A Case Study-Based Investigation into the Factors that Influence the Physical and Technical Interactions on Match Performance within an Under 18's Academy Football Team

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Copyright Statement

Abstract

Youth Development in soccer is of growing importance with governing bodies, leagues and clubs placing high levels of emphasis on the development youth players. Previous research has focused on elite samples but has ignored youth football. Under 18 teams are seen as a key age for players where they are expected to take the step to professional first team football. Furthermore, previous studies analysing the impact of situational variables such as playing position and match location in relation to youth are missing. The aim of this study was to investigate how Physical and Technical match performance indicators are influenced over time periods, by the influence of match location (Home/Away); match status (winning/drawing/losing); and differences in playing positions in under 18 men's academy soccer.

Using 19 males from a single under 18s Premier League soccer club, 7 matches (5 home, 2 away) were used for analysis. Physical performance indicators used in this study include: individual total distance; high speed running; sprint efforts; accelerations; and decelerations. Technical performance indicators used in this study include passes; pass accuracy; forward pass; forward pass accuracy; side pass; side pass accuracy; back pass; back pass accuracy; as well as a range of defensive variables such as aerial duels and tackles. A selection of attacking variables included total shots; shooting accuracy; and line breaks.

The results from this study showed no significant differences were identified across the Physical key performance indicators when comparing home and away games. Significant differences across home and away games were identified in Technical performance indicators with key findings in the total successful passes in 1st half of games (P = 0.034), unsuccessful shots in the 2nd half of games (P = 0.023) and total tackles (P = 0.031). Furthermore, performance indicators such as the total successful tackles (P = 0.055); successful shots in the 1st half of games (P = 0.058); and total passes in the 1st half of games (P = 0.052) were on the verge of significance.

Further significant differences were identified in Physical and Technical variables across playing positions. This study identified significant differences in the total distance covered

by players in the 1st half of games (P = 0.003) across Defender, Midfielder and Forward playing positions. There were further significant differences was identified in the total number of decelerations in the 1st half of games (P < 0.001) across Defender, Midfielder and Forward playing positions.

The key findings of this research showed there was an influence of match location on Technical performance indicators during under 18s match performance however no significant differences were highlighted across Physical performance indicators. Furthermore, some significant differences were found when analysing the Physical performance indicators of under 18s players across Defender, Midfielder and Forward playing positions which were not supported by previous research studies, with skill demands of players not being aligned with playing positions.

Overall, this research is the first of its kind in analysing the effects and impact of situational variables on Physical and Technical performance indicators in under 18s youth soccer, with the results providing insight into the current playing performance of under 18s academy soccer. The study will provide coaches with a greater level of understanding into true match demands in youth soccer match performance, allowing these factors to be considered when planning and implementing training sessions. Future research should further examine the situational variables that influence Physical and Technical performance indicators and how they influence the matches in order to gain a deeper understanding of this topic area.

Acknowledgements

I would like to take this opportunity to thank my both my tutors Andrew Callaway and Shelley Ellis for their continued support and dedication throughout the duration of this research project. Additionally, I would like to thank all of the members of staff at the football academy used in this study for their support and the opportunity to learn in a high-performance sporting environment. I would also like to thank my mum, dad and sister as well as other friends and family for supporting and motivating me throughout this whole process. Finally, I would like to give a special mention to my girlfriend, Megan, for her love and unwavering belief in me throughout this project whilst also completing projects of her own.

Dedications

This research project is dedicated to the memory of my beloved grandma, Maureen Lesley Tong who passed away before I started my research studies. I had promised to make my grandma proud by the achievement of this academic goal and I hope that I have fulfilled that promise. I wish that she could still be alive today to share with me the celebration and the hopeful success of my graduation with a master's degree.

Maureen Lesley Tong
"A loving Wife, Mum and Grandma"
6th June 1944 - 18th June 2019

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Introduction to Performance Analysis in Soccer

Modern day sport is highly competitive and any opportunity to achieve a marginal gain over the opposition in order to improve a team or individuals' performance is taken. One method to achieve a competitive advantage across all sports is performance analysis, especially in team sports such as Association Football. Since the 1960s, researchers of Association Football (soccer) have attempted to investigate the fundamental components that contribute to a successful performance, termed key performance indicators (KPIs) (Mackenzie and Cushion, 2013). In soccer performance analysis, the key components of a teams or player's performance have been divided into three areas (Carling et al., 2005):

- Technical - the frequency and quality of skills executed during a game
- Tactical - the team's style of play and team strategy in order to defeat the opponent
- Physical - the physical movements performed by the player made during a match

Recently, technological advances in video and computer analysis systems have created a substantial increase in soccer performance analysis methods focusing on the individual and match and associated literature informing the field (Mackenzie & Cushion, 2013; Paul, Bradley & Nassis, 2015). Match analysis refers to the process of recording and analysing the series of events and movements during a team's training session or game. This analysis may solely focus around one player or may include the series of actions and movements of a group of players both on and off the ball. However, match analysis can range in complexity when assessing the actions of an individual compared to a combination of movements or interactions between individuals in a team (Carling et al., 2005).

Furthermore, in soccer, there is now a variety of technologies and systems to collect data which can be used to help achieve the competitive edge. These include athlete tracking systems utilising Global Positioning System (GPS) combined with data analysis from gyroscopes, accelerometers and magnetometers (for example Catapult Sports) and semi-automatic multiple camera-based systems such a ProZone®**.** The rapid evolution of match

analysis has seen data that was initially collected using pen and paper now develop into computer-based systems that are capable of recording a player's movement at 100 times per second in both training and competitive game environments.

These technological innovations have increased the reliability, speed and accuracy so that we can now collect data on player performance. However, as a result of varying methodologies of data capture, comparisons between literature is becoming increasingly difficult due to a lack of established criteria to assess the validity and reliability in a competitive environment (Coutts & Duffield, 2010; Cummins et al., 2013; Jennings, Cormack, Coutts, Boyd, & Aughey, 2010). Furthermore, the rapid advancements in technology are coupled with the need for competitive sport to gain a competitive edge has often led to match analysis advancements being released and integrated by professional sporting teams with sometimes little or no scientific evidence supporting the systems authenticity and reliability to deliver results from the manufacturer (Edgecomb & Norton, 2006).

1.2 Elite Player Performance Plan (EPPP)

Since 2012, the current outlook of English academy football has been heavily influenced by the introduction Elite Player Performance Plan (EPPP). The EPPP was a proposed action plan created by the Premier League in collaboration with Football Association (FA) and English Football League (EFL). Introduced in 2012, the EPPP is a long-term development model with the primary focus to develop the world's leading academy system in English football (The Premier League, 2011).

The plan was put into action at the beginning of the 2011/12 season across all 72 football league clubs. The EPPP (The Premier League, 2011) is a talent development structure based on 6 founding principles these are as follows:

1. Implement a system of effective measurement and quality assurance
2. Seek to implement significant gains in every aspect of player development
3. Positively influence strategic investment into the academy system

4. Improve coaching provision
5. Create more time for players to play and be coached
6. Increase the number and quality of home-grown players gaining professional contracts and playing first team football.

Due to the implementation of the EPPP it is believed that the Football Association (FA) will now be able the gather a greater understanding of a successful talent development environment as well as understanding the effective supporting mechanisms that are needed to develop players. In order to create the EPPP, previous research was used on talent identification in elite level sport (Bloom, 1985; Cote, 1999) allowing the FA to create their own Long-Term Player Development (LTPD) model (The Premier League, 2011). As part of this LTPD they created the four-corner model consisting of the main the components which the FA believed are the key factors that a player should develop in order to become a successful elite player, the model consists of the following sections: technical/tactical; psychological; physiological; and social (FA game plan, 2010).

In support of this model, the EPPP brought the introduction of a new system of evaluation on monitoring procedure for academy operations in the form of regular independent audits. As a result, a football academy is now categorized into 4 different levels ranging from 1 to 4 with one being the highest. The status of an academy is now determined by a percentage score on an audit tool which is performed by Independent Standards Organisation (ISO) audit (Table 1).

Academy Category	**% required to achieve status**
Category 1	75% or above
Category 2	65% - 74%
Category 3	50% - 64%
Category 4	35% - 49%

Table 1: The percentages (%) required to achieve Academy category status (Premier League, 2011).

1.3 Application of Performance Analysis in Soccer

A common use of performance analysis in team sports such as Rugby and Soccer is match analysis. Match analysis typically refers to the process of utilising match footage to analyse a team of individuals key performance indicators during a competitive game. In team sports, the introduction of match analysis has not only enhanced the success and improvement in a team's competitive performance but is also being used to improve player development (Hughes and Franks 2004).

In an elite sporting context, match analysis is used to evaluate upcoming opposition performances in order to highlight strengths and weaknesses in an opponent. This has allowed the creation and development of match tactics with specific purpose of nullifying opposition strengths whilst simultaneously exploiting their weaknesses (Carling et al. 2008). Subsequently, the modern-day coaching process is recognised to be a continual cycle of both competition and training, with coaches delivering interventions to enhance player development (Figure 1). In conjunction with match analysis, this process allows coaches to complement training and matches with detailed feedback regarding the performance of individuals and the collective team (Carling et al. 2006). As a result, the analysis element of the coaching process is understood to be a vital part of the cycle (Hughes and Franks 2004).

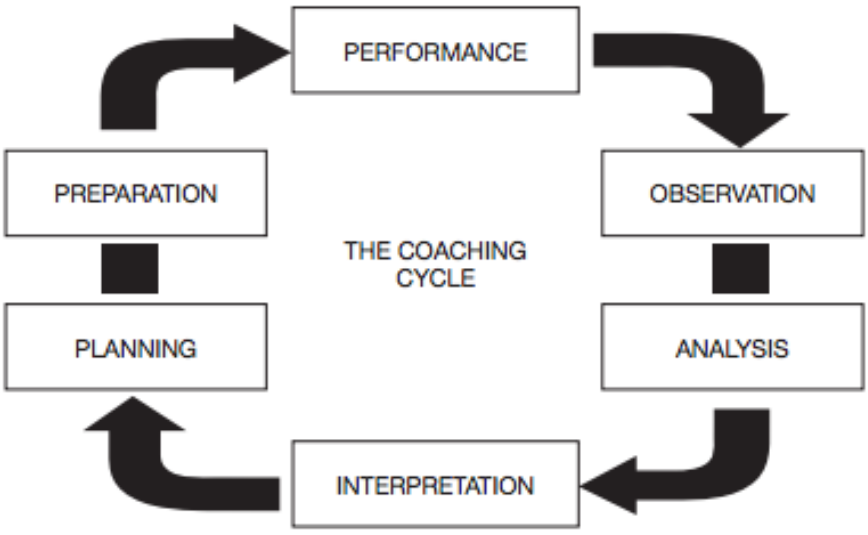

Figure 1: The Coaching cycle (Carling et al. 2006).

In recent years, literature has aimed to provide a more in depth understanding into a team's performance by using varying match analysis methodologies. In order to create a greater understanding of factors that influence success during games, match analysis in sport has challenged researchers to define key performance indicators (KPIs) that reflect desirable outcomes (Medeiros et al. 2014). These performance indicators have been defined as *"a selection, or combination, of action variables that aims to define some or all aspects of performance"* (Hughes and Franks, 2004, pp.167).

The use of match analysis has organised these performance indicators into groups which often segregate variables into match descriptors and indicators of Tactical, Physical and Technical elements (O'Donoghue 2014). Research papers by Rampinini (2009) and Carling & Dupont (2011) have tended to explore the relationships between a variety of actions or performance indicators and their links to successful performance. These studies have looked into similar KPIs such as shooting opportunities (Hughes and Franks 2005; Mahony et al. 2012; Bostanci et al. 2018), ball recovery (Barreira et al. 2013; Almeida et al. 2014; Claudio Alberto et al. 2016), possession (Jones et al. 2004; Lago-Penas and Dellal 2010; Castellano et al. 2012; Collet 2013) and passes (Reep and Benjamin 1968; Hughes and Franks 2005;). These performance indicators are most commonly actions while the team is in possession of the ball and are believed to be highly significant in the outcome of creating a goal scoring chance. This is mainly due to key determinant of a successful performance being judged by the number of goals scored by each team (Michailidis et al. 2018).

Furthermore, these performance indicators measured through match analysis are exposed to, and manipulated by, a variety of external situational variables (O'Donoghue 2014), including phase of the game (1st half/2nd half), playing positions (defence, midfield, forwards), match tactics (playing formation), the location of a match (home/away) and match status (winning/drawing/losing). Some previous research papers have explored the influence of these situational variables in order to gain a greater understanding into the impact on performance (Taylor et al. 2008; Konefał et al. 2018) however these research studies have omitted youth populations.

Previous research to date has tended to focus on adult/elite population leaving research into youth or sub elite soccer to have been dismissed by many researchers (Rosenbloom et al. 2006; Smith et al. 2013). This is surprising due to the increasing levels of professionalism in sub elite soccer and the wider emphasis placed by governing bodies, leagues and clubs to develop youth players. Furthermore, the main goals and benefits of performance analysis which are generally based on the enhancement of players and improving decision making. Moreover, research studies have found that youth soccer players have different needs and abilities when compared to elite players (Rosenbloom et al. 2006), resulting in a large of proportion of previous research that has focused on elite or adult soccer teams irrelevant to youth players.

Therefore, research analysing the match performance under 18s is crucial. The under 18s team is a crucial age category in a soccer clubs academy, this because players at this age are assessed constantly to see if players can make the step up to the professional first team, be sold to clubs to make money or released from their youth contract. It is vitally important for clubs to get these decisions right with around 180 of the 1.5 million males who play organised youth football in England becoming a professional player in the Premier League a success rate of just 0.012% (Calvin, 2017). Furthermore, out of all the males who enter a soccer academy at the age of 9, less than half of 1% make it to, or make a living from, the game at any professional level (Calvin, 2017). This further highlights the importance of clubs to get the decisions they make with under 18s players right and that research into an under 18s team will help provide more data for clubs about the true match performance of players allowing for a more informed decision-making process.

Youth soccer players have been analysed on their Physical, Technical and Tactical performance abilities where it has been found that youth players have a lower ability to perform. An example of this can be seen physically where younger players exhibit a lower VO_{2MAX} outputs compared to the senior players (Stølen et al. 2005). Youth players have also been shown to demonstrate significantly lower Technical and Tactical abilities (Teoldo da Costa et al. 2010; Sevil Serrano et al. 2017). In spite of the clear importance of performance analysis in the role of player development, research papers have often omitted younger populations (Smith et al. 2013), and with clear differences having previously been

identified, there is a defined need to examine the Physical and Technical variables of performance in order to improve the understanding and requirements of youth soccer. This in turn can enhance the coaching process that influences their development.

Therefore, the aim of this study is to produce a clear understanding of the current trends in both the Physical and Technical match performance indicators from a under 18s team in a Premier League football clubs academy. The data collected in this study will provide insight into the current playing performance of under 18s academy soccer. This will provide coaches with a greater level of understanding into true match demands in sub elite soccer match performance, allowing these factors to be considered when planning and implementing training sessions which will result in an enhanced coaching process improving the Physical and Technical preparation of players as well as their overall development.

Consequently, the aim of this work is to investigate the effect that contextual factors have on Physical and Technical performance variables in a under 18 team. The objectives of achieve this aim are:

1. Analyse any significant changes of Physical and Technical performance indicators in under 18 men's academy soccer.

2. Does the match location (Home/Away) influence the Physical and Technical match performance indicators across different match time periods in under 18 men's academy soccer?

3. Does the match status (winning/drawing/losing) influence the Physical and Technical match performance indicators across different match time periods in under 18 men's academy soccer?

4. Does the difference in playing positions influence the Physical and Technical match performance indicators across different match time periods in under 18 men's academy soccer?

2 Review of Literature

The use of performance analysis in a sporting context can be traced back to the early 1900s where the first known publication analysing the probability of success in baseball, investigating various combinations of fielding, batting and pitching (Fullerton, 1912). However, it would not be until the 1960s when performance analysis methods would become more commercially available. As a result, this increased the frequency of research and the use performance of analysis in professional sports clubs (Hughes & Franks, 2004). Even so, it was not until the turn of the century until we saw the introduction of performance analysis specific journals such as the International Journal of Performance Analysis in Sport. In addition, specific areas within published journals became dedicated to performance analysis articles and research studies such as the International Journal of Sports Physiology and Performance and the Journal of Sports Sciences. This created an extensive understanding of the most popular sports in both research and applied settings (Coutts, 2014; Mackenzie & Cushion, 2013). Thus, highlighting the need and overall significance of performance analysis within a research context and sport.

