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USE OF THESIS

ABSTRACT

The physical and technical requirements of a range of small-sided football (soccer) games (SSGs) have previously been examined in order to compare their requirements to competitive match play. SSGs are used to combine the technical, tactical and physical components of normal match play in training in order to make the training sessions specific to football. However, most previous research has focused on youth players and it is known that the playing patterns, and thus session outcomes, are different for elite players. Consequently, research examining elite players is required in order to improve our understanding of the use of SSGs in professional football. The present body of research was implemented to investigate the physical, physiological and perceptual demands of SSGs (3v3 [i.e. three players on each of two teams], 6v6 and 8v8) over an entire season's training and compare these demands to match play in twenty-three players of different playing position from an Australian A-League club. During match play the team adopted a modern 1-4-2-3-1 formation. The physical comparison included the following measurements: total distance (m), distance covered in high velocity running (speed > 4.16 $m \cdot s^{-1}$), total sprint distance (where speed > 6.93 $m \cdot s^{-1}$), number of repeated sprints efforts (≥3 sprints with <30-s inter-sprint recoveries), number of sub-maximal accelerations (acceleration > 1.79 $m \cdot s^{-2}$) and number of maximal accelerations (acceleration > 2.79 $m \cdot s^{-2}$). These were measured with the use of Global Positioning Systems. The physiological load was characterised as the mean heart rate expressed as a percentage of maximum heart rate (% HR_{max}), measured using heart rate monitors. Perceptual comparisons were made using each player's Rating of Perceived Exertion (RPE) using the modified Foster model (0-10 scale). Significant differences were found among SSGs and match play in regards to physical variables, with SSGs eliciting a greater physical demand on

players when compared to match play, for all variables except sprint distances. Furthermore, there were numerous large and moderate effect sizes discovered among playing positions, with wide midfielders and fullbacks typically producing the greatest number of high velocity runs, covering greater sprint distances and performing more repeated sprint efforts (RSE) during SSGs and match play. Central midfielders were found to cover the greater total distance and perform more sub-maximal accelerations, which would suggest they cover the greatest amount of distance at a moderate intensity. Finally, it was found that SSGs play a vital role in position specific training in football (with the addition of goalkeepers) and suggests that the demands on players are relative to match play. Although, additional drills are required to perform a greater number of high intensity efforts.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution or higher education;

(ii) contain any material published or written by another person except where due reference is made in the text; or

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ABBREVIATIONS

ANOVA	Analysis of Variance
BPM	Beats Per Minute
CB	Centre-backs
CM	Central Midfielders
ES	Effect Size
FB	Fullbacks
FIFA	The Fédération Internationale de Football Association
GPS	Global Positioning System
HR	Heart Rate
HR_{max}	Heart Rate Maximum
Hz	Hertz
ICC	Intraclass Correlation Coefficient
MANOVA	Multivariate Analysis of Variance
RHIE	Repeated High Intensity Efforts
RPE	Rating of Perceived Exertion
RSA	Repeated Sprint Ability
RSE	Repeated Sprint Efforts
SD	Standard Deviation
SSG	Small-Sided Game
ST	Strikers
TMA	Time –Motion Analysis
WM	Wide Midfielders
VO_2	Oxygen Uptake
% HR_{max}	Percentage of Heart Rate Maximum

DEFINITIONS

Total Distance	The total distance in metres (m) covered by players
High Velocity Distance	The total distance in metres (m) covered by players at a high velocity (speed > 4.16 $m \cdot s^{-1}$)
Sprint Distance	The total distance in metres (m) covered by players at (near) maximal velocity (speed > 6.93 $m \cdot s^{-1}$)
Repeated Sprint Efforts	The total number of repeated sprint efforts completed/performed by players. Defined as 3 or more sprints with an inter-sprint recovery time of 30 s or less (≥3 sprints with <30-s inter-sprint recoveries)
Sub-Maximal Accelerations	The rate of change of velocity at a sub-maximal speed (acceleration > 1.79 $m \cdot s^{-2}$)
Maximal Accelerations	The rate of change of velocity at a maximal speed (acceleration > 2.79 $m \cdot s^{-2}$)
% Heart Rate Maximum	The percentage of the player’s maximum heart rate (max. working heart rate / maximum heart rate × 100)
Rating of Perceived Exertion	A self-assessment scale (0-10) to rate fatigue during exercise. Using the modified Fosters model.

CHAPTER 1

1.0 INTRODUCTION

1.1 Background to Study

Football coaches at all levels of the game use small-sided games (SSGs) as a way of developing a team's technical and tactical skills (Jones & Drust, 2007) whilst imposing a specific physiological demand that exceeds that of a competitive game (Hill-Haas, Dawson, Coutts & Roswell, 2009; Impellizzeri, Marcora, Castagna, Reilly, Sassi & Iaia, 2006). SSGs can be manipulated through the use of various modifications that affect the physical, physiological and technical demands of the players. These modifications include, but are not limited to, the pitch size, the number of players involved, the game's rules and playing time (Dellal, Lago-Penas & Chamari, 2011). The benefit of SSGs is that they provide players with a relatively comparable experience of competitive match play situations, with the differences being that fewer players are involved, a smaller playing area is used and specific alterations or rules changes can be made that are particular to the team's playing formation or tactics (Little, 2009). More importantly, the aim of SSGs is to provide more touches of the football and a greater number of high velocity running bouts and accelerations than match play in order to improve physical capacity whilst skills are trained. Therefore, monitoring of players is needed in SSGs to ensure that a particular physiological demand is imposed, or that skills are performed with sufficient frequency. Given that such monitoring requires the use of Global Positioning System (GPS) sensors, heart rate monitors and time-motion analyses, such monitoring is rarely done; this may be as true of professional teams as non-professional teams because many players prefer not to be monitored during training.

Monitoring a professional team rather than a non-professional team is additionally important as it allows us to collect data more frequently in a professional setting due to teams training more often. Another advantage of monitoring a professional team is that the data collected may be considered of benefit to both professional and non-professional teams. Perhaps most importantly, however, data are required in professional teams because their levels of profession and fitness levels are likely to be different from non-professional teams, so information regarding the physical, physiological and technical demands will also likely be very different; it is rare, however, to be able to make such measurements in professional athletes. Additionally, there is a substantial need for the physical, physiological and technical demands to be described across a range of SSG types because these demands can be expected to vary significantly between them. Such variation makes it difficult for coaches to choose the most appropriate SSG types for their teams, and data documenting the demands of SSGs would allow for more informed choices to be made.

Research has indicated that a player's physical performances in training sessions that involve the use of a football, in particular SSGs, can impose a substantial physical load (i.e. large number of sprints and distances covered at high intensities) (McMillan, Helgerud, Macdonald & Hoff, 2005), and that SSGs can elicit a level of exercise intensity that elevates a player's heart rate to an appropriate zone (Iaia, Rampinini, Bangsbo, 2009). Furthermore, other studies have shown that training sessions with and without a football can improve a player's physical conditioning equally (Impellizzeri et al., 2006). This suggests that training involving the use of SSGs might not only be beneficial for a player's technical and tactical development, but also benefit their physical conditioning.

Researchers have shown that modern-day footballers may cover ~9-13 km in each game but that this varies relative to playing position (Stolen, Chamari, Castagna & Wisloff, 2005). For example, central defenders are expected to cover the least distance whereas central midfielders will cover the greatest distance during match play (Dellal, Wong, Moalla & Chamari, 2010; Rampinini, Coutts, Castagna, Sassi & Impellizzeri, 2007; Mohr, Krustrup & Bangsbo, 2003). Although these figures are important, it is also vital to determine the intensities adopted to cover these distances (Bradley, Sheldon, Wooster, Olsen, Boanas & Krustrup, 2009). For instance, studies have suggested that a wide midfielder might cover a greater distance at a higher intensity with less recovery time than in any other position (Di Salvo et al., 2009). Therefore, it is important to ensure each playing position is examined in order to determine whether players are completing a sufficient workload in regards to total distances at the correct intensities during the training week.

The monitoring and evaluation of the demands of training and match play in football has become more reliable over recent years with the availability of technology such as GPS and heart rate monitors (Bangsbo, Norregaard & Thorso, 1991; Castagna, Belardinelli, Impellizzeri, Abt, Couttse & D'Ottavioa, 2007; Gabbett & Mulvey, 2008; Little & Williams, 2007; Reilly, 2005; Reilly & White 2004). The use of GPS in football is important due to the capacity to record time-motion characteristics that include the total distance covered at different intensities, the total number of sprints and the total number of accelerations (Hill-Haas et al., 2009). Heart rate monitors provide an effective indication of each player's metabolic expenditure during training and match play (Esposito, Impellizzeri, Margonato, Vanni, Pizzini & Veicsteinas, 2004) and, alongside GPS data, can help coaches and sport science support staff to determine the relationships between a player's physical capacity and their performance in both training and match play (Aughey, 2011).

Due to technological advances and greater access to GPS devices and heart rate monitors, evaluating the physiological load of training sessions involving SSGs and player performances has become more reliable and accurate (Casamichana & Castellano, 2010; Castagna et al., 2007). The units are lightweight (and therefore do not affect player performance) and enable fast data access, so they allow coaches access to real-time feedback to monitor the workloads of the players within a training session or specific training element (Aughey, 2011; Carling, Bloomfield, Nelsen & Reilly, 2008). Therefore, GPS and heart rate monitors are comprehensive tools for coaches and sports scientists to utilise during all forms of football training (Carling, Williams & Reilly, 2005; Hill-Haas et al., 2009). Nonetheless, problems with accessing the equipment and the substantial time required for analysis may prevent their use, so it is ideal that normative data are collated of the physical, physiological and technical demands to allow coaches to choose appropriate SSGs without the need for continuous player monitoring. Whilst such an undertaking might easily be possible in competitive, non-professional players, obtaining such data in professional players has been problematic.

1.2 Purpose of Study

The purpose of the present study is to specifically investigate relationships between the physical, physiological and perceptual demands (technical demands will not be examined) imposed in various SSGs, with those obtained during competitive match play data, in players of different playing positions (1-4-2-3-1 formation) in a professional football team.

