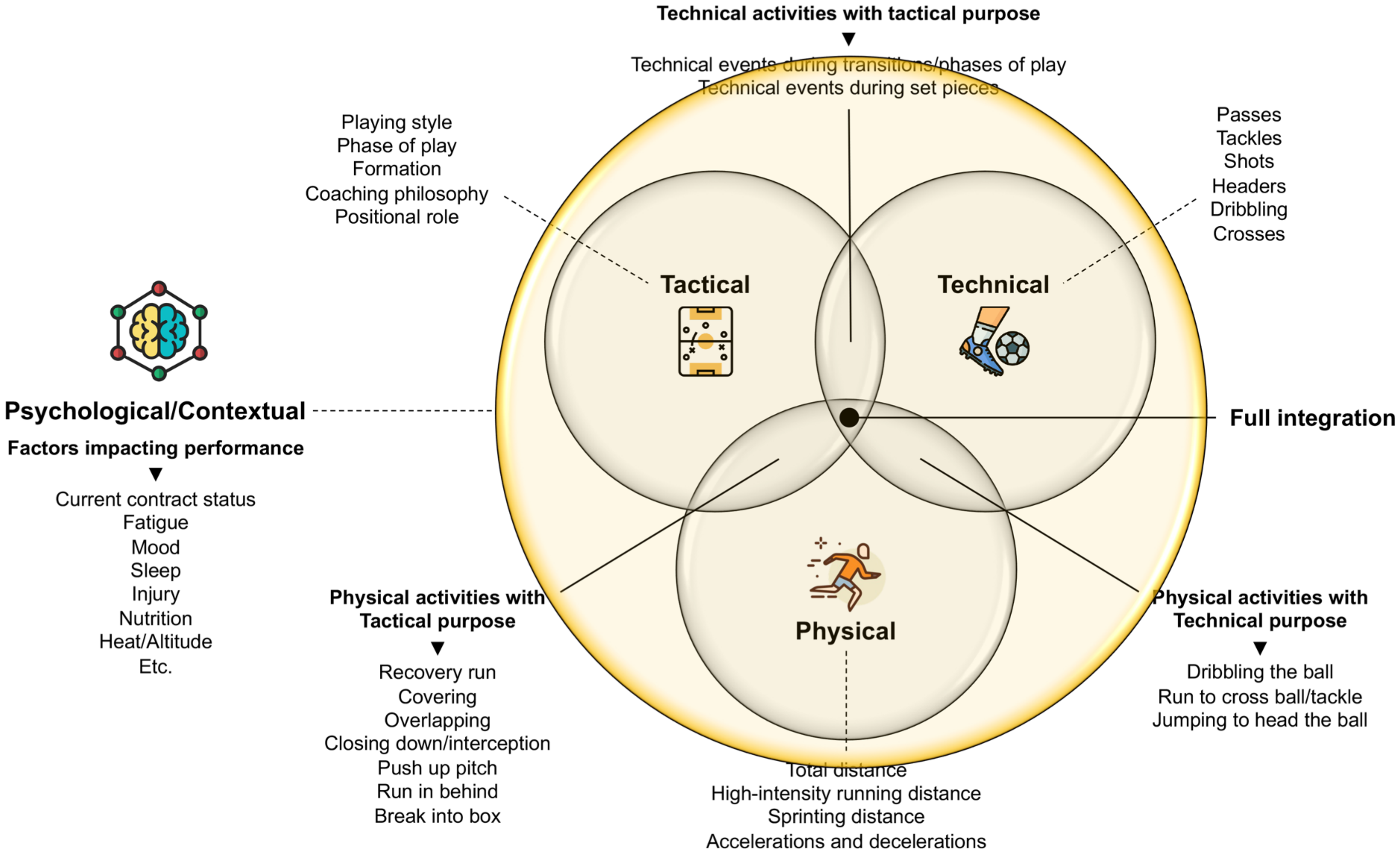


Figure 7.3. An amended diagram to Figure 2.5, including other psychological/contextual factors that impact match performance.

7.7 Practical Recommendations from the Present Research Thesis

It is hoped the data within this thesis will provide coaches and applied practitioners with a better understanding of the match performance in which physical metrics are fused with key tactical purposes. The practical recommendations from this research programme are as follows:

1. Practitioners may apply the integrated approach developed within the research programme to analyse match physical-tactical profiles of players as it was found to be valid and reliable regarding the quantification of match-play physical-tactical performances. That said, additional research is required to independently verify the findings of this present study before the area can fully accept this new paradigm. As the detailed definitions are now contained (Table 3.1 or 4.2), the research team within a football club may adopt this approach with testing its merits and limitations independently. Yet, as languages or words to describe football tactical actions are diverse across countries and even teams in the same country, operational definitions adapted to contextualise physical metrics in relation to tactical actions within the team should be firmly determined and agreed before applying the approach.

2. When collecting player data, a player's specific playing style/tactical role (e.g., WB or FB and CDM or CAM) within the team should be considered since using a general positional analysis such as FB and CM can over or underestimate the physical-tactical demands of players. This type of approaches to specialised positional analyses could help with recruitment within the team as players having the physical-tactical characteristics matched to the team's playing style could be shortlisted for scouting (Carling, Williams and Reilly, 2005). Therefore, recruitment teams should be able to use this level of detail to optimise the recruitment of players with physical qualities that align with the team's desired tactical plan. However, caution should be exercised when making decisions due to the high match-to-match variability of the 'player' physical-tactical performance data (CV: 62-67%).

3. The integrated approach is able to uncover playing styles of teams and players. Hence, this approach could be used within the applied setting to objectively analyse team/player physical-tactical performance during matches based on instructions given to the players (and then make quick tactical modifications). Additionally, such analysed information could be used to give effective feedback to players with the aim of enhancing their tactical performance (e.g., game insights, decision making, etc.; Carling, Williams and Reilly, 2005). However, caution should be taken when making decisions given the high match-to-match variabilities of the 'team' physical-tactical performance data (CV: 48%). Moreover, it may be beneficial for performance analysts to apply the integrated approach to provide insights on opposition team tactics. Thus, coaches may be better informed of the strengths and weaknesses of the opposition team, thus giving more effective instructions to the players for the upcoming match (Plener, 2021).

4. When designing training programmes such as speed endurance training (Ade et al., 2021) and small-sided games (Riboli et al., 2020), fast transition phases (e.g., defence to attack phase or vice versa) should be incorporated whilst replicating the peak demands of players. As peak periods of play are likely to occur during fast transition phases with one team performing high-intensity 'Support Play' and the other team 'Recovery Run' (Chapter 6). In addition, it may be helpful for coaches and practitioners to use the average distance per physical-tactical action and average number of the actions performed during intensified periods during a match together with the key position-specific tasks (Figure 7.1) for devising position-specific training drills that can replicate peak physical demands of play (Figure 7.2). However, since it is unlikely to provide the necessary 'overload' desired to players from time to time during training sessions, especially when training as a team, it seems to be more advantageous to use physical-tactical profiles of each player for separate drills such as an isolated drill or rehabilitation session (Ade et al., 2021).

CHAPTER EIGHT

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