This literature review will provide a background of performance analysis as well as an overview of soccer match performance with the aim to outline the core components with the physical and technical requirements of soccer. The review will then look to analyse the variety of approaches that have been used to analyse soccer match performance and will also assess the current methods used to analyse both Physical and Technical performance indicators in soccer matches. Finally, the review will evaluate the current understanding of match related fatigue from previous research and the variables affecting soccer match performance.

2.1 Introduction to Performance Analysis

Performance analysis is the process of assessing performance in a sport to develop an understanding of actions that can inform decision-making, improve performance as well as support coaches and players in their goals of obtaining peak results. More specifically Performance Analysis of sport is the investigation of actual sports performance or performance in training (O'Donoghue, 2009). The main thing that distinguishes performance analysis from other disciplines of sports science is that it is primary concern is to analyse the performance (O'Donoghue, 2009). This is usually done through observation of the performance which could be live or post competition. In team sports such as soccer this would consist of Tactical, Physical, Technical assessments of player using both video and statistical databasing tools.

2.2 Performance Analysis in the Coaching Process

The goal of performance analysis is to collect objective data to inform the coaching process by providing more accurate and effective feedback loop to both the coaches and more importantly the athletes/players. Performance analysis is not used to replace the current coaching methods and practices but is aimed to work in conjunction with them to create a more objective approach and provide clear visual evidence with the ultimate goal to increase performance (Carling et al., 2005; Franks, 2004; Hughes & Bartlett, 2002). The aim of performance analysis is to enhance performance, this means it could be classified as encompassing all areas of sport science (Bartlett, 2001; Hughes & Bartlett, 2002). However, it is mainly seen to include the three main areas of performance analysis which can be seen in Figure 2.

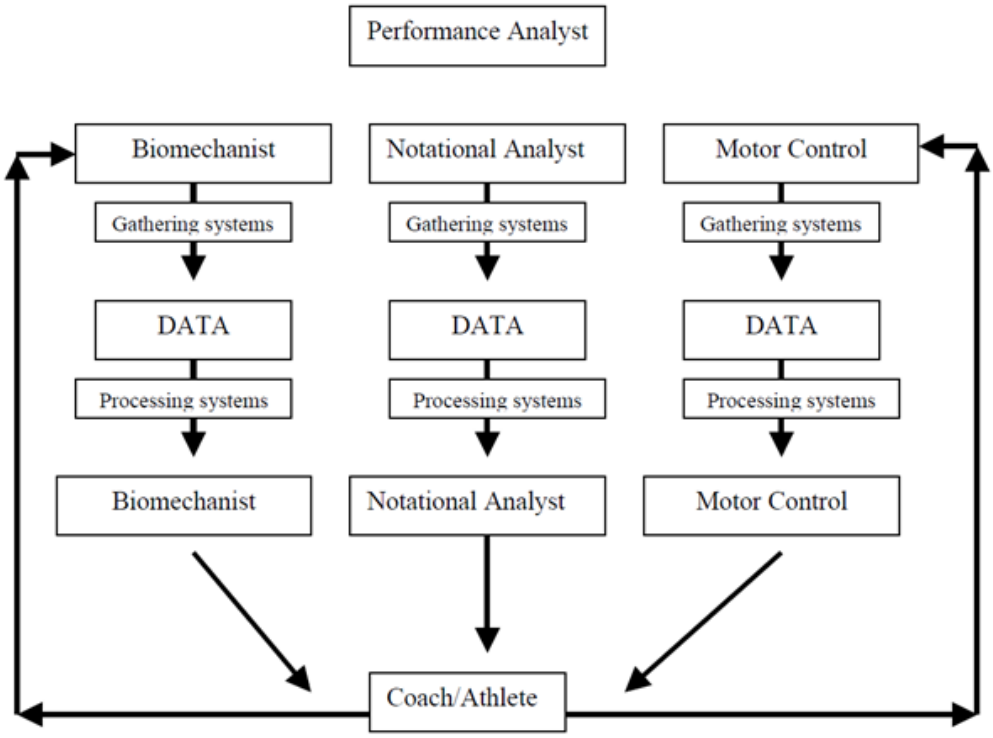

Figure 2: The setup of performance analysis and its feedback process in sport (Hughes, 2004)

Notational analysis refers to the process of identifying and recording Physical and/or Technical performance indicators in a match before analysing how frequently these events take place in the game. The purpose of notational analysis is to identify and realise the difference between a successful or unsuccessful team as well as improving performance (Castellano et al., 2012; Hughes & Franks, 2005; Reep & Benjamin, 1968). Furthermore, notational analysis has also been used as an effective tool for scouting. This can be in the form of player recruitment with clubs and coaches looking for players to improve their team or by providing reports on upcoming opponents highlighting their strengths and weaknesses (Hughes et al., 2012).

The biomechanics discipline investigates the fundamental human movement patterns as well as the biological processes behind the primary movements in sport. Biomechanists will analyse key performance indicators based upon the kinematics and kinetics of a movement in order to highlight the most efficient or inefficient techniques used in the players movements before then suggesting ways of the improving these actions (Bartlett, 2001; Hughes & Bartlett, 2002). Furthermore, motor control and kinesiology are the analysis of

muscle and the role that muscles play in performing sporting movements. Kinesiology delivers information on methods where athletes learn by using both extrinsic and intrinsic feedback processes (Schmidt & Lee, 2011; Winter, 2009).

When performance analysis was first being implemented by professional sports, each sub-discipline of performance analysis worked separately from one another *(Hughes, 2004)*. This meant they were all collecting and analysing data in relation to player performance according to the individual requirements of their specific discipline *(Hughes, 2004)*. As a result, this created multiple feedback loops and processes to both the player and the coach, making it increasingly difficult for both players and coaches to assess all of the data (Figure 2).

In performance analysis the process of providing feedback begins with the performance being recorded and then analysed, this can take place live allowing for feedback to take place during the performance or can take place post performance. The key areas and aspects of the performance that are highlighted by analysis may differ due to the sport, club, team, coach and the individual players however the areas highlighted are generally a combination of both positive and negative aspects. All the information gathered during analysis will then be fed back to the coach, with the coach using this information to make more informed decisions and create future training plans with the aim of improving future performances (Figure 3). They would then have to collate this information in order to make an effective decision (Hughes, 2004).

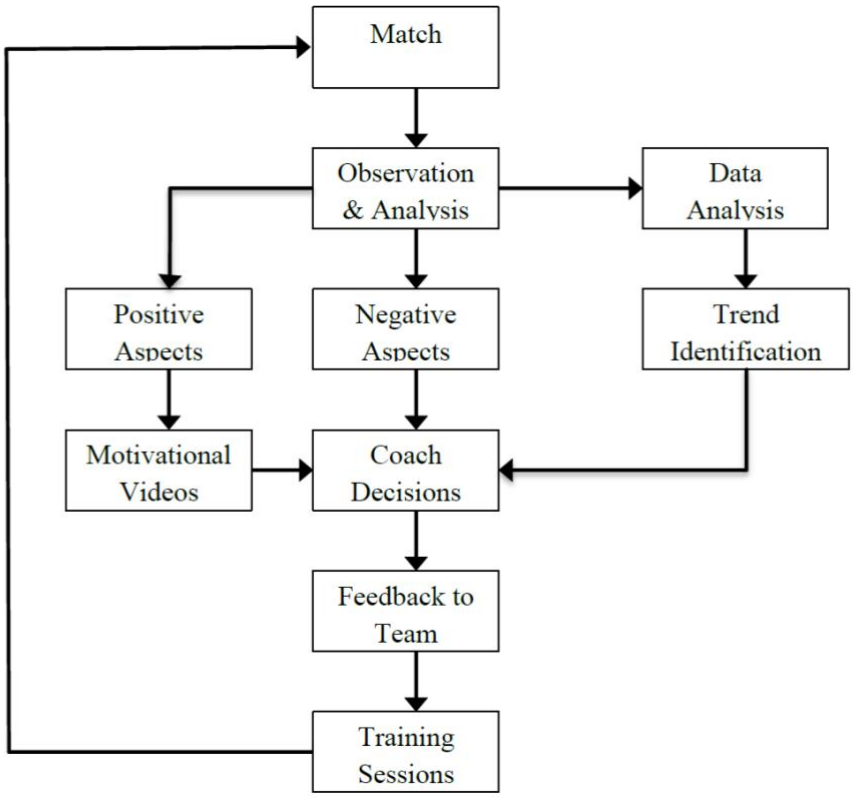

Figure 3: The application of performance analysis in elite sports (O'Donoghue, 2006)

Now with the improvements in technology, a greater understanding can be sought of the effect a successful performance analysis feedback loop can have on performance. Now the modern-day performance analysis process and assessment of performance is a more integrated process with each individual discipline working together with the sole purpose of enhancing performance (O'Donoghue, 2009). This happens with all elements of performance analysis now working together, regularly collating and analysing data in order to agree as a collective on the best method to achieve their goal *(*Hughes, 2004). This method of best practice is then reported to coach, where there is a choice of whether this is then implemented with the players (Figure 4).

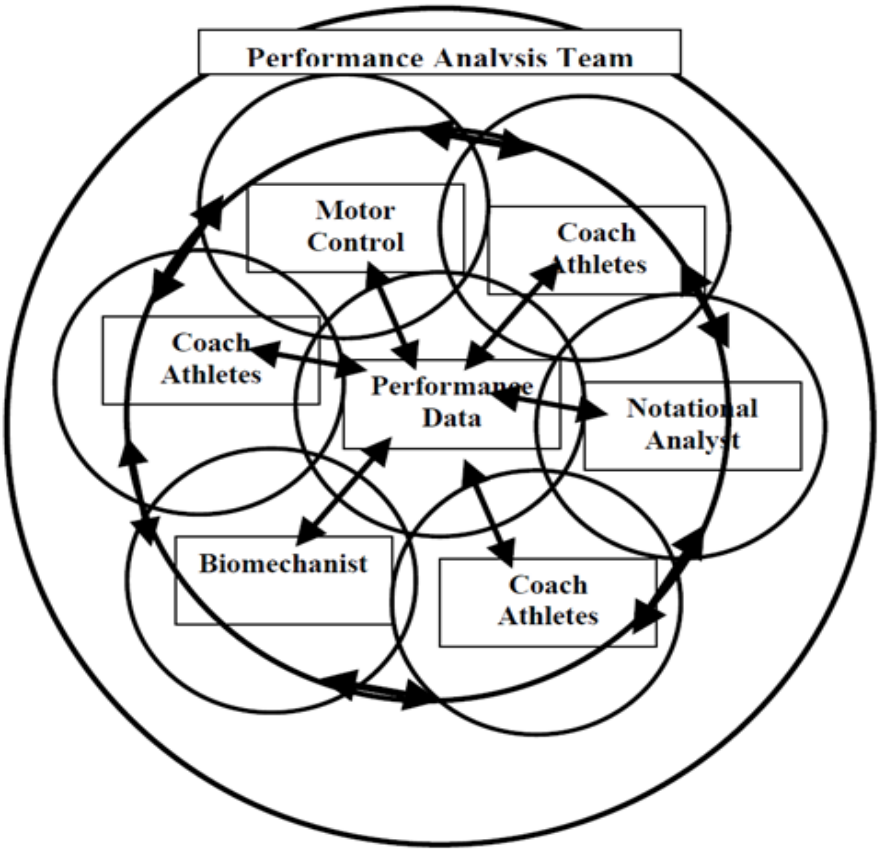

Figure 4: Modern multi-disciplinary approach to performance analysis feedback (Hughes,2004)

In order for performance analysis to be successful and efficient, it must be able to assess all the key areas of performance in order for analysis to be performed. Hughes & Franks (2004) suggest that a view often portrayed by both coaches and analysts is that there are four key areas of a performance that need to be assessed, these are the action being performed, the individual performing the action, the location on the playing area and the outcome. The need to spend time deciding what aspects of the performance must be analysed is crucial, this is so the analysis can influence and improve future performances (Carling et al., 2005; Liebermann & Franks, 2004; Liebermann et al., 2002; Smith, Hammond, & Gilleard, 2005). This can be achieved through analysing the overall effectiveness of training and how the actions from these practices are being implemented into games. Furthermore, through highlighting weaknesses in a match and recreating these scenarios in training to solve the problem, this will reduce the likelihood of its occurrence in future games (Carling et al., 2005). However, modern performance analysis systems collect and generate vast quantities

of data that could be considered to be 'too much data'. If data collected is not interpreted correctly or a large set of data is not needed in order to fulfil the needs of the coach, this may require a long period of time to analyse and sort which could result in an ineffective feedback loop. Furthermore, with the collection of so much data there is potential that the highlighted areas of improvement may not be relevant meaning no effective feedback takes place (Carling et al., 2005; Hughes & Franks, 2004).

When the coach(es) has identified the key areas of the performance that need to be analysed, it is crucial that there is a clear understanding between the coach and the analyst to ensure the correct data is being collected. To achieve this, a set of definitions which outline the actions to record should be created (Hughes et al., 2012; Hughes & Bartlett, 2002; James, Mellalieu, & Jones, 2005). If no clear definitions are put in place it is easy for an analyst to collect the wrong information, leading to incorrect interpretations and practices in the coaching process.

The final consideration to be made once the coach has decided what areas of performance need to be analysed and how this data is collected, is to decide when and where the feedback is provided to the players. With the use of computer-based performance analysis systems, this has reduced the time between the data being collected, the analysis process and data presentation. Therefore, it is the coach's responsibility to determine the best time to deliver feedback based on their group of players or individually which help to maximise the players understanding and development (See Figure 4; Liebermann & Franks, 2004).

2.3 The Physical Demands of Soccer

In elite soccer, the physical demands of a game have been described as a combination of brief high intensity actions with long periods of low intensity running (Buchheit, Mendez-Villanueva, Simpson, & Bourdon, 2010; Bradley & Noakes, 2013; Paul, Bradley, & Nassis, 2015). In an elite soccer match the total distance of outfield players cover ranges between 10-13 km throughout a match, part of this distance is made up with around 1-3 km of high intensity running (4.17–10.0 ms^{-1}) (Buchheit, Mendez-Villanueva, Simpson, & Bourdon, 2010).

In previous research analysing sub elite physical match profiles in under 18 age groups has shown that running performances were lower. Specifically, the total distance covered by players was 8.867km ± 0.859km and high intensity running 0.976km ± 0.240km (Buchheit et al. 2010). However, differences were discovered with the thresholds of high intensity running being used being wider (13.1- 16.kmh^{-1}) compared to the elite. A common theme throughout previous research analysing physical profiles in soccer was the metric range differed between studies. In these studies, the threshold for high intensity running ranged between 13.1 – 23 kmh^{-1} with sprint speed 23.1 - 27 kmh^{-1} (Buchheit et al. 2010; Dupont *et al*. 2010; Carling and Dupont 2011; Carling et al 2011; Rey et al.2010; Lago-Peñ˜as et al 2011; Djaoui et al. Dellal et al. 2013; Carling *et al.* 2015). As a result of different metric thresholds across studies, it made cross comparisons very difficult.

In previous research the use of total distance and high intensity running as Physical performance indicators is common, however research that identifies these parameters as indicators for success is limited. Studies conducted by Mohr et al (2008) and Andersson, Ekblom, & Krustrup, (2008) has shown there are major differences in the physical parameters of elite and youth soccer players. In addition, more recent research has outlined that the high intensity running performance of players in a game can be a parameter for match success, with the more HIR distance completed the greater chance of match success (Bradley *et al.* 2009; Bradley, Lago-Peñas, Rey, & Gomez Diaz, 2013).