1.3 Significance of Study

Despite all the information available on SSGs and match play in football, there is a lack of research, which has examined the physical, physiological and perceptual loads in professional football in Australia. Furthermore, to the best of this author's knowledge, few studies have quantified the RSE demands of SSGs and match play in professional football, making this study a first for professional Australian football.

This study is aimed to assist in the development and application of SSGs in training by quantifying physical, physiological and perceptual variables and comparing the demands to match play in football. Additionally, this study can provide tactical information on the specific positional demands of players in match play with the use of the 1-4-2-3-1 formation. By monitoring these variables it can be determined whether SSGs provide a sufficient physical demand for the players during training, which therefore contribute to improved training specificity.

1.4 Research Questions

1. What are the physical, physiological and perceptual differences, and similarities between SSGs with different team sizes (3v3 [i.e. three players on each of two teams], 6v6, 8v8)?

2. What are the physical, physiological and perceptual differences, and similarities between SSG and match play performances?

3. How do the physical, physiological and perceptual demands in SSGs vary with player position, and how do these compare to the demands of those players in match play?

1.5 Limitations and Delimitations

1.5.1 Limitations

The limitations of the proposed study include the current ban on the use of GPS units in competitive match play in football (FIFA regulations). This therefore limits match play data to pre-season fixtures. It might be speculated that the intensity of exercise in the pre-season games might be significantly lower than in in-season match play, however intrinsic motivation factors (such as team selection for the start of the season) would have increased the intensity of pre-season games to a comparable level to that of competitive match play. In addition, the inability to control the team's formation (1-4-2-3-1) during the match play (which was dictated by the coaches), injuries to players, the level of opposition, dietary practices and weather conditions were beyond researcher's control during the data collection period.

1.5.2 Delimitations

The delimitations of the proposed study are imposed to the range of participants. Participants were limited to the male gender and registered as a professional football player, that were playing for an A-League club in Australian A-League during the 2012/2013 season.

CHAPTER 2

2.0 REVIEW OF LITERATURE

2.1 Introduction

Football is one of the most popular sports across the world and is played by people of all ages at varying levels. The performance of a player is determined by their physical, technical, tactical and psychological attributes. The following review will focus on the physical, physiological and perceptual demands of football, which will specifically relate to small-sided games (SSGs) and match play. The following section of the review will discuss time-motion analysis in football and assess players' activity profiles and characteristics. This review will focus on the available literature and will make reference to professional football wherever possible.

2.2 Physical, Physiological and Perceptual Demands of Football

2.2.1 Acceleration and Sprinting Ability

An individual's performance in sprinting is determined by their capacity to accelerate and the magnitude of maximal velocity (Ross, Leveritt & Riek, 2001). In professional football, maximal or near-maximal sprints have been established as a sprint effort executed at speeds greater than 25.2 $km \cdot h^{-1}$ (Rampinini et al., 2007). Acceleration is defined as the rate of change in velocity (Little & Williams, 2005), and is a physically demanding task (Cavagna, Komarek & Mazzoleni, 1971), requiring more energy expenditure than constant-velocity running (Osgnach, Poser, Bernardini, Rinaldo &

Di Prampero, 2010). These two performance attributes are fundamentally important in professional football and can be a major contributor to the outcome of a match (Svensson & Drust, 2005).

In professional football, mean sprint distances are rarely further than 20 m and these sprint bouts last on average 2 – 4 s in duration (Bangsbo, Norregaard & Thorso, 1991). There is also a significant variation in the number of sprints performed by players due to their position, with studies suggesting that players can execute 19 – 62 sprint bouts in a match (Bangsbo et al., 1991; Mohr et al., 2003; Reilly & Thomas, 1976; Withers, Maricic, Wasilewski & Kelly, 1982), with strikers and fullbacks frequently performing more sprints than centre-backs and central midfielders (Mohr et al., 2003). Furthermore, it has been established that the total distance covered by sprinting will constitute 700 ± 200 m (Burgess, Naughton & Norton, 2006), which counts for approximately 1 - 11% of total distance during a match (Mohr et al., 2003; Withers et al., 1982).

During match play and training, and particularly SSGs, football players often undertake maximal acceleration efforts. Varley and Aughey (2012) found that players not only predominately accelerated from a lower velocity than the typically defined velocity of high-velocity running (speed > $4.17\ m\cdot s^{-1}$) but only half the accelerations failed to exceed this velocity. This would therefore support the requirement for the inclusion of sub-maximal acceleration information when monitoring player movements in match play and SSGs (Varley & Aughey, 2012). It is also important to consider acceleration when monitoring player performance as high-velocity running and associated variables such as sprints are less significant in SSGs as the pitch sizes are significantly smaller (Casamichana, Castellano & Castanga, 2012). Information collected regarding position-specific acceleration patterns would allow sport scientists and coaching staff to improve position specific conditioning drills (Varley & Aughey, 2012). The failure to quantify accelerations could cause underestimation of the amount of high-intensity activity players are involved in (Varley & Aughey, 2012).

2.2.2 Repeated Sprint Ability (RSA)

The term repeated sprint ability (RSA) describes the ability to perform sprints with minimal recovery between sprint bouts (Barbero-Álvarez, Coutts, Granda, Barbero-Álvarez & Castanga, 2009). Repeated sprints are also defined as a high-speed action interspersed with brief recovery intervals (Bradley et al., 2009a; Bradley, Mascio, Peart, Olsen & Sheldon, 2009). Repeated sprints efforts (RSE) have been defined as a minimum of 2 or 3 sprints being performed with a varying mean recovery period between sprints dependent on the research and sport. For example, researchers in field hockey have used recovery periods of ≤ 21 s (Spencer, Lawrence, Rechichi, Bishop, Dawson & Goodman, 2004) and researchers in football have used recovery periods from ≤ 30 s (Spencer, Pyne, Santisteban & Mujika, 2011) up to ≤ 60 s (Buchheit, Mendez-Villanueva, Simpson & Bourdon, 2010).

In professional football, analysis in match play has shown that a player is required to repeatedly produce high-speed actions (high-velocity running, sprinting) interspersed with brief recovery periods (Bradley et al., 2009a; Bradley et al., 2009b). The ability to recover and reproduce high-intensity efforts is therefore considered to be essential for performance in football and other team sports (Glaister, 2005; Spencer, Bishop, Dawson & Goodman, 2005). It is also important to understand that a major factor influencing this ability to recover is whether the recovery is active; for example walking and jogging (Spencer, Dawson, Goodman, Dascombe & Bishop, 2008).

Understanding the determinants of RSE has significant implications for designing training programs that improve and develop a player's match-specific physical performance (Buchheit & Mendez-Villanueva, 2013). Over recent years, research has considerably increased with respect to RSA (Spencer et al., 2011), and has revealed that RSA is a crucial component of football performance (Buchheit et al., 2010). Studies have also established the convergent validity of RSA by determining that it is correlated with match-specific physical performance (Rampinini, Bishop, Marcora, Ferrari, Sassi & Impellizzeri, 2007). Collectively, these findings underline the importance of both running speed and RSA assessment in professional football (Barbero-Álvarez et al., 2008). Despite the significant interest in RSA, however, studies have yet to reveal the exact nature and frequency of repeated sprints in professional football (Buchheit et al., 2010). Additionally, studies (e.g. Bishop, 2003; Drust, Reilly & Cable, 2000; Preen, Dawson & Goodman, 2001) have suggested that RSA is an important fitness component in team sports, including football. However, there is a lack of research examining the performance of RSA in professional football including SSGs and match play. Therefore, special consideration needs to be given to quantifying the number of RSE in SSGs and match play.

2.2.3 Heart Rate

The use of HR to evaluate and monitor and exercise intensity is established by the linear correlation between HR and oxygen uptake (VO_2) over varying submaximal workloads (Astrand & Rodahl, 1986), and is a commonly used method of quantifying intensity in professional and youth football in numerous studies (Esposito et al., 2004; Hoff, Wisloff, Engen, Kemi & Helgerud, 2002; Little & Williams, 2007). Physiological demands have been assessed with the monitoring of HR during training and match play (Ali & Farrally, 1991). Research has determined that the average exercise intensity for a professional football match is close to 80 – 90% of heart rate maximum (HR_{max}) for an outfield player, which equates to an average heart rate of approximately 170 beats per minute (bpm) (Bangsbo, 1994a; Bangsbo, 1994b). In training, the use of HR monitoring is utilised to aid coaches and sports scientists in evaluating training sessions and activities. This then assists in the understanding of the exercise intensity of the training drills (Sassi, Reilly & Impellizzeri, 2005), therefore allowing coaches to prescribe specific training sessions relative to the objective, whether it be to improve physical conditioning or maintain a light intensity during recovery (Reilly & Ekblom, 2005).

The monitoring of HR during training is a highly practised method and is popular with top professional football teams on a global scale. HR monitors improve the quality and specificity of training sessions and also enable the analysis of HR data to understand the difference in physiological demand relative to the players' position, when used in conjunction with time-motion analysis (TMA) data (Drust et al., 2007). For example, it has been reported that central midfielders, wide midfielders and strikers have a greater mean HR during match play when compared to central defenders (Ali & Farrally, 1991).

2.2.4 Rating of Perceived Exertion

The rating of perceived exertion (RPE) is considered to be a useful measure of the intensity of training sessions (Day, McGuigan, Brice & Foster, 2004; McGuigan & Foster, 2004; Noble & Robertson, 1996) and is associated with the level of central fatigue that accumulates during moderate- and long-duration exercise (Reilly, Drust & Clarke, 2008). This method of monitoring player training loads has been validated by previous research (Foster et al., 2001) and is reliable when measured across sessions that include technical, physical and tactical components.