As a result, this does not represent an accurate elite athlete sample with the Bradley *et al.* (2009) and Bradley, Lago- Peñas, Rey, & Gomez Diaz, (2013) research studies (Gratton & Jones 2010). Furthermore, the research conducted by Mohr, Krustrup, Andersson, Kirkendal, & Bangsbo, (2008) used and observed a sample of female soccer players, however the findings of this research was also used as examples in the studies above. This is despite the clear and significant gap that gender differences have when observing physical performance of players (Mujika, Santisteban, Impellizzeri, & Castagna, 2009; Bradley, Dellal, Mohr, Castellano, & Wilkie, 2014; Datson et al, 2017). A study conducted by Bradley *et al.* (2013) discovered a difference in findings between the Physical key performance indicators of players. This study found no major differences were highlighted when analysing the physical profiles of players across the Premier League, Championship and League 1 divisions in English Football.

2.4 The Technical Demands of Soccer

A large proportion of previous research on technical performance has centred around goal scoring. This an understandable area of research due to the number of goals scored by teams being the ultimate decider of the game (Janković, Leontijević, Pašić, & Jelušić, 2011). Nevertheless, despite the obvious importance of goals in relation to soccer match performance they still contribute to a very small percentage of the game therefore limiting the overall knowledge of technical interactions in soccer match performance (Lepschy, Wäsche, & Woll, 2018). Some studies have used a multivariable approach into investigating the influence of Technical performance indicators on match success (Lepschy, Wäsche, & Woll, 2018). There are aspects of soccer match performance that have not been widely researched, one of these areas is Technical performance indicators such as shot accuracy and passing accuracy. Several research papers have agreed that these have a positive influence on match performance and that these performance variables should be more widely used in literature (Janković, et al, 2011; Harrop & Nevill, 2014; Bekris, Gioldasis, Gissis, Komsis & Alipasali, 2014; Liu, Gomez, Lago-Peñas, & Sampaio, 2015; Mao, Peng, Liu, Gomez, 2016; Kite & Nevill, 2017).

Two research papers by Harrop & Nevill, (2014) and Kite & Nevill, (2017) assessed matches from the third tier of English football: League 1. In these studies, they discovered that winning teams had a lower total of passes completed across the game when compared to the losing sides. Although research conducted by Bekris *et al.* (2014) analysed games from the top tier league of France, Germany, Spain and England found different results where winning teams performed a greater number of total passes when compared to the losing sides. However, these differences in results could be put down to methodological differences across research papers with differences in a team playing style, formation and overall team standards. The findings from this paper support this with the results showing there are clear differences in playing styles across soccer leagues with lower league sides using a more direct style of playing with longer passes (Tenga & Sigmundstad 2011) and higher league teams opting for a passing and high possession style approach to game (Bekris *et al.* 2014).

Although previous research has included the use of Technical indicators in their studies there has been a clear bias towards attacking technical indicators when compared to defensive technical indicators. Only a small selection of research papers has analysed defensive Technical variables such as aerial duels, tackles and duels (Bekris *et al.* 2014; Liu *et al*. 2015; Mao *et al.* 2016). All the above-mentioned studies have shown similar findings that aerial duels, tackles and duels have a positive influence on performance despite differences in the analysed games coming from leagues in Germany, France, Spanish and English top tiers (Bekris *et al.* 2014), the Chinese Super league (Mao *et al*. 2016) and the group stages of world cup (Liu *et al.* 2015). This could imply that defensive Technical indicators have a more consistent influence on match performance.

2.5 Situational Variables Affecting Soccer Match Performance

As stated previously, performance analysis processes utilise a unique methodology, collecting data on complex behaviours and interactions between soccer teams throughout live competition (James et al. 2002). As a result of this performance analysis research papers have improved validity due to the un-intrusive nature of the methodology. However as previously mentioned these measured performance indicators are exposed to, and

manipulated by a variety of external situational variables (O'Donoghue 2014), including phase of the game (1st half/2nd half), playing positions (defence, midfield, forwards), match tactics (playing formation), the location of a match (home/away), match status (winning/drawing/losing) and quality of opposition. Some previous research papers have explored the influence of these situational variables in order to gain a greater understanding into the impact on performance (Taylor et al. 2008; Konefał et al. 2018).

2.5.1 Playing Position

A number of previous research papers have analysed the fitness capabilities of players of various playing positions as well as formations (Bangsbo et al., 1991; Bradley et al., 2011; Carling, 2011; Di Salvo et al., 2007; Reilly & Thomas, 1976). One study by Di Salvo et al. (2007) analysed 300 players, investigating the motion characteristics of elite soccer players in the top Spanish Soccer League. This study used a computerised match analysis methodology and the results showed that players in midfield covered more total distance when compared to players in defence and forward positions (Di Salvo et al., 2007). Furthermore, a study by Carling et al. (2011) used a different methodological approach. This study analysed 45 games over the period of three seasons from the highest soccer division in France, using a computerised multi camera tracking system methodology. The aim of the study was to analyse the effect of playing formation on the physical demands of soccer players. One team from the study was selected to be the reference side, utilising a 4-3-3 playing formation. In order for comparisons to take place to assess the impact of playing system on the physical and technical demands of players opposition formations were used, which consisted of a 4-3-3, 4-3-2-1 and 4-4-2. The Physical performance indicators used in this study were total distance, high intensity running (14.4-19.7 kmh^{-1}) and very high intensity running (>19.8 kmh^{-1}). The Technical indicators used in this study consisted of the number of passes as well as the number of touches per possession. The results of this study concluded that the playing formation of the opposition had little to no impact on the reference team's Physical performance indicators (Carling et al., 2011). However, there were differences in the skill-demands according to the opponent's formation that may have applications in the technical and tactical preparation of teams.

Furthermore, another study by Bradley et al. (2011) analysed the effects of 3 different team formations and how they impacted on the Technical performance and high intensity running of players. Three playing formations were selected for analysis 4-3-3, 4-5-1 and 4-4-2. In total twenty games form the English Premier League were analysed using a computerised multi camera tracking system. Overall, this study found that between 4-4-2, 4-3-3 and 4-5-1 playing formations the high intensity running and ball possession time did not change. On the other hand, across different playing positions in the playing formations it was found that attackers in a 4-3-3 had an increase in high intensity running when compared to the attackers in a 4-4-2 or 4-5-1 playing formation (Bradley et al., 2011).

These works demonstrate that playing position is an important variable that needs to be considered when analysing the Physical and Technical performance indicators of soccer players. However, these studies only used data samples from elite competitions with no considerations on using a sample of youth players may alter the findings of these studies. In addition, the studies by Carling et al. (2011) and Bradley et al. (2011) utilised additional situation variables such as the playing formation of both sides to examine its effects on the physical and technical demands of different playing positions in a formation.

2.5.2 Match Location

During the build-up to a game, often mentioned is the idea of “home field advantage”. This phenomenon has been analysed by various studies (Lago and Marín, 2007; Almeida et al, 2014; Liu et al, 2016) and has been highlighted as changes have been observed in a team playing style and behavioural level when playing at home. One study exploring the effect of match location was by Lago and Marín (2007). This study analysed 170 games from the Spanish division during the 2003-2004 season, one of the key findings from the study showed that teams playing at home had significantly more (+6%) possession when compared to playing away. On the other hand, in another study by Lago (2009) it was found that the overall possession of a team was not significantly influenced by match location. However, there were some similar findings across the two studies mentioned, with the away teams that were observed having less possession in the attacking third (-6.4%) when compared to playing at home. In addition, Taylor et al. (2008), highlighted that there were no significant differences between the match location and the technical parameters that

were chosen for analysis. A reason for these inconsistencies in results across various studies has been assumed to be down to the differences in team playing styles across the analysed leagues. The inconsistencies found between studies is assumed to be down to the differences in playing standards across the assessed leagues (Taylor et al, 2008).

Furthermore, more recent research conducted by Almeida et al. (2014), who assessed the effects of match location throughout the 2011- 2012 Champions League, found that for home teams there was a significant regains of possession in areas higher up the pitch. Moreover, a study by Liu et al. (2016) analysed a total of 380 first division game in Spain throughout the 2012-2013 season. This study identified that teams playing at home had a higher frequency in shots, shots on target and assists when compared to playing away from home.

These works demonstrate that match location is an important variable that needs to be considered when analysing the Physical and Technical performance indicators of soccer players. However once again the samples used in these studies are only elite players from elite competitions meaning there is a gap in knowledge in how match location may influence sub elite games and competitions. Furthermore, this could be considered highly valuable to youth coaches if the Physical and Technical performance indicators of players are significantly lower when playing away compared to playing at home, which could result in the head coach needing to alter their coaching process in the build to away fixtures.

2.5.3 Match Status

Another influencing factor to the Technical and Physical performance indicators of soccer players is match status (winning, drawing, losing) and has been considered to directly impact the tactical approach of a team (Bloomfield et al. 2005). This situational variable considers the changing score line during a soccer match and as result highlights the changes or adjustments of tactical styles a team makes in response to the situation. Previous research assessing the effects of match status have shown an increase in possession of both successful and unsuccessful sides when losing (O'Donoghue and Tenga 2001; James et al.

2002). Furthermore, another study conducted by Lago-Penas and Dellal (2010) analysed the match status of game during the 2008/2009 Spanish La Liga season. The results from this study saw an increase in possession of 0.04% or 0.09% when teams were losing, compared to when drawing or winning. These results could indicate adjustments in the winning team's tactical approach or playing style in order to protect their advantage or can display changes made by the losing side with aim to increase possession in order apply attacking pressure on the opposition.

Similar results to the above research were found in another study by Lago (2009). This research highlighted that the losing teams in games have considerably more possession of the ball. In the study Lago explains some of the in-match alterations of tactical styles he observed from some of the team analysed. An example of this came from RCD Espanyol de Barcelona, during the study they opted for a more possession-based style when losing in game in an attempt to dictate the remainder of the match. This is opposed to the counter attacking style that was observed when winning or drawing in games.

Due to the changes in match status and the resulting in-match tactical alterations made by coaches, this has had direct influence on the Physical and Technical performance indicators of players during the course of the game. As result previous research has observed variations in performance indictors across the different score lines of a soccer match. Research has found that losing teams have performed an increased number of crosses and players execute a greater number of dribbles (Taylor et al. 2008) as well as having a larger percentage of possession (Lago 2009). On the other hand, teams in winning positions have found to complete a higher number of clearances, aerial duels and interceptions whilst also completing less passes and dribbles (Taylor et al. 2008). In addition, it has been found that teams are able to score significantly more goals when a match is level (66.3%), this compared to when teams are winning or losing in games (16.9% and 16.8%).

In conclusion, the literature above shows that match status is an important variable that needs to be considered when analysing the Physical and Technical performance indicators of soccer players. However, similar to the situational variables analysed above, the samples

used in all these studies focus on elite soccer performance, with no research on how match status influences sub elite players performance. This is a clear gap in research which this study aims to provide greater understanding into this area.

2.5.4 Quality of Opposition

The quality of opposition has been suggested to be an important influence on performance (Sasaki et al, 1999; Tucker et al, 2005). Previous research has indicated that the opponent will have the biggest influence on the performance indicators of players during match performance (Lago & Martin 2007; Duarte et al, 2013; Folgado et al, 2014). Despite being identified as important, within performance analysis literature there is general neglect of this particular situational factor, with teams generally categorized as ‘‘successful’’ or ‘‘unsuccessful’’ based on their progress within a particular tournament (Grant, Williams, & Hocking, 1999; Hook & Hughes, 2001; Hughes & Churchill, 2005). This can be potentially problematic as a team that is deemed to be successful may not necessarily be of high quality, and vice versa (Scoulding, James, & Taylor, 2004).

Often the comparisons between successful and unsuccessful teams are commonly carried out within a match play of knockout tournaments such as the World Cup or European Championships. In these tournaments weaker teams may progress to the latter rounds of the competition at the expense of stronger teams due to the competition structure (McGarry, 1998; Vuki cević, Trninić, & Dizdar, 2006). This type of study design is also limited because many teams’ performances are amalgamated to produce the successful and unsuccessful groupings. This aggregated data potentially ‘‘masks’’ the factors that determine or contribute to each team’s success or failure in the competition. It would therefore appear that case studies of teams over a sustained period represent a more detailed approach to analysis, with comparisons between case studies offering specific insight into the performance indicators and situational variables of interest (Garganta, Maia, & Basto, 1997).

2.6 Youth Soccer

Throughout the previous research that has been presented so far during this literature review it is noticeable that match analysis methodologies are an increasingly popular method to improve the coaching process (Smith et al. 2013). Despite this, there is clear lack of published research studies that assess the effects of situational variables on Physical and Technical performance indicators specifically in relation to youth soccer.

It has been argued that previous research studies based on elite samples helps to provide suitable information in order to enhance the coaching of youth soccer players as well as providing data as target, which sub elite soccer players can aim to achieve. On the other hand, some research papers have agreed that youth soccer player have a different and more unique set of requirements (Rosenbloom et al. 2006) and abilities. This includes difference in technical, tactical (Teoldo da Costa et al. 2010; Sevil Serrano et al. 2017; Smith et al. 2013) and physical capabilities (Stølen et al. 2005; Djaoui et al. 2014; Harley et al. 2010).

One study that highlights this comes from Harley et al. (2010). This study recognised that youth soccer players and under 16s teams on average completed a total distance of 7672 meters (± 2578) per game, this is considerably less than a study by Djaoui et al. (2014) who highlighted that elite soccer players completed an average total distance of 10894.6 (± 889.8) per game.

Other research papers have reported similar findings, with Stølen et al. (2005) concluding that youth players tended to display lower VO_{2MAX} outputs when compared to elite soccer players. These findings are replicated in small sided games as well as general match play, with a study by Alberto et al. (2019) showing an under 17s team providing significantly lower results in terms of the total distance completed 1733.2 (± 167.6), number of accelerations 13.5 (± 3.6) and the maximal speed of players 19.4 (± 1.2) during small sided games. In comparison a team of elite senior players produced much higher results with total

distance (1957.0 ± 145.5), number of accelerations (20.7 ± 5.1) and the maximal speed of players (20.7 ± 1.2, respectively). The difference in these results can be explained by the different stages of maturation, with the youth players still in the process of adolescence whereas the older and more senior players are already developed allowing them to achieve higher results and intensities.

Finally, Smith et al. (2013) recognised the gap in the literature that can be applied to sub elite soccer players. This study analysed several age groups of teams from the same Blue Square Premier club, with a total of 86 matches analysed. The study highlighted that the under 16s and under 18s teams are the critical stage of development, this is because of the preparation that is needed in order for players to transition in the first team senior squad (Vaeyens et al. 2005). This study evaluated and compared the attacking methods of these three teams; under 16s, under 18s & senior squad. The results found there was no significant differences between the three teams in the duration of attacks, the number of assists and percentage of forward passes completed. However, the study did find disparities across all three age groups in the number of actions that lead up to a goal, showing the first team's enhanced ability of maintaining possession. In addition, location of assist from the under 18s team when compared to the first team was significantly different, with the senior squad utilising the wide spaces more often than the under 18s. The difference in these results could possibly be explained by tactical alterations made by the first team coaching staff, with the wings being using more often in games in order to expose an oppositions weakness and suggests the club philosophy may not be the same across all age groups. On the other hand, under 16s and under 18s are less likely to make such tactical alterations (Vaeyens et al. 2005), with their primary objective being to develop the players whereas the older and more senior players are already developed, and their goal is to win games and get results.

In conclusion it is crucial that research recognises the different demands of sub elite soccer. Younger players have a unique set of requirements when compared to elite players with sub elite players possessing less physical, technical and tactical capabilities. For example,

previous research has shown that senior teams complete a higher total distance covered and distance sprinted (Harley et al. 2010) whereas sub elite teams exhibit a greater intensity in their performance (Pereira Da Silva et al. 2007). This further highlights the difference in physical attributes across age groups, which as result means that the technical and tactical attributes and capabilities are expected to differ between ages. Despite this, the coaching methodologies used to coach youth players is based on previous research that has used an elite sample. This is used to provide suitable information in order to enhance the coaching process and as stated previously provides target data for players to aim to achieve. However, this data cannot be directly applied to the sub elite soccer player due to the unique set of requirements each player has as well as the clear differences in physical, technical and tactical capabilities.

2.7 Physical and Technical Performance Data in soccer

A player's ability to maintain performance levels through fatigue is key factor in soccer match performance (Silva et al. 2018). Previous research has highlighted that the physical performance of players declines throughout the course of a game, this includes declines in players running performance between the first and second halves (Rampinini et al. 2009; Carling & Dupont, 2011; Bradley et al, 2011; Harper, West, Stevenson & Russell, 2014). However, situational variables such as playing position, quality of opposition, match location, match status and game phase have all been found to have an influence on performance (Paul, Bradley, & Nassis, 2015; Silva et al 2018). As a result, the complexity of Physical, Technical and Tactical performance interactions has an effect on the game management and the performance levels of players. Research assessing Physical and Technical on the other hand is limited, this is despite some previous studies highlighting an irregular amount of goals being scored in the final 15-minute period of games showing that variations in technical skill may occur due to fatigue in the final stages of games (Russell, Benton, & Kingsley, 2011).

Research studies have attempted to analyse both physical and technical changes within soccer match performance, with all three studies observing differences. Research conducted by Rampinini et al. (2009) discovered declines in Technical indicators as well as Physical

indicators. The study observed a reduction in short passes and short pass accuracy and physical declines in high intensity running (HIR) and total distance (TD) across halves. These declines were observed between the frequency of passing and duels when comparing the first 5 minutes of the game to the last 5 minutes, however, the method of match analysis used did not distinguish between the ball being in or out of play with a stop in play impacting the HIR and TD values of players. Furthermore, research by Bradley & Noakes, (2013) found that in the final stages of a game the ball is out of play significantly more in comparison to the early stages of the game, which could justify this finding.

Variations in technical findings could be the result of methodological differences between studies, with research papers by Rampinini et al. (2009) and Carling & Dupont (2011). On the other had a study by Russell, Benton, & Kingsley (2011) analysed technical differences by using a soccer match simulation drill. There are clear strengths and weaknesses with both of these methodological approaches, this is because of the complexity of full match demands influencing findings when analysing match play (Lepschy, Wäsche, & Woll, 2018). Furthermore, a decline in player performance are direct result of decreased physiological responses, the effects of situational variables and contextual factors on match play must also be considered with game management strategies being observed due to quality of opposition (Redwood-Brown, O'Donoghue, Nevill, Saward & Sunderland, 2019), tactics and playing position (Paul, Bradley, & Nassis, 2015), match status (Bradley & Noakes, 2013; Konefał et al. 2018; Redwood-Brown et al. 2019) and match location (Lago-Peñas, 2012; Fowler, Duffield & Vaile, 2014; García-Unanue et al. 2018).

A simulation drill approach that was taken by Russell, Benton, & Kingsley (2011) eliminates the effect of these situational variables, with any highlighted declines in player performance more likely to be a result from physiological declines. As a result of the repetitive style of a simulation drill which lacks any motivational contexts that are found in general match play resulting in mental fatigue being a significant influencer to the deterioration of technical performance such as shooting accuracy (Smith et al 2016). Furthermore, the simulation drill by Russell, Benton, & Kingsley (2011) also did not account for positional differences, with all players taking part completing the same 56 passes, 21 dribbles, 10.1km distance and 16 shots. However previous research studies have identified clear positional differences, with

studies highlight midfielders (Buchheit, Mendez-Villanueva, Simpson & Bourdon, 2010; Mendez-Villanueva, Buchheit, Simpson, & Bourdon, 2013; Saward et al. 2016; De Silva et al. 2018) and more specifically central midfielders cover greater total distance in comparison to other playing positions (Saward et al. 2016; De Silva et al. 2018). In addition, it is also highly improbable that players in defensive positions are going to perform this number of dribbles and shots. This suggests that the simulation drill is not an accurate representation of general match play for each player and this lack of playing position consideration may have influenced the results of the simulation.

The study conducted by Rampinini et al. (2009) analysed 186 players across 18 teams in the Italian Serie A. The large dataset used in this study is strength of this research as it allows for results to be generalised across the entire Serie A league. In this study Rampinini et al. (2009) sub analysed their data based on the teams ranking and fatigue group, although this provides more focus to performance differences between groups, situational variables such as variations in playing styles and formation could have still influenced the results (Tenga & Sigmundstad 2011; Harrop & Nevill, 2014; Bekris *et al,* 2014; Paul, Bradley, & Nassis, 2015; Kite & Nevill, 2017; Silva et al. 2018). In order to divide the data into high and low fatigue groups the percentage drop off of high intensity running by each individual player was used. Despite this being an interesting concept to divide the data which would highlight the extent of any technical performance deterioration to either group, again it would be difficult to determine if this drop in high intensity running is solely down to the decreasing physiological performance or if game management tactics have affected these results (Paul, Bradley, & Nassis, 2015; Silva et al. 2018).

In research conducted by Carling & Dupont (2011) a more focused sample was used, analysing 11 midfield players from the French Ligue. Data was only used in this study from players that participated in a full game, with an average of 9 games per player being analysed and a total range of 2 -24 games analysed for an individual player. A sample of six matches are recommended to provide a representative sample (Hughes, Evans and Wells, 2001). Despite the average sample size of this studying meeting this criterion including players with a match sample size that is fewer than six may not provide an accurate representation. The data collected within this study was gathered over the course of three

seasons meaning the variation in individual samples may have been influenced by squad changes and the effects of injury which is highly likely to occur over such a large period of time (Cordes, Lamb & Lames, 2012).

Despite research into both physical and technical data emphasising their clear importance on soccer match performance and their deterioration over the course of match play, a large proportion of previous research has adopted a univariate approach analysing either concept in isolation. Only a selection of studies (Rampinini et al. 2009; Russell, Benton, & Kingsley, 2011; Carling & Dupont, 2011) have analysed both physical and technical performance, however once again within these papers they are analysed as separate concepts.

2.8 Summary of Literature

In summary, it has been established that performance analysis literature has generated performance indicators in order to predict match outcome and a team's style of play (Rein & Memmert 2016; Gomez et al. 2018). In addition to this, literature has tended to focus on Technical performance indicators and the elite players (Zhou et al. 2018). Given that the main intention of match analysis within the coaching cycle is to support player development, literature is omitting the developmental stages of academy football (Raya-Castellano & Uriondo, 2015; Harrop & Nevill, 2014). As a result, performance analysis literature appears detached from the practical application of the discipline and has subsequently inhibited the development of performance analysis as a feedback mechanism at an academy and youth level. Finally, performance analysis studies have gravitated towards the offensive sequence of events that result in a shot at goal. This is due to the primary objective of the sport; requiring a team to score more goals than the opposition and as a result, the majority of studies have labelled a goal as a measure for success (Michailidis et al. 2018). To the researcher's knowledge no studies have looked to analyse Physical and Technical indicators together and how situation variables my influence these indicators within soccer match performance. This concept could be considered particularly useful to academy soccer players, this is because the sole purpose of this level is to prepare players for the demands of soccer match performance (Strudwick, & Doran, 2002; Carling, Lawlor & Wells, 2018). Identifying technical and physical performance fluctuations in

individual players as a result of situational variables would be valuable to coaches in order tailor training sessions to specific player needs.

In conclusion, this study aims to establish a clearer understanding of match performance in relation to both Physical and Technical key performance indicators in under 18s youth soccer. Furthermore, the aim of this work is to investigate the effect that contextual factors such as playing position and match location have on these Physical and Technical performance variables.

3 Methodology

3.1 Sample and Participants

This research paper used a case study methodology, this approach is particularly useful when there is a need to obtain an in depth understanding of an issue, event or phenomenon, in its natural real-life context. With institutional ethical approval (Ethics ID-32179), the Technical (from video) and Physical (from GPS) performance data of a under 18s English soccer academy was analysed during the 2019/2020 season. Across the season, 7 matches (5 home, 2 away) were used, with one game being a replay of the same opposition. All 7 games used for analysis were all competitive fixtures consisting 7 league games. These games were selected due to the high quality of game footage for analysis and the ability to obtain the players physical data from the individual GPS units. Every player in each game will be recorded, including substitutes, an approach that has been previously recommend by Varley et al (2017). This will result in a total of 20 unique players being recorded across all games. All players will have their data normalised to 90 minutes in order to allow fair comparisons on Technical and Physical performance.

3.1.1 Impact of covid-19

As result of the Coronavirus pandemic (Covid-19) and the resulting national lockdown being introduced at the end of March 2020, there was some impact on the data collection in this work. Data collection was halted due to the closure of the club and eventually ended due to the decision to abandon the 2019/20 academy season. All 7 of the games used for analysis were competitive league fixtures consisting of 5 home game and 2 away games, with a total of 2 games being reverse fixtures of the same opposition. 12 games were planned to be recorded however they remaining games were cancelled due to lockdown.

All of these games were selected due to the high quality of game footage for analysis and the ability to obtain the players physical data from the individual GPS units. Every out-field player in each game was recorded, including substitutes with the goalkeepers not being

used in this study. This approach that has been previously recommend by Varley et al (2017). This resulted in a total of 20 unique players being recorded across all 7 games. All players had their data normalised to 90 minutes in order to allow fair comparisons on Technical and Physical performance between players who had completed the full game and substitutes who had played in a small part of the game. Furthermore, another methodological change was enforced due to the results of the 7 games used for analysis. This study previous planned to analyse and assess the impact of match status on both the Physical and Technical performance indicators but due to the smaller sample and the results of these games all being the same this hypothesis was not analysed. The final methodological change was enforced due to the Coronavirus pandemic both the Physical and Technical data provided had been collected across 45-minute halves and an inability to further manipulate the data in to previously planned 15-minute time periods a method that had been previously suggested by Carling and Dupont (2011). This was due to the laptop containing the data being unreachable due to the nationwide lockdown. Additionally, given the sample collected in this study, the team won all games and were winning for all periods, therefore there was no need to record either opponent effect, or periods of the game (per 15 mins).

3.2 Physical Data Procedure

The Physical data was obtained using 10 Hz global positioning system devices with inbuilt 100 Hz accelerometer (Optimeye X4, Catapult), a system which has been proven to have a high-level reliability and consistency (Boyd, Ball, & Aughey, 2011). The Physical data collected can be found in Table 2.

Table 2: Physical performance indicators used and operational definitions

Variable	Definition	Explanation
Total Distance (m)	Absolute distance covered across all speed thresholds in metres	A physical performance indicator that has been widely used across soccer match research (Andersson, Ekblom, & Krustrup, 2008; Mohr, Krustrup, Andersson, Kirkendal, & Bangsbo, 2008;

		Bradley *et al.* 2009; Bradley, Lago-Peñas, Rey, & Gomez Diaz, 2013).
Total High Intensity Running	Movement performed >5.5ms^{-1}	A physical performance indicator that has been widely used across soccer match research (Andersson, Ekblom, & Krustrup, 2008; Mohr, Krustrup, Andersson, Kirkendal, & Bangsbo, 2008; Bradley *et al.* 2009; Bradley, Lago-Peñas, Rey, & Gomez Diaz, 2013).
Number of Sprints	Movement performed >7ms^{-1}	A physical performance indicator that has been widely used across soccer match research (Andersson, Ekblom, & Krustrup, 2008; Mohr, Krustrup, Andersson, Kirkendal, & Bangsbo, 2008; Bradley *et al.* 2009; Bradley, Lago-Peñas, Rey, & Gomez Diaz, 2013).
Number of Accelerations (and Decelerations)	Movement Performed (<) >2.5ms^{-2}	A measure of strenuous physical demand that has been overlooked in previous studies (Paul, Bradley & Nassis, 2015).

3.3 Physical Data Analysis

The Physical data from all the outfield players who competed in the 7 games was obtained through the use of 10 Hz global positioning system devices with inbuilt 100 Hz accelerometer (Optimeye X4, Catapult). The Physical data was then exported into separate Excel (Microsoft Office 2011, Microsoft Corporation, Redmond, USA). files for each game by the clubs Head of Sports Science before then being given to the researcher for data analysis and manipulation once institutional ethical approval had been received (Ethics ID- 32179).

The Physical data provided had been collected across 45-minute halves. The process of data comparison between two halves of soccer is common (Rampinini et al., 2009; Russell, Benton, & Kingsley, 2011; Bradley et al., 2013). This method of comparison allows for an

increased understanding on how Physical performance indicators change across time. Furthermore, this will identify any relationships between specific Physical indicators to be highlighted (Carling, 2011).

The Physical data was then matched with the Technical data of each player from the corresponding game. All this data was placed in a one master Excel data file, creating a 98 row and 74 column spread sheet. Each row of data represented a combination of the players Technical and Physical performance data from one game, with each column representing a key detail from the game or either a Technical or Physical key performance indicator.

In addition, the technical data from all games was then normalised using the following two formulas:

$$\left(\frac{x}{time\ played\ in\ minutes}\right) * 90$$

$$\left(\frac{x}{time\ played\ in\ minutes}\right) * 45$$

In these formulas, x represented the key performance indicator. Two formulas were necessary in order to normalise the data due to the separation of the key performance indicators into a total throughout the 90 minutes as well as two separate totals for each half. These formulas were used in order to allow for comparisons between players who had played a full 90 minutes and substitutes who had played significantly less time. Furthermore, this allowed for any periods of extra time to be excluded from the analysis in order to avoid match duration differences across games (Carling, 2011; Carling & Dupont, 2011). This provide a rating for each key performance indicator if all players had played the full 90 minutes of the match and allowed the researcher to see the performance of a player if they had played the whole game allowing for more accurate comparison of performance.

This data was then be exported from Microsoft Excel allowing for it to be used in statistical tests that were carried out using SPSS (V.21, SPSS Inc., Chicago, IL). Normality testing was conducted and found this data was not normally distributed. This led to non-parametric equivalent test being used. A Mann-Whitney U test was used in order to compare differences between the Physical and Technical key performance indicators across home and away games. A Kruskal-Wallis H test was also selected, this was used to determine if there are statistically significant differences across the 3 playing positions. In order for further analysis and comparisons between different playing positions (Defender, Midfielder, Forward), 3 further Mann Whitney U tests were conducted on the Physical and Technical key performance indicators that showed significant difference in the Kruskal-Wallis H test.

3.4 Technical Data Procedure

The Technical performance data for this study was collected using wide angle video footage from a Cannon Camcorder. The use of wide-angle footage has previously been recommended (Carling *et al.,* 2005; Tenga, Kanstad, Ronglan, & Bahr, 2009). This camera was positioned on a tripod at an elevated angle at an area around the halfway line where possible. From this video footage individual clips were made for every action from each player using Sports Code performance analysis software (Hudl, USA). Utilising a computerised notational analysis system enhances the reliability of the data collected as the user can pause and re-watch footage thus reducing the risk of errors (Hughes & Franks, 2008; Hughes, 2015). The process involves the whole match video being loaded into Sports Code and a button is pressed on a coding window (Figure 5) which then creates a small clip for analysis every time an individual player is on or around the ball. The coding window consists of buttons representing the action being taken and created a series of shorter clips. After this, the individual's clips will then be analysed for Technical indicators using a second Sports Code coding window (Figure 6). The coding of Technical events through the use of each player's individual clips allowed the analyst to concentrate on a single players performance actions instead of analysing multiple players at any one time improving the accuracy of analysis. Operational definitions of Technical events can be found in the tables below, the use of operational definitions ensures that data reliability is improved (Williams,

2012). These definitions were derived from previous research and allows for accurate reproducibility across research.

Figure 5: SportsCode tagging window for individual player clips.

Figure 6: SportsCode tagging window for technical events.