Session RPE (see Figure 1) is an efficient and effective approach of quantifying a training session by collecting a player's rating of the overall intensity of an activity bout (Foster et al., 2001). This approach was developed alongside using endurance athletes as subjects and consists of multiplying the RPE of the overall training session (i.e. session RPE), which was measured by using the modified RPE scale (Figure 1), by its duration to get a single index of session load (Foster, 1998; Foster, Hector, Welsh, Schrager, Green & Snyder, 1995). Team sports involving high intensity, intermittent exercise provide an ideal situation for the use of session RPE to aid in the overall measurement of the training session's intensity (Coutts, Rampinini, Marcora, Castagna & Impellizzeri, 2007) and this has been applied in a number of team sports including football (Impellizzeri, Rampinini, Coutts, Sassi & Marcora, 2004).

The use of session RPE is an important tool for coaches and sports scientists to monitor physiological stress of training sessions in athletes (Impellizzeri, Rampinini & Marcora, 2005). This is a good general indicator of exercise intensity and is demonstrative of the combination of numerous variables such as physical state, training status (Martin, Andersen & Gates, 2000) and the intensity/volume of a training session (Impellizzeri et al., 2005).

Rating	**Descriptor**
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	-
7	Very Hard
8	-
9	-
10	Maximal

Figure 2.1. Modified RPE Scale (Foster et al., 2001)

2.3 Time-Motion Analysis (TMA) and Activity Profiles in Football

2.3.1 Time-Motion Analysis in Football

Time-motion analysis is used to quantify the physical demands of football players during match play and training (Di Salvo, Baron, Tschan, Calderon Montero, Bachl & Pigozzi, 2007; Mohr et al. 2008; Pereira Da Silva, Kirkendall & Leite De Barros Neto, 2007). The management and assessment of these physical demands to achieve optimal performance during match play and training relies on a comprehensive understanding in regards to the demands of football performance (Bloomfield et al., 2007).

Global positioning systems are commonly utilised among professional football teams. Its popularity results from the relative inexpensive cost, quick and simple set up and data analysis is more time efficient, when compared to video-based systems (Dobson & Keogh, 2007; Larsson, 2003). Furthermore, the ability to collect real-time data during training and match play (outdoors) is an additional benefit of GPS (Terrier & Schutz, 2005).

The use of video-based tracking systems has greatly increased in top professional leagues globally. Technologies such as ProZone® (Di Salvo, Collins, McNeill & Cardinale, 2006; Rampinini, Bishop, Marcora, Ferrari Bravo, Sassi & Impellizzeri, 2007) and SportsCode® are highly regarded and these sophisticated platforms have greatly improved the motion analysis of professional football performance (Carling et al., 2008). The disadvantages associated with video-based tracking systems is that they are expensive to install, requiring multiple cameras to set up, limiting the technology to only the elite football teams that have the financial resources to afford such ‘state of the art’ technology (Di Salvo, Collins et al., 2006).

In professional football, GPS analysis of performance has greatly increased over the last decade (Carling et al., 2008). Football teams competing in the English Premier League, La Liga (Spain) and the Australian A-League, use SPI Elite® GPS receivers or an equivalent, that allow real-time data acquisition and instantaneous analysis of physical data from all players that have a GPS unit during training sessions and match play (“GPSports’ SPI Elite & Team AMS,” n.d.). The reliability and validity of SPI Elite® GPS receivers has been established to be high; the intraclass correlation coefficient (ICC) in regards to total distance was 0.81 (Macleod & Sunderland, 2007). Due to the high reliability, processing speed and precision of GPS units, TMA research has become more detailed and accurate by reducing analysis time and data errors. Although many studies have used data recorded by GPS, which provides valuable knowledge in the demands of team sports (Spencer, Lawrence, Rechichi, Bishop, Dawson & Goodman, 2004), the main governing body of football (The Fédération Internationale de Football Association; FIFA) has strictly prohibited the use of any electronic transmitting devices including GPS during competitive match play (Carling et al., 2008).

2.3.2 Activity Profile and Performance Characteristics

There have been advances in human tracking technology that has given coaches and sports scientists an improved ability to perform TMA in football. With this increased ability, coaches are able to produce detailed match play and training activity profiles of players, which then allows for a considerably improved understanding of the physical and tactical demands of football (Wehbe, Hartwig & Duncan, 2013).

Activity profiles in football are position specific, due to a player's tactical role, position and available space on the pitch (Bradley et al., 2009a; Di Salvo, Baron, Gonzalez-Haro, Gormasz, Pigozzi & Bachl, 2010). Factors such as weather conditions, the level of opposition and conditioning of players (Drust, Atkinson & Reilly, 2007) can affect game-to-game demands. In addition, Drust et al. (2007) stated that tactical constraints as well as individual activity patterns, including direct involvement in play, responding to attacking or defensive movements of the opposition and motivation to support teammates, caused variations in player performance from match to match. Studies have shown that differences in position can affect the physical and physiological demand of the players (Varley & Aughey, 2012). By collecting information, training loads can be established and significantly improve profiling the demands of professional football players (Wehbe et al., 2013). This allows specific training methods to be prepared that replicate match demands while also adding to the players' weekly workloads.

The time-motion analysis of player performance in football is generally performed by capturing a series of movement activities, which are established according to their intensity with the fundamental types involving standing, walking, jogging, running and sprinting (Carling et al., 2008). These fundamental measures have been observed in match play, and Mohr et al. (2003) found that the absolute time spent over standing, walking, jogging, low velocity running, medium velocity running, high velocity running, sprinting and 'miscellaneous' was 19.5%, 41.8%, 16,7%, 9.5%, 4.5%, 2.8%, 1.4%, 2.8%, 1.4% and 3.7%, respectively. This study, among others, shows that submaximal levels of intensity (standing, walking and jogging) are performed more than maximal levels of intensity, and therefore are more inclined to dominate the work rate profile of football players (Di Salvo et al., 2007; Mohr et al., 2003; Strudwick & Reilly, 2001).

Defenders have been established to be involved in the greatest number of lateral and backwards movements when compared to other positions (Bloomfield, Polman & O'Donoghue, 2007; Rienzi, Drust, Reilly, Carter & Martin, 2000), whereas strikers perform the greatest number of diagonal runs and arc movements in advancing directions (Bloomfield et al., 2007) compared with defenders and midfielders. In contrast, midfield players execute low-to-moderate intensity actions more frequently and for longer periods (Bangsbo, 1994) and remain stationary for considerably less duration (Bloomfield et al., 2007; Reilly & Thomas, 1976; Rienzi et al., 2000) when compared to defenders and strikers.

Previous studies in TMA have established that professional football players will spend only around 10% of match play running at a high intensity speed, with the majority of time spent in low-intensity speed zones (Bradley et al., 2009a; Carling, Bloomfield, Nelsen & Reilly, 2008). Further, research has also shown that high intensity activities have been related to the outcome of a match. Therefore, it would be beneficial to profile the high intensity demands of a player's match and training performance, because measuring other variables such as total distances do not display much information about the match or training intensity of the players (Bradley, 2009a; Di Salvo et al., 2010; Di Salvo et al., 2009; Mohr et al, 2003; Stolen et al., 2003).

The number of sprints performed during match play by each player varies significantly (3 – 40) and is largely associated with playing positions (Di Salvo et al., 2007). Rampinini et al. (2007) reported that strikers spend the most time sprinting as compared to other positions, while wide midfielders cover the greater distance sprinting during match play (Zubillaga, Gorospe, Mendo & Villaseñor, 2007). In contrast, central defenders spend the least duration sprinting (Rampinini et al., 2007) and cover the lowest distance (Di Salvo et al., 2007) when compared across other playing positions during match play.

The outcome of a football match is determined by the players' abilities to competently perform a multitude of physical and technical tasks (Jozak, Perić, Bradić & Dizdar, 2011), and that these requirements are determined by their positional role and tactical instructions (Bradley et al., 2011; Di Salvo, Baron, Tschan, Calderon Montero, Bachl & Pigozzi1, 2006; Di Salvo, Gregson, Atkinson, Tordoff & Drust, 2009; Mohr, Krustrup, Andersson, Kirkendal & Bangsbo, 2008). An in-depth analysis of physical and technical loads imposed using various team formations (including 1-4-3-3 and 1-4-2-3-1; which are now commonly used by top European and South American professional teams) has provided insight into position-specific changes during match play and provided useful information to aid the design of training sessions (Vigne, Gaudino, Rogowski1, Alloatti & Hautier, 2010). Further information regarding the physical and physiological demands, in particular, of SSGs and the similarity to match play would allow for SSGs to be better incorporated into training plans (Bangsbo, 1994a; Eniseler, 2005; Krustrup, Mohr, Steensberg, Benck, Kjaer & Bangsbo, 2006; Mohr, Krustrup & Bangsbo, 2005).

2.4 Physiological Demands of Small-Sided Games

In football, it is accepted that players/coaches must ensure that training stimuli are similar to the competitive demands of the players to achieve maximum benefits from training (Bompa, 1983; Mallo & Navarro, 2008). Therefore, physical and physiological factors can be trained in a more 'football-specific' way than simply asking players run without specific purpose (Hoff, Wisløff, Engen, Kemi & Helgerud, 2002). This is a main reason for the development of small-sided games (SSGs), which are now commonly implemented by coaches in order to develop and improve players' physical, physiological and technical qualities (Hill-Haas et al., 2009; Hill-Haas, Coutts, Rowsell & Dawson, 2008; Rampinini et al., 2006). This established principle has been confirmed by numerous studies (Hill-Haas, Dawson, Impellizzeri & Coutts, 2011) suggesting that SSGs have substantial relevance for improving the training specificity. Evidence has also determined that not only do SSGs develop physical, physiological and technical factors, but they also stimulate a greater level of enjoyment and dedication among players, which appears to improve the level of play (Sampaio, Abrantes & Leite, 2009; Wall & Côte, 2007).