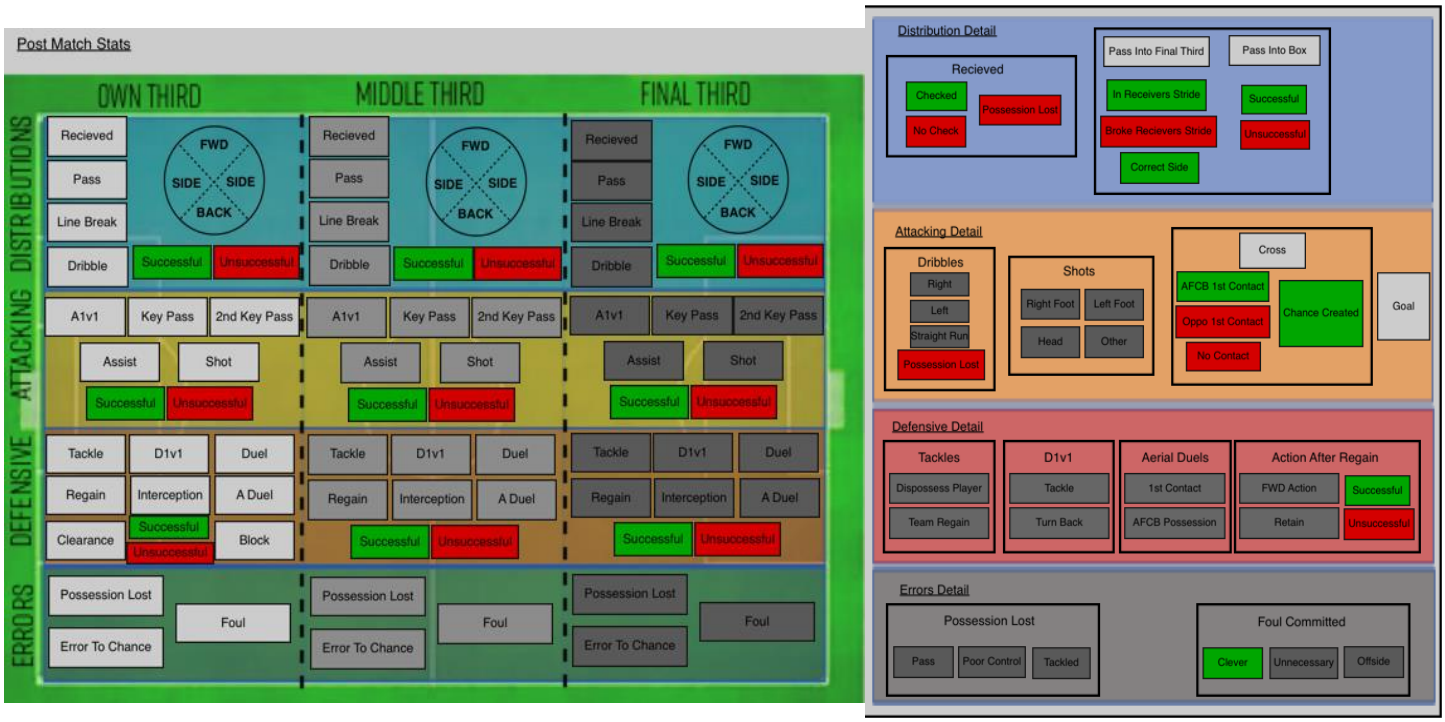

Table 3: Technical for passing performance indicators used and operational definitions.

Variable	Definition	Explanation
Pass	An intentionally ball played from one player to another (Taylor et al. 2008; Williams 2012; Liu et al. 2013; Wallace and Norton 2014; OPTA 2019).	A Key performance indicator that has been heavily linked with the success of a team or individual (Göral, 2015; Liu, Gómez, Gonçalves, & Sampaio, 2016; Zambom-Ferraresi, Rios, & Lera-López, 2018).
Passing Accuracy	The number of successful/ unsuccessful passes and the total number of passes (excludes crosses and corners).	

Passing Direction	**<u>Forward-</u>** The direction of the ball following an action that results in vertical movement directly towards the opposition's goal. **<u>Sideways-</u>** The direction of the ball following an action that results in lateral movement. **<u>Backward-</u>** The direction of the ball following an action that results in vertical movement directly away from the opposition's goal.	In soccer tournaments it has been found that there is a high association between forward passes and team success (Bostanci et al. 2018). However, it has not been used in research that analyse the effects of situation variables on technical performance indicators.
Penetrative Pass (Line Break)	Forward pass that breaks an opponent's defensive line. (Liu et al. 2013; OPTA 2019).	A measure of strenuous physical demand that has been overlooked in previous studies (Paul, Bradley & Nassis, 2015).

Table 4: Technical for attacking performance indicators used and operational definitions.

Variable	Definition	Explanation
Dribble	Attempt by a player to intentional move the ball in order beat an opponent with the ball or to travel with ball (Liu et al. 2013; OPTA 2019).	A key performance indicator that is used by all positions in soccer. Previous research papers have had differing findings on how dribbling performance is affected by different variables (Rampinini

	Successful when player beats the opponent. Unsuccessful if player is tackled or loses possession of the ball.	et al. 2009; Russell et al. 2011; Draganidis et al. 2013).
Dribble Accuracy	The number of successful/ unsuccessful dribbles and total number of dribbles.	
Shot	An attempt made on goal with aim to score. This attempt can be made by any part of the body. A Successful shot will be considered on target.	A key performance indicator used across both technical performance research studies with a decline in accuracy highlighted by a majority of papers (Rampinini et al. 2009; Russell, Benton, & Kingsley, 2011; Varley et al. 2017).
Shot Accuracy	The number of successful/ unsuccessful shots and total number of shots.	

Variable	Definition	Explanation
Tackle	The action of player to successfully gain possession from an opposition player in possession and maintains possession (Liu et al. 2013; OPTA 2019).	Previous research by Rampinini et al. (2009) has shown that tackles are a relevant skill parameter as it involves both decisions making and technical skill.

Tackle Accuracy	The number of successful/ unsuccessful tackles and total number of tackles.	
Aerial Duels	Direct contest of a header with an opponent. Successful if first contact was won.	The success of this key performance indicator is reliant on multiple factors that have been shown to be affected by situational variables including timing, body positioning and jump height (Altmann, Kuberczyk, Ringhof, Neumann & Woll, 2018).
Aerial Duel Accuracy	The number of successful/ unsuccessful aerial duels and total number of aerial duels.	

Table 5: Technical for defensive performance indicators used and operational definitions.

3.5 Technical Data Analysis

The Technical data was gathered from each player's individual match clips, each game was coded using code windows using Sports Code analysis software. This data was then exported into Microsoft Excel (Microsoft Office 2011, Microsoft Corporation, Redmond, USA). The Technical data for each player was manipulated and sorted in Microsoft Excel using the relevant key performance indicators that had been highlighted earlier. This created individual Excel files for all outfield players involved each of the 7 games, with each file showing the individuals instances where the players were either in possession or close contact with the ball. This created a total of 97 individuals player Excel files, each of these spreadsheets ranged between 9 and 349 rows of data spread across 60 columns for every player across the 7 analysed games. The Technical data was collected across 45-minute halves. The process of data comparison between two halves of soccer is common (Rampinini et al., 2009; Russell, Benton, & Kingsley, 2011; Bradley et al., 2013). This method

of comparison allows for an increased understanding on how Technical performance indicators change across time. Furthermore, this will identify any relationships between specific Technical indicators to be highlighted (Carling, 2011).

From these 97 individuals excel sheets were then combined and matched with the Physical data of each player from the corresponding game. All this data was placed in a one master Excel data file, creating a 98 row and 74 column spread sheet. Each row of data represented a combination of the players Technical and Physical performance data from one game, with each column representing a key detail from the game or either a Technical or Physical key performance indicator (Figure 7).

	A	B	C	D	E	F	G
1	Player ID	Game	Home/Away	Player Postion	Total Game Time (MINS)	1st Half Total Game Time	2nd Half Total Game Time
2	Player 1	Exeter	Home	Midfield	96	47	49
3	Player 2	Exeter	Home	Midfield	96	47	49
4	Player 3	Exeter	Home	Defender	96	47	49
5	Player 4	Exeter	Home	Midfield	96	47	49
6	Player 5	Exeter	Home	Forward	96	47	49
7	Player 6	Exeter	Home	Forward	96	47	49
8	Player 7	Exeter	Home	Defender	96	47	49
9	Player 8	Exeter	Home	Defender	96	47	49
10	Player 9	Exeter	Home	Midfield	96	47	49

Figure 7: Screenshot of master excel data file.

In addition, the Technical data from all games was then normalised using the following two formulas:

$$\left(\frac{x}{time\ played\ in\ minutes}\right) * 90$$

$$\left(\frac{x}{time\ played\ in\ minutes}\right) * 45$$

In these formulas, x represented the key performance indicator. Two formulas were necessary in order to normalise the data due to the separation of the key performance indicators into a total throughout the 90 minutes as well as two separate totals for each

half. These formulas were used in order to allow for comparisons between players who had played a full 90 minutes and substitutes who had played significantly less time. Furthermore, this allowed for any periods of extra time to be excluded from the analysis in order to avoid match duration differences across games (Carling, 2011; Carling & Dupont, 2011). This provide a rating for each key performance indicator if all players had played the full 90 minutes of the match and allowed the researcher to see the performance of a player if they had played the whole game allowing for more accurate comparison of performance.

This data was then be exported from Microsoft Excel allowing for it to be used in statistical tests that were carried out using SPSS (V.21, SPSS Inc., Chicago, IL). Normality testing was conducted and found this data was not normally distributed. This led to non-parametric equivalent test being used. A Mann-Whitney U test was used in order to compare differences between the Physical and Technical key performance indicators across home and away games. A Kruskal-Wallis H test was also selected, this was used to determine if there are statistically significant differences across the 3 playing positions. In order for further analysis and comparisons between different playing positions (Defender, Midfielder, Forward), 3 further Mann Whitney U tests were conducted on the Physical and Technical key performance indicators that showed significant difference in the Kruskal-Wallis H test.

Table 6: Table of hypothesises

Research Hypothesis	Null Hypothesis
Research hypothesis 1: Significant difference across time periods for Physical variables.	*Null hypothesis 1:* **No** significant difference across time periods for Physical variables.
Research hypothesis 2: Significant difference across time periods for Technical variables.	*Null hypothesis 2:* **No** significant difference across time periods for Technical variables.

Research hypothesis 3: Significant relationships highlighted between Physical and Technical variables for match location (Home/Away).	*Null hypothesis 3:* **No** significant relationships highlighted between Physical and Technical variables for match location (Home/Away).
Research hypothesis 4: Significant relationships highlighted between Physical and Technical variables between playing positions (Defenders/ Midfielders/ Attackers)	*Null hypothesis 4:* **No** significant relationships highlighted between Physical and Technical variables between playing positions (Defenders/ Midfielders/ Attackers).

3.6 Reliability

In order to improve the accuracy and credibility of this research paper, inter- and intra-rater reliability tests have been conducted on the Technical data. This was to ensure that any human error or differences of interpretation between definitions are highlighted and resolved (O'Donoghue, 2007). Intra-rater reliability represents test that are conducted by the same observer more than once, these tests are performed in order to ensure there is a level of consistency in the researcher's data collection (Bloomfield, Polman & O'Donoghue, 2007).

Inter-rater reliability are tests that are performed by an external observer. This was done using a Cohen Kappa test. This external observer was another performance analyst working at the same club, this analyst was presented with the operational definitions allowing familiarisation with Technical events. Performing this test has shown any discrepancies between definitions to be highlighted and resolved (Thomas *et al.*, 2015). The Kappa statistic varies from 0 to 1, where:

- 0 = agreement equivalent to chance.
- 0.1 – 0.20 = slight agreement.
- 0.21 – 0.40 = fair agreement.
- 0.41 – 0.60 = moderate agreement.
- 0.61 – 0.80 = substantial agreement.

- 0.81 – 0.99 = near perfect agreement.
- 1.00 = perfect agreement.

Two levels of analysis were conducted. Firstly, the observer's ability to create the same clips per player (Table 7), secondly, testing the reliability of the variables chosen (Table 8). A sample of 3 individual player clips were selected in order to assess the reliability. These clips contained a range of 199 to 236 instances, these clips consisted of a player from each playing positions in order to test the reliability of the operational definitions. The recommended percentage of acceptable reliability being >0.80% will be used (Thomas *et al.*, 2015). If any results from the kappa receive a reliability agreement of less than 0.80% then the data will be analysed to see if these errors are a missed instance or mis-matched in the excel file. Another reason for any discrepancies could be the interpretation of the operational definitions (misunderstanding between analysts), this would result in a discussion in order to create a more accurate definition. The table below contains the intra-rater and inter-rater kappa agreement percentages for the Technical event definitions. Inter-rater and Intra-rater reliability tests will not be conducted on the Physical data collected due to the high reliability of the 10 Hz global positioning system devices (Boyd, Ball, & Aughey, 2011).

	Intra Reliability Kappa	Agreement (Y/N)	Inter Reliability Kappa	Agreement (Y/N)
Player 1	0.86	Y	0.82	Y
Player 2	0.83	Y	0.85	Y
Player 3	1.00	Y	0.93	Y

Table 7: Intra rater and inter rater kappa agreement percentage for the technical event player clips.

Performance Indicator	Intra Reliability Kappa
Pass	1
Passing Accuracy	0.9
Passing Direction	0.9
Penetrative Pass (Line Break)	1
Dribble	1
Dribble Accuracy	1
Shot	1
Shot Accuracy	1
Tackle	1
Tackle Accuracy	1
Aerial Duels	1
Aerial Duel Accuracy	1

Table 8: Intra rater kappa agreement percentage for the chosen performance variables.

4 Results

This study analysed 7 games from an under 18s English soccer academy during the 2019/2020 season. All 7 games used for analysis were all competitive fixtures consisting 7 league games. These games were selected due to the high quality of game footage for analysis and the ability to obtain the players Physical data from the individual GPS units, below is a table showing a summary of the matches used for analysis.

Opponent	Result (Win/Draw/Lose)	Home/Away	Score line
Exeter	Win	Home	3-1
Newport	Win	Home	6-0
Swindon	Win	Away	2-4
Newport	Win	Away	0-4
Oxford	Win	Home	5-2
Plymouth	Win	Home	3-0
Yeovil	Win	Home	3-0

Table 9: Summary of the 7 matches used for analysis.

4.1 Physical Indicator Differences across Match Location

A Mann-Whitney U test was used to analyse the Physical performance indicator differences across home and away games, see Table 10 for a summary of findings.

Variable	Home	Away	P Value	Significance (Y/N)
Total Distance	7582.68 (±3662.54)	7120.67 (±3666.08)	0.435	N
Total Distance 1st Half	5367.15 (±413.87)	5342.72 (±491.08)	0.769	N
Total Distance 2nd Half	3826.68 (±1536.54)	3459.25 (±1475.05)	0.306	N
Total High-Speed Distance	508.68 (±313.45)	513.42 (±339.52)	0.975	N
High-Speed Distance 1st Half	346.45 (±173.78)	344.40 (±149.48)	0.938	N
High-Speed Distance 2nd Half	251.22 (±152.21)	279.71 (±170.03)	0.463	N
Total Number of Sprints	6.48 (±5.11)	7.86 (±5.69)	0.234	N
Total Number of Sprints 1st Half	5.09 (±3.24)	5.00 (±3.71)	0.771	N
Total Number of Sprints 2nd Half	3.19 (±2.41)	4.19 (±2.60)	0.084	N
Total Accelerations	18.90 (±10.38)	22.29 (±15.07)	0.458	N
Total Accelerations 1st Half	13.29 (±4.54)	16.21 (±6.61)	0.139	N
Total Accelerations 2nd Half	9.46 (±5.40)	11.29 (±7.32)	0.345	N
Total Decelerations	48.20 (±24.10)	47.29 (±25.38)	0.984	N

Total Decelerations 1st Half	31.43 (±8.82)	33.95 (±8.48)	0.203	N
Total Decelerations 2nd Half	25.88 (±12.65)	24.25 (±11.16)	0.619	N

Table 10: Significance of physical performance indicator differences across home and away games.

The results show no significant differences were identified across the Physical key performance indicators when comparing home and away games.

4.2 Technical Indicator Differences across Match Location

A Mann-Whitney U test was used to analyse the Technical performance indicators differences across home and away games (Table 11).

Table 11: Significance of Technical passing performance indicator differences across home and away games.

Variable	Home	Away	P Value	Significance (Y/N)
Total Passes	46.52 (±23.67)	48.88 (±20.78)	0.613	N
Total Passes 1st Half	24.31 (±11.10)	31.35 (±13.40)	0.052	Y
Total Passes 2nd Half	17.02 (±11.04)	14.53 (±9.55)	0.311	N
Total Successful Passes	40.72 (±22.37)	43.42 (±20.62)	0.583	N
Total Successful Passes 1st Half	21.12 (±10.93)	28.79 (±13.51)	0.034	Y
Total Successful Passes 2nd Half	14.99 (±9.93)	12.39 (±8.58)	0.212	N

Total Unsuccessful Passes	5.04 (±3.32)	5.25 (±4.24)	0.994	N
Total Unsuccessful Passes 1st Half	3.09 (±1.72)	2.52 (±1.59)	0.165	N
Total Unsuccessful Passes 2nd Half	2.33 (±1.57)	2.72 (±1.84)	0.403	N

Table 12: Significance of passing direction performance indicator differences across home and away games.