Studies by Rampinini et al. (2007) and Owen, Twist and Ford (2004) suggest that reducing the number of players active in an SSG increased the intensity of the SSG. Additionally, results showed that the mean heart rate of the players decreased when additional players were introduced to the game. Similar results were found by Hill-Haas, Rowsell, Dawson and Coutts (2009), who observed that smaller SSGs caused a higher mean average heart rate with players in the higher heart rate zones for a longer period of time. These results suggest that coaches are able to manipulate the intensity of SSGs by limiting player numbers. Furthermore, coaches are also able to influence physical, physiological and technical demands on players, which may improve the quality of tactical training specificity (Clemente, Couceiro, Martins & Mendes, 2012).

In addition to the number of players, coaches can also alter pitch size to alter training intensity (Tessitore, Meeusen, Piacentini, Demarie & Capranica, 2006). Pitch size can modify the players' movement and therefore significantly impact on the physical and physiological stimulus. Smaller field sizes may promote a greater number of accelerations and de-accelerations, whereas larger pitch sizes would allow the players more time and space to cover distances in high velocity running and sprints, as well as having more time on the football (Clemente et al., 2012).

In relation to the player number and pitch size, task constraints are a vital factor that can be used to influence the performer-environment interaction regarding the coaches intended outcomes (Araújo, David & Hristovski, 2006). One example is the addition of goalkeepers to the SSG. Mallo and Navarro (2008) found that the addition of goalkeepers in SSGs changed the physical and physiological demands of the players; mean heart rate was lower as well as total distance covered. This could be due to players organising themselves defensively to protect their goal. Furthermore, there is a dearth of information on position-specific roles (i.e. centre-backs, fullbacks, central midfielders, wide midfielders and strikers) during SSGs, and these position-specific roles compared to the demands of match play, specifically in professional Australian footballers.

Comprehensively, research has indicated that manipulation of factors such as playing number, field size and task constraints in SSGs directly impact the physical, physiological and technical demands imposed on the players. Therefore, coaches need to consider the level of the players (e.g. professional vs. semi-professional), and the goals set for the training session before implementing specific SSGs with constraints (Clemente et al., 2012). SSGs represent an important opportunity to specifically improve players' physical, physiological and technical attributes. In conclusion, there is extensive literature available on the physical, physiological and perceptual aspects of professional football, however there is limited knowledge on the comparisons of match play and the use of SSGs in training at an elite level, therefore more research is necessary in this area. By quantifying the work rates of the players with the use of GPS and heart rate monitors, its possible to determine the physical and physiological requirements match play and each SSG demands, and therefore can establish the differences in playing position, and the effect playing position has on a players work load. The use of GPS and heart rate monitors in a regular practise in professional football has been shown to be valid and reliable for tracking total distances (at varying intensities) and the speed of player movement. There is also paucity in TMA literature focusing on the use of GPS derived data in professional football when comparing training techniques such as SSGs to match play. This thesis will provide information on the demands of match play and SSGs and investigate the significant differences when compared, utilising GPS and heart rate technology.

CHAPTER 3

3.0 METHOD

3.1 Participants

Twenty-three outfield football players aged 19 to 35 volunteered from one Australian A-League football team, representing the highest level of football participation within Australia. Participants were divided into five groups according to their playing position; centre-backs (n=4), fullbacks (n=2), central midfielders (n=8), wide midfielders (n=6) and strikers (n=3), and their characteristics are outlined in Table 1. Goalkeepers were excluded from the study. Ethical clearance was obtained from Edith Cowan University's Human Research Ethics Committee. The participants were provided with an information letter (Appendix A) outlining the possible risks, requirements and benefits involved with the study. Informed consent was obtained from each player in the study (Appendix B).

Table 3.1 *Participant characteristics (mean ± standard deviation).*

Position	Age (years)	Height (cm)	Body Mass (kg)
Centre-backs	27.7 ± 3.9	185.3 ± 4.3	78.8 ± 5.9
Fullbacks	23 ± 2	176.0 ± 1	73.5 ± 2.5
Central Midfielders	27 ± 6.2	177.5 ± 3	75.2 ± 2.8
Wide Midfielders	26.2 ± 4.9	175.3 ± 5.7	74.8 ± 7.5
Strikers	27.3 ± 4.6	185.0 ± 3.3	82.0 ± 5.9
Mean of all groups	26.6 ± 5.2	179.1 ± 5.7	76.5 ± 5.9

3.2 Procedure

3.2.1 Research Design

The present study included measurement of physical, physiological and perceptual demands of players during SSGs and match play. 4 games during pre-season were analysed as well as three SSGs (3v3, 6v6 and 8v8) and were randomised through 25 weeks of the season. The duration for each SSG ranged from 3-10 min dependent on the size of the SSG (3v3 and 6v6 SSGs were shorter in duration compared to 8v8 to maximise intensity). Additionally each SSG varied in sets during each training session ranging from 1-4 sets per SSG (i.e. 3 × 3 min 3v3 SSG and 2 × 8 min 8v8). Recovery time between each set ranged from 2-3 min. Before any SSGs and matches were performed, players completed a dynamic warm-up determined by the strength and conditioning coach. Players that were selected for analysis during the SSGs and match play were issued with a GPS unit and heart rate monitor before each training session and match commenced. A maximum of 15 players were simultaneously monitored during each training session and match play (due to the limited number of available GPS units) over the season; designated players were evenly distributed across playing positions. Different players over the course of the season were used each week to increase the data volume.

All SSGs used for analysis required the use of full-sized goals and two goalkeepers as additions. The pitch size was determined by the size of the SSG, and by the club's coaches (10 m × 6 m per player). The pitch size for match play was a standard playing size; these are presented in Table 3.2.

Table 3.2 *Pitch dimensions for SSGs and match play.*

Player Numbers	Field Dimensions
3v3	30 m × 18 m
6v6	60 m × 36 m
8v8	80 m × 48 m
11v11	110 m × 66 m

The aim of SSGs for the attacking team is to create as many goal-scoring opportunities as possible whilst retaining possession of the football. The defending team was required to limit the number of goal-scoring opportunities of the attacking team and legally take possession of the football. As the SSGs increased in player number, the tactical roles became more important and players were encouraged to keep to their designated playing positions and only move into areas of the pitch that were related to those positions, as instructed by the coaches. For example, Figure 2 shows the positions for a 6v6 SSG.

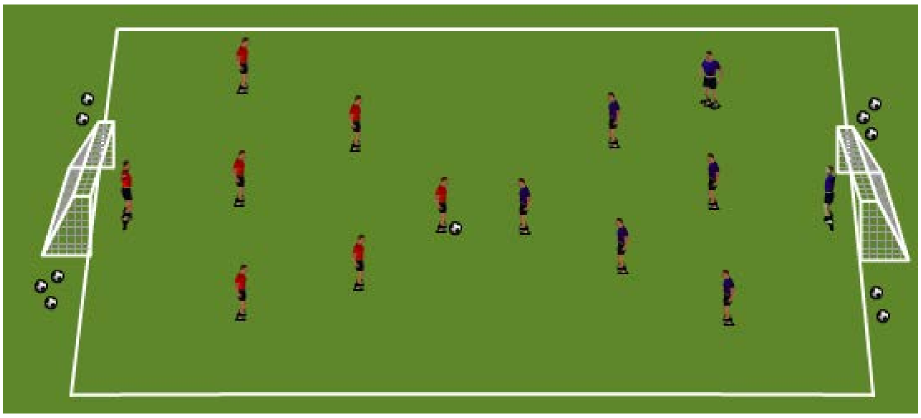


Figure 3.1 6v6 small-sided game (SSG) with full-sized goals

Each SSG (3v3, 6v6, 8v8) was compared to the others to determine similarities or differences. To ensure the data could be compared between SSGs and match play, each variable was quantified per player, per 10 minutes of play (variable quantity/10 minutes/player). Standardising the physical data is required because match play duration is longer than SSGs.

The data collection period included the 2012/2013 A-League season (and pre-season) from the 25th of August 2012 to 11th of February 2013. The pre-season games that were included were obtained at the end of the pre-season training period, thus the team had undergone previous pre-season matches prior to analysis. It is also important to note that the A-League pre-season is not a typical pre-season compared to European competition. The pre-season runs for 13 weeks (Europe 6-8 weeks). Therefore the players were considered to be at an appropriate fitness level prior to the period of data collection. Also, the intensity of the pre-season games may be speculated to be lower, but it is considered that players' motivation during these last pre-season games was at a significantly high level due to them competing for places in the team. This can also be said for the opposition players, and would have increased the intensity of the pre-season games.

To ensure player anonymity, all performance data collected in training and match play were made anonymous before analysis; e.g., each player's position and GPS number were used. All training sessions over the 2012/2013 season up to the 11th of February that involved the use of SSGs were used for analysis. Match play from A-League games could not be analysed using the GPS units due to FIFA regulations so data were analysed from four pre-season matches (2012/2013 season).

3.2.2 Physical, Physiological and Perceptual Measures

The six physical variables studied were: total distance (m), total distance covered at high velocity (speed > 4.16 $m \cdot s^{-1}$), total number of repeated sprints efforts (≥3 sprints with <30-s inter-sprint recoveries), total sprint distance (speed > 6.93 $m \cdot s^{-1}$), number of submaximal accelerations (acceleration > 1.79 $m \cdot s^{-2}$) and number of maximal accelerations (acceleration > 2.79 $m \cdot s^{-2}$). Speed zones were established by the use of commonly used velocity thresholds (Bradley et al., 2009; Di Salvo et al., 2009; Di Salvo et al., 2007; Rampinini et al., 2007; Varley & Aughey, 2012). The physiological variable that was measured includes the average heart rate expressed as a percentage of the players' maximum heart rate (% HR_{max}). The players underwent the maximal aerobic speed test (MAS test) in the first week of pre-season to determine individual maximum heart rate. Perceptual demands were measured by the players' RPE with the use of the modified Foster model (Foster et al., 2001).