Variable	Home	Away	P Value	Significance (Y/N)
Total FWD Passes	13.43 (±8.53)	14.83 (±8.80)	0.464	N
Total FWD Passes 1st Half	7.83 (±4.34)	9.26 (±5.48)	0.202	N
Total FWD Passes 2nd Half	5.34 (±3.96)	4.75 (±4.10)	0.277	N
Total SIDE Passes	13.14 (±17.42)	22.88 (±14.80)	0.873	N
Total SIDE Passes 1st Half	11.60 (±6.94)	15.46 (±10.07)	0.204	N
Total SIDE Passes 2nd Half	8.67 (±7.12)	6.43 (±5.52)	0.145	N
Total BACK Passes	9.19 (±6.38)	11.04 (±7.18)	0.237	N
Total BACK Passes 1st Half	5.07 (±2.77)	6.41 (±3.61)	0.217	N
Total BACK Passes 2nd Half	3.73 (±2.42)	3.90 (±2.75)	0.805	N
Total Line Breaks	5.63 (±6.04)	5.12 (±6.55)	0.333	N

Total Line Breaks 1st Half	3.59 (±2.18)	4.24 (±3.95)	0.839	N
Total Line Breaks 2nd Half	3.11 (±2.44)	2.88 (±3.21)	0.161	N

A significant difference in the total number of passes in the 1st half of games was identified: P = 0.052. This difference indicated that the total number of passes in the 1st half of games played in games played at home (24.31 ± 11.10) was significantly higher when compared to away games (31.35 ± 13.40) (P = 0.052). In addition, another significant difference could be seen in the total number of successful passes in 1st half of games: P = 0.034. Further analysis into this difference indicates that the total number of successful passes in the 1st half of games played in games played at home (21.12 ± 10.93) was significantly higher when compared to away games (28.79 ± 13.51).

Table 13: Significance of Technical defensive performance indicator differences across home and away games.

Variable	Home	Away	P Value	Significance (Y/N)
Total Tackles	4.23 (±5.41)	5.70 (±4.77)	0.031	Y
Total Successful Tackles	2.49 (±3.46)	3.79 (±3.48)	0.055	Y
Total Unsuccessful Tackles	1.58 (±3.12)	1.87 (±2.22)	0.166	N
Total Successful tackles 1st Half	1.76 (±0.82)	2.00 (±1.66)	0.734	N
Total Successful tackles 2nd Half	1.61 (±0.95)	1.92 (±1.40)	0.755	N
Total Unsuccessful tackles 1st Half	1.25 (±0.61)	1.69 (±1.35)	0.411	N
Total Unsuccessful tackles 2nd Half	1.47 (±0.91)	1.14 (±0.41)	0.626	N

Total Aerial Duels	2.38 (±2.19)	2.96 (±2.57)	0.324	N
Total Successful Aerial Duels	1.32 (±1.67)	2.13 (±2.57)	0.184	N
Total Unsuccessful Aerial Duels	1.01 (±1.42)	0.78 (±1.18)	0.583	N
Total Successful Aerial Duels 1st Half	1.72 (±1.00)	2.33 (±1.32)	0.160	N
Total Successful Aerial Duels 2nd Half	1.57 (±0.83)	1.16 (±0.41)	0.108	N
Total Unsuccessful Aerial Duels 1st Half	1.47 (±0.65)	1.54 (±0.87)	0.974	N
Total Unsuccessful Aerial Duels 2nd Half	0.96 (±0.04)	1.03 (±0.29)	0.716	N

Examination of this data highlighted a significant difference in the total number of tackles was identified: P = 0.031. Upon further analysis into this difference has indicated that the total number of tackles in home games (4.23 ± 5.41) was significantly higher when compared to games played away (5.70 ± 4.77). Another significant difference can be highlighted in the total number of successful tackles: P = 0.055. Analysis into this difference indicates that the total number of successful tackles in home games (2.49 ± 3.46) was significantly higher when compared to away games (3.79 ± 3.48).

*Table 14: Significance of Technical attacking performance indicator differences across home and away games. * denotes insufficient data to run the test.*

Variable	Home	Away	P Value	Significance (Y/N)
Total Dribbles	4.33 (±4.06)	3.46 (±4.19)	0.210	N
Total Successful Dribbles	3.79 (±3.81)	3.31 (±4.15)	0.414	N
Total Unsuccessful Dribbles	3.16 (±1.06)	0.03 (±0.17)	0.110	N
Total Successful Dribbles 1st Half	2.58 (±1.66)	2.54 (±1.85)	0.656	N
Total Successful Dribbles 2nd Half	1.56 (±0.75)	1.87 (±1.45)	0.902	N
Total Unsuccessful Dribbles 1st Half	1.47 (±1.01)	0.96 (±0.00)	0.468	N
Total Unsuccessful Dribbles 2nd Half	1.28 (±0.67)	0.00 (±0.00)	*	*
Total Shots	1.96 (±2.63)	1.56 (±1.80)	0.909	N
Total Successful Shots	0.69 (±1.33)	0.60 (±1.04)	0.944	N
Total Unsuccessful Shots	1.17 (±1.78)	0.95 (±1.60)	0.470	N
Total Successful Shots 1st Half	1.29 (±0.61)	0.95 (±1.60)	0.058	N
Total Successful Shots 2nd Half	1.34 (±0.48)	0.94 (±0.00)	0.121	N
Total Unsuccessful Shots 1st Half	1.76 (±1.05)	1.38 (±0.51)	0.228	N
Total Unsuccessful Shots 2nd Half	1.13 (±0.51)	2.06 (±0.78)	0.023	Y

A significant difference in the total number of successful shots in the 1st half of games was identified: P = 0.058. This difference indicated that the total number of successful shots in the 1st half of games played at home (0.68 ± 1.33) was higher when compared to away games (0.60 ± 1.04). Finally, a significant difference can be noted in the total number of unsuccessful shots in the 2nd half of games: P = 0.023. Analysis into this difference indicates that the total number of unsuccessful shots in the 2nd half of games played at home (1.13 ± 0.51) was significantly higher when compared to away games (2.06 ± 0.78). No other significant differences were identified across any of the other Technical key performance indicators when comparing home and away games (Table 11).

4.3 Physical Key Performance Indicator Differences across Different Playing Positions

In order to analyse the Physical key performance indicator differences across all 3 different playing positions (Defender, Midfielder, Forward) a Kruskal-Wallis H test was conducted (Table 15).

Table 15: Significance of Physical performance indicator differences across playing positions

Variable	Defender	Midfielder	Forward	P Value	Significance (Y/N)
Total Distance	7573.42 (±3709.11)	7494.02 (±3849.43)	7084.81 (±3108.11)	0.649	N
Total Distance 1st Half	5164.33 (±329.74)	5540.48 (±438.04)	5360.33 (±433.16)	0.003	Y
Total Distance 2nd Half	3817.54 (±1652.72)	3802.68 (±1558.44)	3363.47 (±1107.58)	0.379	N
Total High-Speed Distance	494.17 (±335.06)	509.96 (±327.54)	541.08 (±278.57)	0.854	N
High-Speed Distance 1st Half	334.89 (±151.91)	338.37 (±188.35)	389.92 (±126.92)	0.632	N

High-Speed Distance 2nd Half	250.61 (±177.14)	263.59 (±149.93)	265.84 (±143.43)	0.821	N
Total Number of Sprints	7.57 (±5.37)	6.16 (±5.56)	7.31 (±4.25)	0.264	N
Total Number of Sprints 1st Half	4.86 (±3.18)	5.03 (±3.77)	5.50 (±2.61)	0.706	N
Total Number of Sprints 2nd Half	3.89 (±2.83)	3.17 (±2.28)	3.40 (±2.32)	0.686	N
Total Accelerations	17.78 (±10.86)	21.00 (±12.88)	20.76 (±11.37)	0.485	N
Total Accelerations 1st Half	12.58 (±4.97)	14.88 (±5.615)	15.08 (±4.87)	0.145	N
Total Accelerations 2nd Half	8.34 (±5.84)	11.11 (±6.20)	10.12 (±5.63)	0.085	N
Total Decelerations	41.88 (±22.78)	52.00 (±25.79)	48.47 (±21.93)	0.199	N
Total Decelerations 1st Half	26.79 (±8.86)	35.66 (±8.06)	33.42 (±4.16)	<0.001	Y
Total Decelerations 2nd Half	22.39 (±11.59)	27.72 (±13.05)	24.88 (±10.03)	0.302	N

The results show a significant difference in the total distance covered by players in the 1st half of games: P = 0.003 across defender (5164.33 ±329.74), midfielder (5550.48 ±438.04) and forward (5360.33 ± 433.16) playing positions. Another significant difference was identified in the total number of decelerations in the 1st half of games: P < 0.001 across Defender (26.79 ± 8.86), Midfielder (35.66 ± 8.06) and Forward (33.42 ± 4.16) playing

positions. In order to analyse this data further, separate Mann-Whitney U tests have been conducted on the key Physical performance and the Defender, Midfielder and Forward playing positions.

4.3.1 Defender vs Midfielders

A Mann-Whitney U test was used to analyse the Physical performance indicators differences across Defenders and Midfield playing positions, see Table 16 for a summary of findings.

Variable	P Value	Significance (Y/N)
Total Distance 1st Half	< 0.001	Y
Total Decelerations 1st Half	< 0.001	Y

Table 16: Significance of Physical performance indicator differences across Defender and Midfield playing positions.

A significant difference in the total distance covered in the 1st half between Defender and Midfield playing positions was identified: P = <0.001. This difference indicated that the total distance covered in the 1st half by the Midfield playing positions was significantly higher than the total distance covered by Defenders. Another significant difference was identified in the total of decelerations in the 1st half between Defender and Midfield playing positions: P = <0.001. Further analysis into this difference indicated that the total of decelerations completed by the Midfield playing positions was also significantly higher than the total of decelerations completed by Defenders.

4.3.2 Defender vs Forwards

A Mann-Whitney U test was used to analyse the Physical performance indicators differences across Defenders and Forward playing positions, see Table 17 for a summary of findings.

Variable	P Value	Significance (Y/N)
Total Distance 1st Half	0.524	N
Total Decelerations 1st Half	0.003	Y

Table 17: Significance of Physical performance indicator differences across Defender and Forward playing positions.

A significant difference was identified in the total of decelerations in the 1st half between Defender and Forward playing positions: P = 0.003. This difference indicated that the total of decelerations completed by the Defenders was significantly higher than the total of decelerations completed by Forwards. However, no significant difference was identified in the total distance covered in the 1st half between Defender and Forward playing positions.

4.3.3 Midfielders vs Forwards

A Mann-Whitney U test was used to analyse the Physical performance indicators differences across Midfield and Forward playing positions, see Table 18 for a summary of findings.

Variable	P Value	Significance (Y/N)
Total Distance 1st Half	0.133	N
Total Decelerations 1st Half	0.178	N

Table 18: Significance of Physical performance indicator differences across Midfield and Forward playing positions.

The analysis of results from the Mann-Whitney U test found no significant differences were identified in the total distance covered in the 1st half or the total of decelerations completed between the Midfield and Forward playing positions.

4.4 Technical Key Performance Indicator Differences across Different Playing Positions

In order to analyse the Technical key performance indicator differences across all 3 different playing positions (Defender, Midfielder, Forward) a Kruskal-Wallis H test was conducted, see Table 19 for a summary of findings.

Table 19: Significance of passing performance indicator differences across playing positions.

Variable	Defender	Midfielder	Forward	P Value	Significance (Y/N)
Total Passes	54.07 (±20.08)	50.62 (±22.99)	24.42 (±10.35)	< 0.001	Y
Total Passes 1st Half	33.24 (±10.14)	26.39 (±20.08)	12.01 (±3.73)	< 0.001	Y
Total Passes 2nd Half	20.56 (±11.64)	16.29 (±9.81)	7.97 (±4.17)	< 0.001	Y
Total Successful Passes	49.21 (±19.86)	44.47 (±21.09)	18.32 (±8.14)	< 0.001	Y
Total Successful Passes 1st Half	30.58 (±10.74)	23.02 (±10.44)	9.27 (±3.79)	< 0.001	Y
Total Successful Passes 2nd Half	18.27 (±10.89)	14.09 (±8.47)	6.22 (±3.08)	< 0.001	Y
Total Unsuccessful Passes	4.02 (±3.57)	5.56 (±3.42)	6.22 (±3.82)	0.075	N
Total Unsuccessful Passes 1st Half	2.63 (±1.87)	3.25 (±1.69)	2.66 (±1.31)	0.243	N
Total Unsuccessful Passes 2nd Half	2.71 (±1.92)	2.40 (±1.69)	2.14 (±1.02)	0.816	N

Table 20: Significance of passing direction performance indicator differences across playing positions.

Variable	Defender	Midfielder	Forward	P Value	Significance (Y/N)
Total FWD Passes	17.90 (±8.20)	13.49 (±8.33)	6.90 (±4.78)	< 0.001	Y
Total FWD Passes 1st Half	11.63 (±4.41)	6.98 (±3.73)	4.18 (±2.67)	< 0.001	Y
Total FWD Passes 2nd Half	6.98 (±4.43)	4.87 (±3.65)	2.49 (±1.85)	< 0.001	Y
Total SIDE Passes	26.80 (±16.35)	24.83 (±17.71)	10.94 (±5.31)	0.001	Y
Total SIDE Passes 1st Half	16.07 (±8.62)	12.81 (±7.32)	5.54 (±2.74)	< 0.001	Y
Total SIDE Passes 2nd Half	10.35 (±8.25)	7.78 (±5.80)	3.71 (±1.98)	0.010	Y
Total BACK Passes	8.62 (±7.48)	11.64 (±6.23)	6.58 (±4.09)	0.009	Y
Total BACK Passes 1st Half	5.68 (±3.51)	6.08 (±2.88)	3.25 (±1.45)	0.025	Y
Total BACK Passes 2nd Half	3.90 (±2.83)	4.13 (±2.47)	2.51 (±1.50)	0.140	N
Total Line Breaks	7.49 (±6.09)	5.52 (±6.56)	1.50 (±2.12)	< 0.001	Y
Total Line Breaks 1st Half	4.55 (±3.09)	3.51 (±2.70)	1.68 (±0.49)	0.060	N
Total Line Breaks 2nd Half	3.65 (±2.69)	3.05 (±2.70)	1.56 (±0.93)	0.213	N

*Table 21: Significance of Technical attacking performance indicator differences across playing positions. * denotes insufficient data to run the test.*

Variable	Defender	Midfielder	Forward	P Value	Significance (Y/N)
Total Dribbles	3.12 (±3.68)	5.13 (±4.58)	3.00 (±2.63)	0.044	Y
Total Successful Dribbles	2.77 (±3.36)	4.65 (±4.43)	2.61 (±2.55)	0.051	Y
Total Unsuccessful Dribbles	0.22 (±0.57)	0.27 (±1.19)	0.13 (±0.37)	0.663	N
Total Successful Dribbles 1st Half	2.47 (±1.93)	2.75 (±1.68)	2.19 (±1.38)	0.892	N
Total Successful Dribbles 2nd Half	1.74 (±1.05)	1.61 (±0.94)	0.92 (±1.64)	0.704	N
Total Unsuccessful Dribbles 1st Half	0.98 (±0.00)	3.00 (±*)	0.95 (±1.37)	0.150	N
Total Unsuccessful Dribbles 2nd Half	1.16 (±0.45)	1.41 (±0.89)	*	0.457	N
Total Shots	0.76 (±1.24)	1.85 (±2.36)	3.91 (±3.00)	< 0.001	Y
Total Successful Shots	0.25 (±0.76)	0.52 (±1.16)	1.84 (±1.55)	< 0.001	Y
Total Unsuccessful Shots	0.48 (±0.82)	1.22 (±1.79)	1.84 (±1.55)	0.052	Y
Total Successful Shots 1st Half	1.59 (±1.05)	0.97 (±0.01)	1.30 (±0.52)	0.283	N
Total Successful Shots 2nd Half	1.49 (±0.78)	1.22 (±0.44)	1.20 (±0.43)	0.745	N
Total Unsuccessful Shots 1st Half	1.16 (±0.40)	1.39 (±0.62)	2.38 (±1.23)	0.018	Y
Total Unsuccessful Shots 2nd Half	1.20 (±0.70)	1.23 (±0.58)	1.72 (±0.82)	0.495	N

Table 22: Significance of Technical defensive performance indicator differences across playing positions.

Variable	Defender	Midfielder	Forward	P Value	Significance (Y/N)
Total Tackles	2.79 (±2.69)	6.16 (±6.52)	4.10 (±3.15)	0.016	Y
Total Successful Tackles	1.82 (±2.01)	3.78 (±4.41)	2.36 (±2.11)	0.067	N
Total Unsuccessful Tackles	0.82 (±1.34)	2.26 (±3.69)	1.66 (±2.14)	0.067	N
Total Successful tackles 1st Half	1.63 (±0.99)	2.11 (±1.31)	1.50 (±0.70)	0.237	N
Total Successful tackles 2nd Half	1.43 (±0.66)	2.02 (±1.38)	1.34 (±0.65)	0.271	N
Total Unsuccessful tackles 1st Half	1.23 (±0.62)	1.64 (±1.15)	0.96 (±0.02)	0.053	Y
Total Unsuccessful tackles 2nd Half	1.06 (±0.35)	1.60 (±1.01)	1.19 (±0.47)	0.170	N
Total Aerial Duels	3.64 (±2.56)	2.08 (±2.04)	1.72 (±1.74)	0.005	Y
Total Successful Aerial Duels	2.79 (±2.45)	1.07 (±1.40)	0.51 (±1.08)	< 0.001	Y
Total Unsuccessful Aerial Duels	0.82 (±0.80)	0.93 (±1.59)	1.20 (±1.53)	0.521	N
Total Successful Aerial Duels 1st Half	2.22 (±1.27)	1.57 (±0.79)	0.97 (±0.01)	0.223	N
Total Successful Aerial Duels 2nd Half	1.68 (±0.84)	1.12 (±0.36)	0.93 (±0.01)	0.058	Y
Total Unsuccessful Aerial Duels 1st Half	1.20 (±0.41)	1.94 (±0.90)	1.44 (±0.52)	0.218	N
Total Unsuccessful Aerial Duels 2nd Half	0.97 (±0.39)	0.94 (±0.02)	1.12 (±0.37)	0.040	Y

The Kruskal-Wallis H test highlighted significant differences across the 3 playing positions in a variety of Technical performance indicators (Table 19). In order to analyse this data further, separate Mann-Whitney U tests have been conducted on the key Technical performance indicators across Defender, Midfielder and Forward playing positions.

4.4.1 Defender vs Midfielders

The Technical performance indicators differences across Defender and Midfield playing positions, see Table 23 for a summary of findings.

Variable	P Value	Significance (Y/N)
Total Passes	0.187	N
Total Passes 1st Half	0.021	Y
Total Passes 2nd Half	0.063	N
Total Successful Passes	0.136	N
Total Successful Passes 1st Half	0.012	Y
Total Successful Passes 2nd Half	0.059	N
Total FWD Passes	0.005	Y
Total FWD Passes 1st Half	< 0.001	Y
Total FWD Passes 2nd Half	0.015	Y
Total SIDE Passes	0.513	N
Total SIDE Passes 1st Half	0.136	N
Total SIDE Passes 2nd Half	0.242	N
Total BACK Passes	0.040	Y
Total BACK Passes 1st Half	0.427	N
Total Line Breaks	0.098	N
Total Dribbles	0.019	Y
Total Successful Dribbles	0.026	Y
Total Tackles	0.006	Y
Total Unsuccessful tackles 1st Half	0.195	N

Total Aerial Duels	0.004	Y
Total Successful Aerial Duels	0.001	Y
Total Unsuccessful Aerial Duels 2nd Half	0.085	N
Total Shots	0.011	Y
Total Successful Shots	0.072	N
Total Unsuccessful Shots	0.066	N
Total Unsuccessful Shots 1st Half	0.321	N

Table 23: Significance of technical performance indicator differences across Defender and Midfield playing positions

The results from the Mann-Whitney U test showed that 12 out of the 26 Technical performance indicators tested showed a significant difference was identified between the Defender and Midfielder playing positions (Table 23) .Upon analysis into these differences, it was seen that all 12 of the key performance indicators was significantly higher by the Midfielders when compared to the Defenders.

4.4.2 Defender vs Forwards

The Technical performance indicators differences across Defender and Forward playing positions, see Table 24 for a summary of findings.

Variable	P Value	Significance (Y/N)
Total Passes	< 0.001	Y
Total Passes 1st Half	< 0.001	Y
Total Passes 2nd Half	< 0.001	Y
Total Successful Passes	< 0.001	Y
Total Successful Passes 1st Half	< 0.001	Y
Total Successful Passes 2nd Half	< 0.001	Y
Total FWD Passes	< 0.001	Y
Total FWD Passes 1st Half	< 0.001	Y
Total FWD Passes 2nd Half	< 0.001	Y

Total SIDE Passes	< 0.001	Y
Total SIDE Passes 1st Half	< 0.001	Y
Total SIDE Passes 2nd Half	0.003	Y
Total BACK Passes	0.637	N
Total BACK Passes 1st Half	0.069	N
Total Line Breaks	< 0.001	Y
Total Dribbles	0.733	N
Total Successful Dribbles	0.724	N
Total Tackles	0.098	N
Total Unsuccessful tackles 1st Half	0.193	N
Total Aerial Duels	0.009	Y
Total Successful Aerial Duels	< 0.001	Y
Total Unsuccessful Aerial Duels 2nd Half	0.082	N
Total Shots	< 0.001	Y
Total Successful Shots	< 0.001	Y
Total Unsuccessful Shots	0.026	Y
Total Unsuccessful Shots 1st Half	0.011	Y

Table 24: Significance of Technical performance indicator differences across Defender and Forward playing positions.

The results from the Mann-Whitney U test showed that 19 out of the 26 Technical performance indicators tested showed a significant difference was identified between the Defender and Forward playing positions (Table 24). From these 19 significant results, Defenders were significantly higher than Forwards in 18. A significant difference was identified in the total of unsuccessful shots in the 1st half between Defender (1.16 ± 0.40) and Forward (2.38 ± 1.23) playing positions: P = 0.011. Analysis into this difference indicated that the total of unsuccessful shots in the 1st half completed by the Forwards was in fact higher than the total of unsuccessful shots in the 1st half completed by Defenders; this was the only one of these performance indicators to show this finding.

4.4.3 Midfielders vs Forwards

The Technical performance indicators differences across Midfield and Forward playing positions, see Table 25 for a summary of findings.

Variable	P Value	Significance (Y/N)
Total Passes	< 0.001	Y
Total Passes 1st Half	< 0.001	Y
Total Passes 2nd Half	0.001	Y
Total Successful Passes	< 0.001	Y
Total Successful Passes 1st Half	< 0.001	Y
Total Successful Passes 2nd Half	< 0.001	Y
Total FWD Passes	0.001	Y
Total FWD Passes 1st Half	0.029	Y
Total FWD Passes 2nd Half	0.009	Y
Total SIDE Passes	0.001	Y
Total SIDE Passes 1st Half	0.001	Y
Total SIDE Passes 2nd Half	0.024	Y
Total BACK Passes	0.003	Y
Total BACK Passes 1st Half	0.005	Y
Total Line Breaks	0.003	Y
Total Dribbles	0.122	N
Total Successful Dribbles	0.101	N
Total Tackles	0.311	N
Total Unsuccessful tackles 1st Half	0.023	Y
Total Aerial Duels	0.609	N
Total Successful Aerial Duels	0.068	N
Total Unsuccessful Aerial Duels 2nd Half	0.102	N
Total Shots	0.006	Y
Total Successful Shots	< 0.001	Y

Total Unsuccessful Shots	0.298	N
Total Unsuccessful Shots 1st Half	0.028	Y

Table 25: Significance of Technical performance indicator differences across Midfield and Forward playing positions.

The results from this Mann-Whitney U test showed that 19 out of the 26 Technical performance indicators tested showed a significant difference was identified between the Midfielder and Forward playing positions (Table 25). Upon further analysis into these differences, it was seen that all 19 of the key performance indicators that showed significance were significantly higher by the Midfielders when compared to the Forwards.

5 Discussion

The intention of this study was to understand the effect of contextual factors such as playing position and match location on under 18s youth soccer Physical and Technical match performance indicators. The under 18s team of a professional football club is an important stage of a club's academy due to the players being regularly assessed to see if players can make the step up to the professional first team, be sold to clubs to make money or released from their youth contract. The lack of research into this age group is therefore surprising with previous research primarily focusing on comparisons between the physical and technical performance of under 18 players and the more developed first team players. There is a clear lack of research into the understanding of match demands in this age group. As stated previously it is vitally important for clubs to get these decisions right with around 180 of the 1.5 million males who play organised youth football in England becoming a professional player in the Premier League a success rate of just 0.012% (Calvin, 2017). Furthermore, out of all the males who enter a soccer academy at the age of 9, less than half of 1% make it to, or make a living from, the game at any professional level (Calvin, 2017).

Furthermore, the due to the lack of understanding of match demands of this age group, this results from this study will provide coaches with insights to true match demands within elite youth soccer match performance, allowing these factors to be considered when planning and implementing training sessions. The results from this study indicate significant differences in both Physical and Technical performance across match location and playing positions. The results from this study show similarities in physical performance of this under 18s team when compared to under 18 sides from other research papers (Rampinini et al. 2009; Carling & Dupont, 2011, Russell, Benton, & Kingsley, 2011). However, there are large differences in the technical performance of this under 18s teams when compared to other teams from the same age group. This could be due to the impact of the clubs playing philosophy on this data as well as the potential influence of teams different playing formations. Therefore, it can be suggested that the physical results from this study can be generalised across other under 18s teams whereas the technical performance cannot be generalised towards other teams from the same age group.

5.1 Physical and Technical Performance Indicators Differences across Match Location

In previous research the physical demands of a game have been described as a combination of brief high intensity actions with long periods of low intensity running (Buchheit, Mendez-Villanueva, Simpson, & Bourdon, 2010; Bradley & Noakes, 2013; Paul, Bradley, & Nassis, 2015). Studies analysing physical match profiles in under 18 age groups has shown that running performances were lower than elite players. Specifically, the total distance covered by players was 8.867km ± 0.859km and high intensity running 0.976km ± 0.240km (Buchheit et al. 2010). When these results are compared to the results of this study results which found the total distance covered by players was 7582.68 km (±3662.54 km) during home games and 7120.67 km (±3666.08 km) during away games. Furthermore, the high intensity running of the players in this study was 0.508 km (± 0.313 km) during home games and 0.513 km (± 0.339 km). Studies analysing Physical and Technical variables across match play have previously been investigated with differing results (Rampinini et al. 2009; Carling & Dupont, 2011). One study by Rampinini et al. (2009) discovered declines in three Technical indicators (involvements with the ball, short passes and successful short passes) from the first to the second half. Rampinini et al. (2009) also discovered differences in Physical indicators as well with total distance and high intensity running being higher in the first half rather than the second half. Their study also observed a reduction in short passes and short pass accuracy and physical declines in high intensity running (HIR) and total distance (TD) across halves. However, neither study by Rampinini et al (2009) or Carling & Dupont (2011) accounted for the effects of situational variables. Therefore, the physical and technical results from these studies did not compare the differences between performance indicators across home and away games.

The findings in the Physical performance within the current study are surprising when compared to the results of previous studies by Rampinini et al. (2009) and Carling & Dupont (2011). More specifically the study by Carling & Dupont (2011) found physical declines in high intensity running and total distance across both the 1st half and 2nd half but did not look into the affects that match location may play on these performance indicators. The results

in this study showed no significant differences were identified across the Physical performance indicators when comparing home and away games.

An explanation of this finding could be due to the method in which data was collected. Due to this data being collected in tournament conditions, its plausible that Tactical performance factors, and current match status (winning, drawing, losing), are likely to interact with Physical performance variables (Rampinini et al. 2009; Carling & Dupont, 2011; Bradley et al. 2013; Bush et al. 2015; Paul et al. 2015). Bloomfield et al. (2005) specifically investigated match status and the effects of this situational variables on team strategies found that match status has been considered to directly impact the tactical approach of a team (Bloomfield et al. 2005). This provides further evidence of the influence of situation variables such as tactics and match status on Physical performance indicators. A further explanation of this finding could come from sample size of the data with 5 of the 7 games used for analysis being home games. This creates an imbalance meaning it is more likely find an increase in data from home games due to there being more of this data being used in this, this finding would be more highly significant if the balance of home and away games was equal.

All of the Technical performance indicators from this study that showed a significant difference in results were all significantly higher at home games rather than away games. More specifically this study found the total number of passes in the 1st half of home games: P = 0.052 and the total number of successful passes in 1st half of home games: P = 0.034, was significantly higher when compared to away games. Previous research has established that adult players complete higher total passes and successful passes in match play when compared to under 18s players (Rampinini et al. 2009). Therefore, one explanation for these differences in results could be due to the methodological differences between the Rampinini et al. (2009), Carling & Dupont, (2011) and this current study. This is because both the Rampinini et al. (2009) and Carling & Dupont, (2011) studies used adult professional players as their sample. It could therefore be argued that the group of academy players (under 18) used in the current study have not reached their full ability when executing these technical skills whilst under fatigue (Mooney et al. 2011; Owen, Wong, Paul & Dellal, 2014). Rampinini et al (2009) and Carling & Dupont (2011) identified that there was

a reduction in passes throughout the match, however these studies did not consider the influence that match location may have on these performance variables. Extending on the work of Rampinini et al (2009) and Carling & Dupont (2011) the results from this study suggest there is an influence of home field advantage on these games with significantly more 1st half total number of passes (P = 0.052), and 1st half total number of successful passes (P = 0.034), at home rather than away.

The current study found that defensive variables and their accuracy had significant differences across home and away games, with the total number of tackles (P = 0.031) and the total number of successful tackles (P = 0.055) being significantly higher during home games. In addition, the current study found that attacking variables such as the total number of successful shots in the 1st half of home games (P = 0.058) and the total number of unsuccessful shots in the 2nd half of home games (P = 0.023) was significantly higher. Similar findings were reported by one study conducted by Russell et al. (2011) who identified reductions on shooting accuracy when analysing under 18s academy players. However, this study obtained through a match simulation environment rather actual match play so was not influenced by situation variables such as match location.

A majority of research into the Technical performance of players has centred around goal scoring. This an understandable area of research due to the number of goals scored by teams being the ultimate decider of the game (Janković, Leontijević, Pašić, & Jelušić, 2011). Nevertheless, despite the obvious importance of goals in relation to soccer match performance they still contribute to a very small part of the game therefore limiting the overall knowledge of technical interactions in soccer match performance (Lepschy, Wäsche, & Woll, 2018). However, previous research has suggested that the frequency of attacking variables is considerably higher during a match simulation drill when compared to match play (Carling & Dupont, 2011). This is because in match play large durations of the playing time is based around building up to these moments, therefore the frequency of such events would be low (Carling & Dupont, 2011). Therefore, in the results of this study the frequency of attacking variables would be much lower when compare to the Carling & Dupont (2011) study due to the data in this research being collected through match play.

Overall the results from this study found that there is clear evidence of the effect of match location especially on the Technical performance indicators in under 18s soccer match performance. There is a consistent finding with a clear supporting evidence that "home field advantage" is a factor across performance variables when playing at home. This phenomenon that has been analysed by previous studies by Almeida et al (2014) and Liu et al (2016). These research papers changes were observed in the playing style of a team and the behavioural level of players when playing in games at home. Furthermore, several studies have suggested that the quality of the team affects the degree of home field advantage obtained in sport (Schwartz and Barsky, 1977; Madrigal and James, 1999; Lago-Peñas, 2009; Lago-Peñas and Lago-Ballesteros, 2011). This could explain the inconsistent findings in this study with no Physical performance indicators and only some Technical performance indicators showing influence of home field advantage. This could be due to a variety of other factors situational variables and factors that contribute to overall team performance such as team tactics, team selection as well as player psychology, all areas that should be consider for further research.