3.3 Small-Sided Games and Match Play Analysis

3.3.1 GPS, Heart Rate and Rating of Perceived Exertion Monitoring of Football Players During Small-Sided Games and Match Play

Physical variables involving total distance, total distance covered at high velocity, total number of repeated sprints, total sprint distance, number of sub-maximal accelerations and number of maximal accelerations were measured by GPS systems (5 Hz, Wi SPI, GPSports Systems, ACT, Australia). The criteria for measuring repeated sprints was based on previous research (Spencer et al., 2011) where a repeated sprint is defined as three or more sprints with a mean inter-sprint recovery time of ≤ 30 s. Heart rate monitors (Polar Electro OyTM, Kempele, Finland) were used in conjunction with the GPS units and recorded each player's heart rate (HR) responses (HR as a percent of maximum) during the SSGs and match play. Team AMS (GPSports Systems, ACT, Australia) software was used to download the training and match play data; Team AMS is a program that manages and analyses session data collected from the GPS units. This allowed for an individual comparison of each player's match play and training sessions.

Match play data were obtained from four pre-season matches that were completed between August–September, 2012. Data was recorded for an average of 94 min (45 min each half plus 4 min of added time) in each match. In these games, no player was dismissed or injured, therefore the workload of each individual player was not affected. A 1-4-2-3-1 formation was used by the team, which includes the use of centre-backs, fullbacks, centre midfielders, wide midfielders and a striker. Training session data collection occurred throughout the season in order to increase the quantity of data obtained; the process was completed during the 2012/2013 A-League season, which runs from 4th October, 2012, until 11th February (due to coaching change), 2013 (and pre-season). A minimum of two sessions was recorded each week, and every session incorporated a variety of SSGs. Each SSG that was analysed was run a minimum of 8 times across the season, dependent upon the players' match performances each week. All physical and physiological data were obtained whilst the players' were involved in the SSG. Rating of perceived exertion data was recorded at the conclusion of each training session where GPS and HR monitoring occurred for

SSGs and match play. Any player that left the club prior to the 11th February 2013 was not included in the final analysis if a consent form was not obtained.

3.4 Statistical Analysis

Statistical analysis was conducted by using SPSS version 19 (SPSS Inc., Chicago, IL, USA). Results are presented as mean ± standard deviation (SD) unless otherwise stated. The physical data collected involving total distance, high velocity running, number of repeated sprint efforts, sprint distance, number of sub-maximal accelerations and number of maximal accelerations was standardised (variable quantity/10 min/player) to allow comparison between SSGs using a repeated measures MANOVA.

A multivariate ANOVA (MANOVA) with repeated measures was used to examine the within-subject effects of game type (3v3 SSG, 6v6 SSG, 8v8 SSG, and match play) on (1) variables quantifying physical demand, and (2) variables quantifying physiological demand.

A single ANOVA (game type) was used to examine differences in perceptual demand (RPE). Significant differences were further examined using one-way ANOVAs and Tukey's post-hoc test to determine the location of significant differences. Statistical significance was set at $p < 0.05$. The differences between player positions (central defenders, fullbacks, central midfielders, wide midfielders, strikers) to determine the within subject and between subject effects were interpreted using effect size (ES). ES is determined by ES values, which involves large (0.8), moderate (0.5) or small (0.2) (Cohen, 1988).

CHAPTER 4

4.0 RESULTS

4.1 Physical, Physiological and Perceptual Measures for Match Play and Small-Sided Games

Table 4.1 shows the physical, physiological and perceptual variables for match play. Tables 4.2, 4.3 and 4.4 display the physical, physiological and perceptual variables for the SSGs (8v8, 6v6 and 3v3). This includes: total distance (m), high velocity distance (m>4.16m/s), sprint distance (m>6.93m/s), sub-maximal accelerations (m>1.79m/s), maximal accelerations (m>2.79m/s), repeated sprint efforts (≥3 sprints <30-s), players' heart rates as a percentage of maximum heart rate (% HRmax) and rating of perceived exertion (0-10). Tables 4.5-4.11 show the large effect sizes for positional differences within each game type and Tables 4.12-4.16 present the large effect sizes for positional differences between game types, for example, centre-back versus centre-back in match play and 3v3. Appendices C, D and E show variables presenting moderate effect sizes.

4.2 Small-Sided Games

4.2.1 Physical Measures

Although no statistical difference was found between SSGs for total distance, moderate effect sizes (Appendix C) were found between 3v3 and 6v6 (0.57). Total distance covered in 3v3 was 1319.9 ± 22.4 m, which was greater than in 6v6 (1249.6 ± 59.7 m).

The distance covered at high velocity in all positions was significantly different ($p < 0.05$) between 8v8 and 3v3. The total high velocity distance for 8v8 was 68.3 ± 22.6, which was greater than the distance covered during the 3v3 SSG (31.9 ± 10.0).

There was significant difference in sprint distance between 8v8 and 3v3. Players covered 10.7 ± 6.5 m in 8v8, which was greater than in 3v3 in all positions. Moderate effect sizes (Appendix C) were also observed between 3v3 and 6v6 (-0.60), in addition to 6v6 and 8v8 (-0.53). In 3v3 players covered 0.5 ± 0.4 m, a lesser distance than in 6v6 (3.7 ± 2.6 m), with a moderate effect size of -0.60. Furthermore, 8v8 sprint distance was greater than 6v6 (3.7 ± 2.6 m), with a moderate effect size of 0.53.

There were differences in the quantity of sub-maximal accelerations between all the SSGs. 3v3 was found to produce the greatest distance for sub-maximal accelerations in all positions (28.8 ± 2 m) when compared to 8v8 (16.5 ± 0.5 m) and 6v6 (20.3 ± 2 m). There were no significant differences between SSGs in regards to maximal accelerations.

Significant differences in RSE were also found between 3v3 and 8v8 ($p < 0.05$). The total number of RSEs in all positions in 8v8 (1.7 ± 0.7) was less than 3v3 (3.9 ± 1.3). Furthermore, moderate effect sizes were established between 3v3 and 6v6 (0.57). 3.9 ± 1.3 RSEs were performed during 3v3, which was more than the 2.2 ± 0.8 RSEs in 6v6.

4.2.2 Physiological and Perceptual Measures

Significant differences in RPE were observed between 6v6 (4.9 ± 0.3) and 3v3 (6.2 ± 0.8). Additionally, moderate effect sizes were found between 6v6 and 8v8 (-0.60). The average RPE for 8v8 was 5.5 ± 0.4. No significance was found between SSGs in regards to % HRmax.

Table 4.1 *Physical, physiological and perceptual measures for match play according to playing position.*

Measures	(CB) Centre-backs (n = 4)	(FB) Fullbacks (n = 2)	(CM) Central Midfielders (n = 8)	(WM) Wide Midfielders (n = 6)	(ST) Strikers (n = 3)	All Positions (n = 23)
Total distance (m)	1036.5 ± 17.7	1050.5 ± 23.5	1217.8 ± 16.5	1064.9 ± 30.5	1142.3 ± 40.9	1118.9 ± 66.9*
High velocity distance (m>4.16 m/s)	40.9 ± 1.0	76.2 ± 2.3	54.4 ± 1.0	74.9 ± 2.6	65.9 ± 2.7	67.9 ± 8.7
Sprint distance (m>6.93 m/s)	6.0 ± 0.3	20.9 ± 1.0	8.0 ± 0.3	14.6 ± 0.8	17.1 ± 0.8	15.2 ± 4.7**
Sub-Maximal accelerations (m>1.79 m/s)	10.1 ± 0.3	11.6 ± 0.4	13.9 ± 0.3	12.7 ± 0.5	10.8 ± 0.5	12.2 ± 1.2*
Maximal accelerations (m>2.79 m/s)	2.4 ± 0.1	3.2 ± 0.1	2.8 ± 0.1	3.8 ± 0.2	2.9 ± 0.2	3.2 ± 0.4***
RSE (≥3 sprints <30-s)	0.6 ± 0	0.7 ± 0	0.7 ± 0	1.3 ± 0.1	0.6 ± 0	0.8 ± 0.3***
% HRmax	78.0 ± 6.9	81.0 ± 4.2	81.0 ± 7.7	81.0 ± 10.5	75.0 ± 8.0	79.5 ± 2.6****
RPE (0-10)	6.5 ± 0.5	6.5 ± 0.5	6.8 ± 0.4	6.0 ± 0	7.0 ± 0	6.6 ± 0.4*****

*Significant difference ($p < 0.05$) of between match play and 3v3, 6v6 and 8v8
**Significant difference ($p < 0.05$) between match play and 3v3 and 6v6
***Significant difference ($p < 0.05$) between match play and 3v3
****Significant difference ($p < 0.05$) between match play and 8v8
*****Significant difference ($p < 0.05$) between match play and 6v6

Table 4.2 *Physical, physiological and perceptual measures for 8v8 according to playing position.*

Measures	(CB) Centre-backs (n = 4)	(FB)Fullbacks (n = 2)	(CM) Central Midfielders (n = 8)	(WM) Wide Midfielders (n = 6)	(ST) Strikers (n = 3)	All Positions (n = 23)
Total distance (m)	1163.7 ± 15.6	1217.4 ± 19.4	1380.1 ± 12.8	1288.8 ± 15	1170.7 ± 21.9	1244.1 ± 81.3*
High velocity distance (m>4.16 m/s)	32.4 ± 0.9	100.8 ± 2.7	59.9 ± 1.3	80.1 ± 2.2	68.0 ± 1.8	68.3 ± 22.6**
Sprint distance (m>6.93 m/s)	3.6 ± 0.3	15.4 ± 1	6.4 ± 0.4	21.2 ± 1.1	7.0 ± 0.4	10.7 ± 6.5**
Sub-Maximal accelerations (m>1.79 m/s)	16.8 ± 0.3	16.5 ± 0.3	17.4 ± 0.3	16.1 ± 0.3	15.9 ± 0.5	16.5 ± 0.5***
Maximal accelerations (m>2.79 m/s)	3.9 ± 0.1	6.3 ± 0.2	3.7 ± 0.1	6.1 ± 0.2	5.7 ± 0.2	5.1 ± 1.1
RSE (≥3 sprints <30-s)	0.7 ± 0	2.7 ± 0.1	1.2 ± 0	2.0 ± 0.1	1.7 ± 0.1	1.7 ± 0.7**
% HRmax	83.0 ± 2.8	84.0 ± 2.3	86.0 ± 4	88.0 ± 5.3	80.0 ± 5.4	84.2 ± 2.7*
RPE (0-10)	5.5 ± 0.5	5.8 ± 1.6	5.9 ± 0.9	5.7 ± 0.7	4.8 ± 1.5	5.5 ± 0.4

*Significant difference ($p < 0.05$) between 8v8 and match play
**Significant difference ($p < 0.05$) between 8v8 and 3v3
***Significant difference ($p < 0.05$) between 8v8 and 3v3, 6v6 and match play

Table 4.3 *Physical, physiological and perceptual measures for 6v6 according to playing position.*

Measures	(CB) Centre-backs (n = 4)	(FB) Fullbacks (n = 2)	(CM) Central Midfielders (n = 8)	(WM) Wide Midfielders (n = 6)	(ST) Strikers (n = 3)	All Positions (n = 23)
Total distance (m)	1194.1 ± 2.7	1250.8 ± 4	1356.0 ± 1.3	1255.5 ± 1.5	1191.4 ± 3.4	1249.6 ± 59.7*
High velocity distance (m>4.16 m/s)	22.4 ± 0.3	68.5 ± 0.7	44.8 ± 0.2	56.1 ± 0.3	37.9 ± 0.5	45.9 ± 15.7
Sprint distance (m>6.93 m/s)	0.4 ± 0	7.6 ± 0.2	2.0 ± 0	5.6 ± 0.1	3.0 ± 0.1	3.7 ± 2.6*
Sub-Maximal accelerations (m>1.79 m/s)	17.2 ± 0.1	22.4 ± 0.2	22.5 ± 0.1	19.4 ± 0.1	20.0 ± 0.1	20.3 ± 2**
Maximal accelerations (m>2.79 m/s)	3.4 ± 0	7.1 ± 0.1	5.4 ± 0	6.6 ± 0	5.7 ± 0.1	5.7 ± 1.3
RSE (≥3 sprints <30-s)	1 ± 0	3.0 ± 0	2.0 ± 0	3.1 ± 0	1.8 ± 0	2.2 ± 0.8
% HRmax	82.0 ± 4.6	84.0 ± 2.8	82.0 ± 6.2	85.0 ± 4.4	81.0 ± 4.3	82.8 ± 1.5
RPE (0-10)	5.0 ± 1.2	5.5 ± 1.1	4.8 ± 1.3	4.7 ± 1.1	4.7 ± 0.9	4.9 ± 0.3***

*Significant difference ($p < 0.05$) between 6v6 and match play
**Significant difference ($p < 0.05$) between 6v6 and 3v3, 8v8 and match play
***Significant difference ($p < 0.05$) between 6v6 and 3v3 and match play

Table 4.4 *Physical, physiological and perceptual measures for 3v3 according to playing position.*

Measures	(CB) Centre-backs (n = 4)	(FB) Fullbacks (n = 2)	(CM) Central Midfielders (n = 8)	(WM) Wide Midfielders (n = 6)	(ST) Strikers (n = 3)	All Positions (n = 23)
Total distance (m)	1336.0 ± 3.2	1328.1 ± 4.5	1347.1 ± 2.2	1301.6 ± 3.6	1286.5 ± 3.4	1319.9 ± 22.4*
High velocity distance (m>4.16 m/s)	17.9 ± 0.7	49.3 ± 1.5	30.0 ± 0.6	30.6 ± 0.9	31.9 ± 1	31.9 ± 10**
Sprint distance (m>6.93 m/s)	0.6 ± 0.1	1.4 ± 0.2	0.3 ± 0	0.3 ± 0.1	0.1 ± 0	0.5 ± 0.4***
Sub-Maximal accelerations (m>1.79 m/s)	28.5 ± 0.4	28.1 ± 0.4	32.2 ± 0.2	28.9 ± 0.3	26.0 ± 0.3	28.8 ± 2****
Maximal accelerations (m>2.79 m/s)	3.9 ± 0.1	10.0 ± 0.3	7.7 ± 0.1	8.8 ± 0.2	7.4 ± 0.2	7.6 ± 2.1*
RSE (≥3 sprints <30-s)	1.7 ± 0.1	5.4 ± 0.2	3.3 ± 0.1	5.1 ± 0.1	4.1 ± 0.1	3.9 ± 1.3***
% HRmax	83.0 ± 3.3	85.0 ± 3.1	81.0 ± 7.2	87.0 ± 5.6	82.0 ± 5.2	83.6 ± 2.2
RPE (0-10)	6.1 ± 0.8	7.7 ± 0.5	6.0 ± 1.1	5.9 ± 1.2	5.2 ± 0.7	6.2 ± 0.8*****

*Significant difference ($p < 0.05$) between 3v3 and match play
**Significant difference ($p < 0.05$) between 3v3 and 8v8
***Significant difference ($p < 0.05$) between 3v3 and match play and 8v8
****Significant difference ($p < 0.05$) between 3v3 and 6v6, 8v8 and match play
*****Significant difference ($p < 0.05$) between 3v3 and 6v6

4.3 Small-Sided Games and Match Play

4.3.1 Physical Measures

Total distance covered during match play (1118.9 ± 66.9 m, Table 3.1) was significantly less to those in small-sided games. A moderate effect size (see Appendix C) was found for the difference in high velocity distance between match play (67.9 ± 8.7 m) and 3v3 (31.9 ± 10 m). Sprint distance covered in match play (15.2 ± 4.7 m) in all positions was found to be significantly greater than 6v6 (3.7 ± 2.6 m) and 3v3 (0.5 ± 0.4 m). Sub-maximal acceleration results showed significant difference between match play (12.2 ± 1.2) and all SSGs (16.5 ± 0.5, 20.3 ± 2 and 28.8 ± 2, for 8v8, 6v6 and 3v3, respectively). Fewer in maximal accelerations were observed in match play (3.2 ± 0.4) than 3v3 (7.6 ± 2.1) in all positions. Also, the number of RSEs during 3v3 (3.9 ± 1.3) was greater than the number of RSEs produced in match play (0.8 ± 0.3). Moderate effect sizes were also found between match play and 6v6 (2.2 ± 0.8), and match play and 8v8 (1.7 ± 0.7 m).

4.3.2 Physiological and Perceptual Measures

The players' heart rate percentages in match play (79.5 ± 2.6 in all positions) were less than in 8v8 (84.2 ± 2.7). In addition, moderate effect sizes were found between match play and 3v3 (83.6 ± 2.2), and match play and 6v6 (82.8 ± 1.5). A significant difference was found for RPE between match play (6.6 ± 0.4) and 6v6 (4.9 ± 0.3).

Table 4.5 *Large effect sizes for total distance in match play and small-sided games between playing positions. CB: Centre-backs, FB: Fullbacks, CM: Central Midfielders, WM: Wide Midfielders, ST: Strikers*

Game Type	Positions	Effect Size
Match Play	CB vs CM	-0.98
	CB vs ST	-0.85
	FB vs CM	-0.97
	FB vs ST	-0.80
	CM vs WM	0.95
8v8	CB vs FB	-0.83
	CB vs CM	-0.99
	CB vs WM	-0.97
	FB vs CM	-0.98
	FB vs WM	-0.89
	CM vs WM	0.95
	CM vs ST	0.98
	WM vs ST	0.95
6v6	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	FB vs CM	-0.99
	FB vs ST	0.99
	CM vs WM	0.99
	CM vs ST	0.99
	WM vs ST	0.99
3v3	CB vs CM	-0.89
	CB vs WM	0.98
	CB vs ST	0.99
	FB vs CM	-0.93
	FB vs WM	0.95
	FB vs ST	0.98
	CM vs WM	0.99
	CM vs ST	0.99
	WM vs ST	0.90

Table 4.6 *Large effect sizes for high velocity distance in match play and small-sided games between playing positions. CB: Centre-backs, FB: Fullbacks, CM: Central Midfielders, WM: Wide Midfielders, ST: Strikers*

Game Type	Positions	Effect Size
Match Play	CB vs FB	-0.99
	CB vs CM	-0.98
	CB vs WM	-0.99
	CB vs ST	-0.98
	FB vs CM	0.98
	FB vs ST	0.89
	CM vs WM	-0.98
	CM vs ST	-0.94
	WM vs ST	0.86
8v8	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.99
	FB vs WM	0.97
	FB vs ST	0.99
	CM vs WM	-0.98
	CM vs ST	-0.93
	WM vs ST	0.94
6v6	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.99
	FB vs WM	0.99
	FB vs ST	0.99
	CM vs WM	-0.99
	CM vs ST	0.99
	WM vs ST	0.99
3v3	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.99
	FB vs WM	0.99
	FB vs ST	0.98

Table 4.7 *Large effect sizes for sprint distance in match play and small-sided games between playing positions. CB: Centre-backs, FB: Fullbacks, CM: Central Midfielders, WM: Wide Midfielders, ST: Strikers*

Game Type	Positions	Effect Size
Match Play	CB vs FB	-0.99
	CB vs CM	-0.95
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.99
	FB vs WM	0.96
	FB vs ST	0.89
	CM vs WM	-0.98
	CM vs ST	-0.99
	WM vs ST	-0.83
8v8	CB vs FB	-0.99
	CB vs CM	-0.96
	CB vs WM	-0.99
	CB vs ST	-0.97
	FB vs CM	0.98
	FB vs WM	-0.93
	FB vs ST	0.98
	CM vs WM	-0.99
	WM vs ST	0.99
6v6	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.99
	FB vs WM	0.98
	FB vs ST	0.99
	CM vs WM	-0.99
	CM vs ST	-0.99
	WM vs ST	0.99
3v3	CB vs FB	-0.91
	CB vs CM	0.93
	CB vs WM	0.85
	CB vs ST	0.96
	FB vs CM	0.96
	FB vs WM	0.95
	FB vs ST	0.97