However, further evidence of "home field advantage" is suggested in the higher frequency of Technical performance indicators especially in the first half of home games. This suggests teams playing at home attempt to dictate the game in the first half with higher total passes and successful passed. In addition, this study suggests in games played at home, the home side are more aggressive in there defending performance variables by completing more tackles and having more successful tackles in home games. This highlights the desire to enforce tactical superiority in the opening stages of a match (Akenhead et al. 2013; Russell et al. 2016). This is further evidenced by the attacking performance variables with a greater number of successful shots in the 1st half of home games and the total number of unsuccessful shots in the 2nd half of home games. These findings are supported by a study from Liu et al. (2016) who identified that teams playing at home had a higher frequency in passes, shots, shots on target and assists when compared to playing away from home as well as noting increases in these variables during the 1st half games. This suggests that the phenomenon of home field advantage is present during under 18s soccer performance.

5.2 Physical Performance Indicators differences across Playing Positions

This current study follows on from previous research papers in analysing the Physical key performance indicators across various playing positions (Bradley et al., 2011; Carling, 2011; Di Salvo et al., 2007). Di Salvo et al. (2007) found that players in Midfield covered more total distance when compared to players in Defence and Forward playing positions. This results from the current study reported similar findings to Di Salvo et al. (2007) with significant differences between Defender and Midfield playing positions in the total distance covered in the 1st half ($P < 0.001$) and total of decelerations in the 1st half ($P < 0.001$). However, there were no difference between the Defender vs Forward and Midfield vs Forward playing positions, differing from the results presented by Di Salvo et al. (2007).

The reasoning for these findings can be due to the desire to enforce tactical superiority in the opening stages of a match (Akenhead et al. 2013; Russell et al. 2016). This implies that teams look to impose themselves on the opposition by having more possession and being more attacking therefore players in the more advance positions are likely to cover a greater distance. These results may show the influence of the teams playing formation and playing philosophy during these games with Midfield players covering more total distance and completing more decelerations due to the tactical instructions given to these players by the coach.

A significant difference was identified in the total of decelerations in the 1st half between Defender and Forward playing positions ($P < 0.001$), this further strengthens the desire of teams to enforce tactical superiority in the opening stages of a match (Akenhead et al. 2013; Russell et al. 2016). Explanations for this finding are hard to explain due to a lack of game context from the GPS derived accelerations and decelerations. A sudden acceleration of a player could be due to the regaining of possession high up in the field and Midfielders accelerating to join in the counterattack. Decelerations could be the result of sudden stop to press a player, a tackle or an injury and this information is lacking from the data collection. If these contexts were provided it could provide reasoning into why the findings of this study, saw the total decelerations being higher Midfielders when compared to Defenders and why

the number of decelerations is higher in Defenders rather than Forward playing positions. This highlights the need for more research into both accelerations and decelerations within under 18s soccer match performance.

Finally, the results from this study found that no significant differences were identified in the total distance covered in the 1st half or the total of decelerations completed between the Midfield and Forward playing positions. This finding is supported by research conducted by Carling et al. (2011), who reported a similar no significant differences being identified between the Midfield and Forward playing positions. However, this study used a different methodological approach with a significantly larger sample of 45 games being analysed. Furthermore, the study by Carling et al. (2011) used games over the period of three seasons from the highest soccer division in France, using a computerised multi camera tracking system methodology. The aim of the study was to analyse the effect of playing formation on the physical demands of soccer players.

5.3 Technical Performance Indicators differences across Playing Positions

This current study follows on from previous research papers in analysing the Technical key performance indicators across various playing positions (Bradley et al., 2011; Carling, 2011). The research conducted by Carling et al. (2011), analysed 45 games over the period of three seasons from the highest soccer division in France. The aim of the study was to analyse the effect of playing formation and positions on the physical demands of soccer players. The Physical performance indicators used in this study were total distance, high intensity running (14.4-19.7 kmh^{-1}) and very high intensity running (>19.8 kmh^{-1}). The Technical indicators used in this study consisted of the number of passes as well as the number of touches per possession. The results of this study concluded that the playing formation of the opposition had little to no impact on the reference team's Physical performance indicators (Carling et al., 2011). However, there were differences in the skill-demands according to the opponent's formation that may have applications in the technical and tactical preparation of teams.

Furthermore, the study by Bradley et al. (2011) analysed the effects of 3 different team formations and how they impacted on the technical performance and high intensity running of players. Three playing formations were selected for analysis 4-3-3, 4-5-1 and 4-4-2. In total 20 games form the English Premier League were analysed. The results from this study found that between these 3 playing formations the high intensity running and ball possession time did not change. On the other hand, across different playing positions in the playing formations it was found that attackers in a 4-3-3 had an increase in high intensity running when compared to the attackers in a 4-4-2 or 4-5-1 playing formation (Bradley et al., 2011). This study has shown that in youth soccer there is highly significant differences throughout various Technical performance indicators across the 3 playing positions that were analysed, these positions were Defender, Midfield and Forward. These findings have been broken down into the subsections below.

5.3.1 Defender vs Midfielders

When comparing Defenders and Midfield playing positions this study found that 12 out of the 26 Technical performance indicators tested selected for analysis showed a significant difference between the Defender and Midfielder playing positions (Table 23) . Analysis into these findings found that total passes in the 1st half (0.021), total successful passes in the 1st half (0.012), forward passing as well as attacking variables and their accuracy were all significantly higher by the Midfielders when compared to the Defenders. This finding is supported by previous research, with a study by Carling et al. (2011) stating there are clear differences in skill demands across playing positions. This due to positioning of player defenders being responsible for not conceding so are therefore more likely to train defensive and forwards being more likely to train offensive skills such as shooting.

However, there were some new findings in relation to defensive variables differing to Carling et al. (2011) work. This study found that total tackles (0.006), total aerial duels (0.004) and total successful aerials duels (0.001) were all significantly higher for the Midfielders than Defenders. Typically, in this under 18s team and the club playing philosophy the Defender playing positions seem to have focused more defensively focused roles and positions taken up by the Defenders in the playing formation. Furthermore, this finding was not found previously by Carling et al. (2011) who showed that defensive

variables were higher in relation to Defenders rather than Midfielders or Forwards. A rationale for this finding is that the although studies have looked to incorporate Technical variables in their studies, bias has been observed towards attacking Technical variables compared to defensive. The use of defensive performance indicators within soccer match performance is still a scarcely researched area especially in relation to youth soccer, with only few studies analysing tackles, duels and aerial duels (Bekris *et al.* 2014; Liu *et al*. 2015; Mao *et al.* 2016). In addition, another explanation could from the differing of samples of playing positions being used in this study. In total 19 players were used across the 7 games selected for analysis with examinations being made from a total N= 6 Defenders, N=9 Midfielders and N=4 Forwards. This further highlights the need for greater research into defensive performance indicators with a sample that can be generalised, unlike this current study.

5.3.2 Defender vs Forwards

The results from this study found that when comparing Defender and Forward playing positions that 19 out of the 26 Technical performance indicators tested showed a significant difference was identified between the Defender and Forwards playing positions. Upon examination of these differences, it was seen that all 18 of the 19 performance indicators was significantly higher by the Defenders when compared to the Forwards.

These findings found that, total passes, total passes 1st half & 2nd half, total successful passes, successful passes 1st half & 2nd half, forward passing, side passing as well as defensive variables were all significantly higher for Midfielders than Defenders. This finding was expected due to the more defence orientated nature of the defender playing position. This suggest further evidence that they are clear differences in skill demands across playing positions (Carling et al, 2011). It was also expected for the Defenders to have more possession of the ball and this can be seen through the higher number of total passes and successful passes across both halves of the game.

An explanation for this finding comes from the roles and responsibilities of the Forward playing position during match play. The primary role of the Forward is to be involved the more advanced areas of the pitch, so it is therefore expected for this position to have higher

ranks in attacking key performance indicators such as shots (Carling et al, 2011). Furthermore, the tactical influence and match status of the games could also explain this significant as the majority of a match is based around building up to these attacking moments therefore the frequency of such events would be low (Carling & Dupont, 2011). However, when analysing the attacking variables this study found that the total of unsuccessful shots in the 1st half (P = 0.011), was significantly higher by Forwards than Defenders. This further supports the theory by Carling et al (2011) that the primary concern of the Forward is to be involved the higher up areas of the pitch, so it is therefore expected for this position to have higher ranks in attacking key performance indicators such as shots. However, from the results in this study this was the only one of the attacking key performance indicators to show this finding.

Other attacking variables selected in this study it was found total shots (< 0.001), total successful shots (< 0.001) and total unsuccessful shots (0.026) were all significantly higher by the Defenders when compared to the Forwards. This was an unexpected finding for this study, with the more defensively focused roles and positions taken up by the Defenders in the playing Formation. A rationale for this finding could from the sample of data used in this current study. In total, 19 players were used across the 7 games selected for analysis with examinations being made from a total N= 6 Defenders, N=9 Midfielders and N=4 Forwards. This shows a clearer unbalanced sample size with more Defenders than Forwards being used in the study. It could therefore be suggested that these two extra players could account for the increased number of attacking variables seen by Defenders especially due to the low frequency of these attacking events (Carling & Dupont, 2011). This highlights the need for further research into the Physical and Technical performance indicators of youth soccer players especially when comparing difference in these performance variables across playing positions, with a more even sample of players being used in order to provide future studies with a clear understanding of performance differences.

5.3.3 Midfielders vs Forwards

The final playing positions analysed and compared in this current study were the Midfield and Forwards. The results from this study found that when comparing these playing positions that 19 out of the 26 Technical performance indicators tested showed a significant

difference was identified between the Midfielder and Forward playing positions. Upon further analysis into these differences, it was seen that all 19 of the key performance indicators that showed significance were significantly higher by the Midfielders when compared to the Forwards.

When analysing these findings found that total passes, total passes 1st half (< 0.001) & 2nd half (0.001), total successful passes (< 0.001), successful passes 1st half (< 0.001) & 2nd half (< 0.001), forward passing, side passing, back passing as well as attacking and defensive variables were all significantly higher by the Midfielders when compared to the Forwards. This finding was expected due to the more defence orientated positioning and creative roles taken on by the Midfield playing position when compared to Forwards. This finding provides further support to previous research that there are differences in skill demands across playing positions (Carling et al. 2011). It was therefore expected for the Midfielders to have more possession off the ball and be more defensive this can be seen through the higher number of total passes, successful passes across both halves of the game, line breaks and tackles.

Previous work by Carling et al (2011) has stated that the role and requirements of the Forward position within match play is to be involved the more advanced areas of the pitch, so it is therefore expected for this position to have higher ranks in attacking key performance indicators. Therefore, an unexpected finding from the current study can be seen in the attacking variables when comparing these two playing positions. This is because the total shots, total successful shots and total unsuccessful shots in the 1st half were all significantly higher by the Midfielders when compared to the Forwards. No significant difference was highlighted between Midfielders and Forwards in relation to the total unsuccessful shot's key performance indicator. This was an unusual finding and is not supported by previous research. This could also be due to the clubs playing philosophy with forwards remaining higher up the pitch regardless of being in or out of possession.

A rationale for these findings may come from the influence of tactics and playing formation. The team's formation did not change throughout the 7 analysed matches used for analysis in this, with a 4-4-1-1 formation being used in all games. The clubs playing philosophy did

not alter with the same key principles being used throughout the analysed game however considerations must be made for tactical adjustments made by the coaches which may have varied from game to game depending on the opponent. This is further supported by a previous study by Carling et al. (2011) analysed the effects of 3 different team formations and how they impacted on the Technical performance. Three playing formations were selected for analysis 4-3-3, 4-5-1 and 4-4-2 across the 22 games from the English Premier League. Overall, this study found that between 4-4-2, 4-3-3 and 4-5-1 playing formations the ball possession time did not change. However, there was a 22% reduction was evident in the number of passes per player in the second half compared with the first half in a 4–4–2 system. The percentage of successful passes was highest in a 4–4– 2 formation compared with 4–3–3 and 4– 5–1 formation. Furthermore, players in 4–4–2 (P 5 0.01) and 4–3–3 (P 5 0.05) formations received more passes than those in a 4–5–1 formation. On the other hand, across different playing positions in the playing formations it was found that attackers saw a reduction in Technical variables (Carling et al., 2011). However, there is a need for further research into the Physical and Technical performance indicators of youth soccer players especially when comparing difference in these performance variables across playing positions.

5.4 Practical Applications

This study provides insight into the Physical and Technical differences across time periods during under 18s youth soccer match performance, it is also the first study of its kind to analyse the impact contextual factors such as playing position and match location has on these performance variables during under 18s soccer match performance.

One of the key findings from this study are that is some clear evidence highlighting influence of home field advantage in the results of this study. The results from this studied showed there is some influence of match location on the Technical key performance indicators from this study, with significant differences being found in 5 key performance indicators. However, this study found there was no significant differences the Physical performance indicators across home and away. As result it can be suggested that match location does

have an influence on the Physical and Technical performance indicators of under 18s players however, it cannot be full assumed this is a direct result of match location. This due to the influence of further situational variables such as playing formation, match tactics and match status may have had on these results. Furthermore, with this being a single team study it is unclear whether these situational variables would affect all under 18 teams to the same level. This is due to the influence of different club playing philosophies, quality of players, preparation of players as well as differences in the quality of coaches and services available to players depending on their academies EPPP category.

Another key finding for this study was the influence of playing position of the Technical and Physical performance indicators of players. Significant differences were identified when comparing the performance indicators across Defender, Midfielder and Forward playing positions. Therefore, it can be implied that playing position does have an influence on the Physical and Technical performance indicators of under 18s players however, it cannot be full assumed that these significant differences were direct result of playing position. These results were also influence by other situational variables such as playing formation, match tactics and match status. Furthermore, the influence of the clubs playing philosophy has played a significant role in these results. This is due to the roles and responsibilities given to the different groups of players in the teams playing formation a 4-4-1-1 system. As result of this it is difficult for comparisons to be made with other under 18s due to the differences in each teams and clubs playing philosophy.

Overall, the findings and results from this study will allow for training sessions at this club to be tailored directly to team needs at particular times of a match providing a more focused approach of when and where players need training to cope with the demands of soccer match performance. Highlighting the effects of situational variables may be specifically beneficial from an individual player standpoint for example, highlighting that player X's pass success is higher in games played at home rather than away games could point to the player being highly influenced psychologically at away games. Furthermore, if the Midfielders total distance covered within the second half of match is lower than that of the Forwards this will provide coaches, and fitness coaches with the information to individualise training for

player X, providing them with similar situations in training to help them cope with match demands.

5.5 Future Considerations

As stated previously one of the main issues with this current study comes from the sampling of players used, this comes down to impact of the Coronavirus pandemic on this research. Due to the effects of Covid-19, a total 19 players were used across the 7 games selected for analysis with examinations being made from a total N= 6 Defenders, N=9 Midfielders and N=4 Forwards. This shows a clear unbalanced sample size with an uneven number of more Defenders, Midfielders and Forwards being used in the study. Therefore, further research should be conducted with a more even sample in order to gain a greater understanding into the Physical and Technical differences across time periods during under 18s youth soccer match performance as well as the impact contextual factors on these variables. This would consist of using the same number of players across the 3 playing positions and increase the number of games used for analysis in order to gain further insight into the true impact of situation variables on under 18s soccer match performance.

In addition, more situational variables should be assessed in order to determine the impact of these factors on both Physical and Technical performance indicators. This would include assessing the impact of match status (winning/losing/drawing) a finding that would have been shown in this thesis if it remained unaffected by Covid-19. Further assessment should take place on the impact of tactics on key performance indicators especially in regards playing formation of both teams. Another issue with the current study was the merging of Technical variables into attacking and defensive categories, this is due to the large number of events within the 45-minute halves when analysed individually. It could therefore be recommended that game should be spilt down into shorter 15-minute time periods in order to gain a more accurate insight into how the performance indicators change from one period to another. This was the methodologically approach that was to be taken by this study before the effects of the Coronavirus pandemic.

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