Table 4.8 *Large effect sizes for sub-maximal accelerations in match play and small-sided games between playing positions. CB: Centre-backs, FB: Fullbacks, CM: Central Midfielders, WM: Wide Midfielders, ST: Strikers*

Game Type	Positions	Effect Size
Match Play	CB vs FB	-0.90
	CB vs CM	-0.98
	CB vs WM	-0.95
	FB vs CM	-0.95
	CM vs WM	0.82
	CM vs ST	0.96
	WM vs ST	0.88
8v8	FB vs CM	-0.80
	CM vs WM	0.89
	CM vs ST	0.87
6v6	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs WM	0.99
	FB vs ST	0.99
	CM vs WM	0.99
	CM vs ST	0.99
	WM vs ST	-0.95
3v3	CB vs CM	-0.98
	CB vs ST	0.96
	FB vs CM	-0.98
	FB vs ST	0.94
	CM vs WM	0.98
	CM vs ST	0.99
	WM vs ST	0.97

Table 4.9 *Large effect sizes for maximal accelerations in match play and small-sided games between playing positions. CB: Centre-backs, FB: Fullbacks, CM: Central Midfielders, WM: Wide Midfielders, ST: Strikers*

Game Type	Positions	Effect Size
Match Play	CB vs FB	-0.97
	CB vs CM	-0.92
	CB vs WM	-0.97
	CB vs ST	-0.84
	FB vs CM	0.86
	FB vs WM	-0.89
	CM vs WM	-0.94
	WM vs ST	0.91
8v8	CB vs FB	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.98
	FB vs CM	0.99
	CM vs WM	-0.99
	CM vs ST	-0.98
6v6	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.99
	FB vs WM	0.96
	FB vs ST	0.98
	CM vs WM	-0.99
	CM vs ST	-0.92
	WM vs ST	0.98
3v3	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.98
	FB vs WM	0.92
	FB vs ST	0.98
	CM vs WM	-0.96
	WM vs ST	0.96

Table 4.10 *Large effect sizes for RSE in match play and small-sided games between playing positions. CB: Centre-backs, FB: Fullbacks, CM: Central Midfielders, WM: Wide Midfielders, ST: Strikers*

Game Type	Positions	Effect Size
Match Play	CB vs WM	-0.97
	FB vs WM	-0.96
	CM vs WM	-0.97
	WM vs ST	0.98
8v8	CB vs FB	-0.99
	CB vs CM	-0.96
	CB vs WM	-0.99
	CB vs ST	-0.96
	FB vs CM	0.99
	FB vs WM	0.96
	FB vs ST	0.98
	CM vs WM	-0.98
	CM vs ST	-0.95
	WM vs ST	0.84
6v6	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.98
	FB vs CM	0.99
	FB vs ST	0.99
	CM vs WM	-0.99
	CM vs ST	0.82
	WM vs ST	0.99
3v3	CB vs FB	-0.99
	CB vs CM	-0.99
	CB vs WM	-0.99
	CB vs ST	-0.99
	FB vs CM	0.98
	FB vs ST	0.96
	CM vs WM	-0.99
	CM vs ST	-0.97
	WM vs ST	0.98

Table 4.11 *Large effect sizes for RPE in match play and small-sided games between playing positions. FB: Fullbacks, CM: Central Midfielders, WM: Wide Midfielders, ST: Strikers*

Game Type	Positions	Effect Size
Match Play	CM vs WM	0.81
	WM vs ST	-0.99
3v3	FB vs ST	0.89

4.4 Positional Differences in Small-Sided Games and Match Play

4.4.1 Small-Sided Games

Large effect sizes were found between various playing positions in 3v3 when total distance was compared (Table 4.5). Central midfielders covered the most total distance during 3v3 (1347.1 ± 2.2 m) with strikers covering the least (1286.5 ± 3.4 m). In addition, moderate effect sizes were also detected between centre-backs and fullbacks (see Appendix D).

The total distance covered by centre-backs varied between 3v3 (1336 ± 3.2 m), 6v6 (1194.12 ± 2.7 m) and 8v8 (1163.7 ± 15.6 m). For fullbacks large effect sizes were observed between 3v3 vs 6v6 and 3v3 vs 8v8. A moderate effect size was observed between 6v6 vs 8v8. The greatest distance covered for fullbacks was during 3v3 (1328.1 ± 4.5 m) with the least distance (1217.4 ± 19.4 m) covered during 8v8. Large effect sizes were found for central midfielders between SSGs for total distance. Central midfielders covered the most total distance during 8v8 (1380.1 ± 12.8 m) when compared to 3v3 (1347.1 ± 2.2 m) and 6v6 (1356.1 ± 1.3 m). In addition, moderate effect size was discovered between 6v6 and 8v8 (see Appendix E). Wide midfielders total distances covered varied between 3v3 (1301.6 ± 3.6 m), 6v6 (1255.5 ± 1.5) and 8v8 (1288.8 ± 15 m). Large effect sizes were observed between all SSGs apart from 3v3 vs 8v8, which observed a moderate effect size. Large effect sizes for strikers were observed between 3v3 vs 6v6 and 3v3 vs 8v8, whilst moderate effect sizes was observed between 6v6 vs 8v8. Strikers covered the greater distance during 3v3 (1286.5 ± 3.4 m) than 6v6 and 8v8 (Tables 4.12-4.16).

High velocity distance covered among players during SSGs observed large effect sizes within all SSGs and playing positions (Table 4.6), with moderate effect sizes found in 3v3 for central midfielders vs strikers and wide midfielders vs strikers. The greatest distance covered at high velocity during SSGs was by fullbacks during 8v8 (100.8 ± 2.7 m) with the least during 3v3 (17.9 ± 0.7 m) by centre-backs.

Large effect sizes were determined for centre-backs between all SSGs. The high velocity distance covered during 8v8 (32.4 ± 0.9 m) was greater than the distance covered during 3v3 (17.9 ± 0.7 m) and 6v6 (22.4 ± 0.3 m). Fullbacks covered the greatest distance compared to all positions during each SSG. Large effect sizes between each SSG for fullbacks were observed in high velocity distance between all SSGs. Fullbacks covered the greatest high velocity distance during 8v8 (100.6 ± 2.7 m) compared to distances during 3v3 (49.3 ± 1.5 m) and 6v6 (68.5 ± 0.7 m). Large effect sizes were observed for central midfielders between all SSGs for high velocity distance. Central midfielders covered 59.9 ± 1.3 m during 8v8, which was greater than 3v3 (30 ± 0.6 m) and 6v6 (44.8 ± 0.2 m). Wide midfielders covered the greatest amount of high velocity distance, after fullbacks, and large effect sizes were observed between all SSGs. Wide midfielders covered 80.1 ± 2.2 m during 8v8, which was greater than the high velocity distances covered during 3v3 (30.6 ± 0.9 m) and 6v6 (56.1 ± 0.3 m). Large effect sizes were observed for strikers for high velocity distances during all SSGs. The greatest high velocity distance was during 8v8 (68 ± 1.8 m) when compared to 3v3 (31.9 ± 1 m) and 6v6 (37.9 ± 0.5 m).

Total sprint distance covered during all SSGs observed large effect sizes within all game types (Table 4.7). All distances between playing positions varied during each SSG with wide midfielders covering the greatest total sprint distance during 8v8 (21.2 ± 1.1 m). The lowest total sprint distances covered was by strikers during 3v3 (0.1 ± 0 m). In addition, moderate effect sizes were observed during 8v8 (central midfielders vs strikers) and 3v3 (central midfielders vs strikers and wide midfielders vs strikers). Large effect sizes for total sprint distance for centre-backs was found between all SSGs. Centre-backs covered the most sprint distance during 8v8 (3.6 ± 0.3 m) when compared to 3v3 (0.6 ± 0.1 m) and 6v6 (0.4 ± 0 m). Large effect sizes were observed for fullbacks between all SSGs. Fullbacks covered the greatest total sprint distance during 8v8 (15.4 ± 1 m) when compared to 3v3 (1.4 ± 0.2 m) and 6v6 (7.6 ± 0.2 m). Large effect sizes were observed for Central midfielders between all SSGs for total sprint distance. The greatest sprint distance for central midfielders was during 8v8 (6.4 ± 0.4 m) when compared to 3v3 (0.3 ± 0 m) and 6v6 (2 ± 0 m). Large effect sizes were observed for wide midfielders among all SSGs, the greatest distance was during 8v8 (21.2 ± 1.1 m) compared to 3v3 (0.31 ± 0.1 m) and 6v6 (5.6 ± 0.1 m). Large effect sizes for strikers were observed for total sprint distance among all SSGs. The greatest sprint distance for strikers was during 8v8 (7 ± 0.4 m) compared to 3v3 (0.1 ± 0 m) and 6v6 (3 ± 0.1 m).

Sub-maximal accelerations observed large and moderate effect sizes within all game types (Table 4.8). The number of sub-maximal accelerations varied among all playing positions with the greatest number produced by central midfielders during 3v3 (32.24 ± 0.2). Moderate effect sizes were found during 8v8 between centre-backs vs all other playing positions, and fullbacks vs wide midfielders and strikers. Large effect sizes for centre-backs during SSGs were observed for sub-maximal accelerations. Centre-backs produced the greatest number of sub-maximal accelerations during 3v3 (28.5 ± 0.4) compared to 6v6 (17.2 ± 0.1) and 8v8 (16.8 ± 0.3). In addition, moderate effect sizes were observed between 6v6 and 8v8. Large effect sizes were observed for fullbacks among all SSGs. The greatest number of sub-maximal accelerations was produced during 3v3 (28 ± 0.4) compared to 6v6 (22.4 ± 0.2) and 8v8 (16.5 ± 0.3). Large effect sizes were observed among central midfielders between all SSGs. Central midfielders produced the greatest number of sub-maximal accelerations during 3v3 (32.24 ± 0.2) compared to 6v6 (22.5 ± 0.1) and 8v8 (17.4 ± 0.3). Large effect sizes were observed for wide midfielders among all SSGs for the number of sub-maximal accelerations. The greatest number produced for wide midfielders was during 3v3 (28.88 ± 0.3) in comparison to 6v6 (19.4 ± 0.1) and 8v8 (16.1 ± 0.3). Large effect sizes were observed among strikers during all SSGs. The greatest number of sub-maximal accelerations produced by strikers was during 3v3 (26 ± 0.3) in comparison with 6v6 (20 ± 0.1) and 8v8 (15.9 ± 0.5).

Large effect sizes were observed among maximal accelerations between most of the playing positions in all SSGs (Table 4.9). Fullbacks produced the greatest number of maximal accelerations during 3v3 (10 ± 0.3). The lowest number of maximal accelerations was produced during 6v6 (3.4 ± 0) by centre-backs. Furthermore, moderate effect sizes were observed for 8v8 (centre-backs vs central midfielders, fullbacks vs strikers and wide midfielders vs strikers) and 3v3 (central midfielders vs strikers).

Large effect sizes were observed among centre-backs between all SSGs apart from 3v3 vs 8v8. The greatest number of maximal accelerations produced by centre-backs was during 8v8 (3.9 ± 0.1) with the smallest numbers occurring during 3v3 (3.9 ± 0.1) and 6v6 (3.4 ± 0). Large effect sizes were observed among fullbacks between all SSGs. Fullbacks produced the greatest number of maximal accelerations during 3v3 (10 ± 0.3) with the lowest number of maximal accelerations produced in 6v6 (7.1 ± 0.1) and 8v8 (6.3 ± 0.2). Large effect sizes were observed among central midfielders between all SSGs. The greatest number of maximal accelerations produced by central midfielders was during 3v3 (7.7 ± 0.1) with 6v6 (5.4 ± 0) and 8v8 (3.7 ± 0.1) producing a lower number of maximal accelerations. Large effect sizes were observed among wide midfielders between all SSGs. The greatest number of maximal accelerations produced by wide midfielders was during 3v3 (8.8 ± 0.2), with the lower number of maximal accelerations produced during 6v6 (6.6 ± 0) and 8v8 (6.1 ± 0.2). Large effect sizes were observed among strikers between the majority of SSGs (3v3 vs 6v6 and 3v3 vs 8v8). The greatest number of maximal accelerations produced during SSGs for strikers were during 3v3 (7.37 ± 0.2) compared to 6v6 (5.7 ± 0.1) and 8v8 (5.7 ± 0.2).

Large effect sizes for RSE were observed between all playing positions among all SSGs (Table 4.10), with the exception of two moderate effect sizes observed between fullbacks vs wide midfielders in 3v3 and 6v6. Fullbacks produced the greatest amount of RSE during 3v3 (5.4 ± 0.2). The least amount of RSE produced was during 8v8 (0.7 ± 0) by centre-backs.

Large effect sizes were observed among centre-backs for RSE between SSGs. The greatest number of RSE produced during SSGs was during 3v3 (1.7 ± 0.1) with 6v6 (1 ± 0) and 8v8 (0.7 ± 0) producing lower RSE. Large effect sizes were observed among fullbacks between all SSGs, with the greatest amount of RSE produced during 3v3 (5.4 ± 0.2) when compared to 6v6 (3 ± 0) and 8v8 (2.7 ± 0.1). Large effect sizes were observed among central midfielders between all SSGs, with the greatest number of RSE being produced during 3v3 (3.3 ± 0.1) when compared to 6v6 (2 ± 0) and 8v8 (1.2 ± 0). Large effect sizes were observed between all SSGs among wide midfielders. 3v3 (5.1 ± 0.1) produced the greatest number of RSE, when compared to 6v6 (3.13 ± 0) and 8v8 (2 ± 0.1). Large effect sizes were observed among strikers between the majority of SSGs, with moderate effect sizes observed between 6v6 vs 8v8. Strikers produced more RSE during 3v3 (4.1 ± 0.1) than 6v6 (1.8 ± 0) and 8v8 (1.7 ± 0.1).

No large effect sizes were observed among the players' % HR_{max}, which indicates all SSGs were similar. However, moderate effect sizes were observed during 8v8 between centre-backs vs wide midfielders, central midfielders vs strikers and wide midfielders vs strikers. Wide midfielders during 8v8 (88 ± 5.3) produced the greatest % HR_{max} with the lowest during 8v8 (80 ± 5.4) among strikers. Furthermore, all positions between SSGs (i.e. centre-backs vs 3v3, 6v6 and 8v8) observed no large or moderate effect sizes.

RPE observed a single large effect size between fullbacks vs strikers during 3v3 (Table 4.11). Additionally, moderate effect sizes were reported between centre-backs vs fullback and strikers, in addition to fullbacks vs central midfielders and wide midfielders. The greatest RPE perceived was during 3v3 (7.7 ± 0.5) among fullbacks, with the lowest perceived RPE during 6v6 (4.7 ± 0.9) among strikers. All positions between SSGs observed moderate effect sizes for fullbacks during 3v3 vs 6v6 and 3v3 vs 8v8.

Table 4.12 *Large effect sizes for centre-backs between small-sided games and match play.*

Measure	Game Type	Effect Size
Total Distance	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.80
	6v6 vs Match Play	0.98
	8v8 vs Match Play	0.96
High Velocity Distance	3v3 vs 6v6	-0.97
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.99
	8v8 vs Match Play	-0.97
Sprint Distance	3v3 vs 6v6	0.88
	3v3 vs 8v8	-0.98
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.99
	8v8 vs Match Play	-0.96
Sub-maximal Accelerations	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.99
Maximal Accelerations	3v3 vs 6v6	0.95
	3v3 vs Match Play	0.99
	6v6 vs 8v8	-0.95
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.99
RSE	3v3 vs 6v6	0.98
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.90
	6v6 vs Match Play	0.99

Table 4.13 *Large effect sizes for fullbacks between small-sided games and match play.*

Measure	Game Type	Effect Size
Total Distance	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.96
	3v3 vs Match Play	0.99
	6v6 vs Match Play	0.98
	8v8 vs Match Play	0.96
High Velocity Distance	3v3 vs 6v6	-0.99
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.98
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.91
	8v8 vs Match Play	-0.97
Sprint Distance	3v3 vs 6v6	-0.99
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.98
	6v6 vs Match Play	-0.99
	8v8 vs Match Play	-0.99
Sub-maximal Accelerations	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.99
Maximal Accelerations	3v3 vs 6v6	0.98
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.93
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.99
RSE	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.90
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.99

Table 4.14 *Large effect sizes for central midfielders between small-sided games and match play.*

Measure	Game Type	Effect Size
Total Distance	3v3 vs 6v6	-0.92
	3v3 vs 8v8	-0.87
	3v3 vs Match Play	0.98
	6v6 vs Match Play	0.98
	8v8 vs Match Play	0.98
High Velocity Distance	3v3 vs 6v6	-0.99
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.98
	8v8 vs Match Play	0.92
Sprint Distance	3v3 vs 6v6	-0.99
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.99
	8v8 vs Match Play	-0.91
Sub-maximal Accelerations	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.98
Maximal Accelerations	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.97
RSE	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.98
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.96

Table 4.15 *Large effect sizes for wide midfielders between small-sided games and match play.*

Measure	Game Type	Effect Size
Total Distance	3v3 vs 6v6	0.99
	3v3 vs Match Play	0.98
	6v6 vs 8v8	-0.84
	6v6 vs Match Play	0.97
	8v8 vs Match Play	0.97
High Velocity Distance	3v3 vs 6v6	-0.99
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.98
Sprint Distance	3v3 vs 6v6	-0.99
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.99
	8v8 vs Match Play	0.95
Sub-maximal Accelerations	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.97
Maximal Accelerations	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.86
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.98
RSE	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.96

Table 4.16 *Large effect sizes for strikers between small-sided games and match play.*

Measure	Game Type	Effect Size
Total Distance	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.96
	3v3 vs Match Play	0.92
High Velocity Distance	3v3 vs 6v6	-0.96
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.99
Sprint Distance	3v3 vs 6v6	-0.99
	3v3 vs 8v8	-0.99
	3v3 vs Match Play	-0.99
	6v6 vs 8v8	-0.99
	6v6 vs Match Play	-0.99
	8v8 vs Match Play	-0.99
Sub-maximal Accelerations	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs 8v8	0.98
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.98
Maximal Accelerations	3v3 vs 6v6	0.98
	3v3 vs 8v8	0.97
	3v3 vs Match Play	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.99
RSE	3v3 vs 6v6	0.99
	3v3 vs 8v8	0.99
	3v3 vs Match Play	0.99
	6v6 vs Match Play	0.99
	8v8 vs Match Play	0.99
RPE	3v3 vs Match Play	-0.87
	6v6 vs Match Play	-0.87

4.4.2 Match Play

During match play, large effect sizes for total distance were observed between centre-backs vs central midfielders and strikers, fullbacks vs central midfielders and strikers, and central midfielders vs wide midfielders. Central midfielders covered the greatest total distance (1217.8 ± 16.5 m) whilst centre-backs covered the least (1036.5 ± 17.7 m). Additionally, moderate effect sizes (see Appendix E) were observed between centre-backs vs wide midfielders, and strikers vs central and wide midfielders.

Large effect sizes for centre-backs were observed between match play and all SSGs. The greatest distance covered was during 3v3 (1336 ± 3.2 m) when compared to match play (1036.5 ± 17.7 m). Large effect sizes were observed for fullbacks between all SSGs and match play. The greatest distance covered was during 3v3 (1328.1 ± 4.5 m) when compared to match play. Large effect sizes were observed among central midfielders between match play and all SSGs. Central midfielders covered the greatest total distance during 8v8 (1380.1 ± 12.8 m) in comparison to match play. Large effect sizes were observed among wide midfielders between match play and all SSGs. The greatest total distance by wide midfielders was produced during 3v3 (1301.6 ± 3.6 m) compared to match play. In contrast to other positions, large effect sizes were observed among strikers between 3v3 and match play. Strikers covered the greatest distance during 3v3 (1286.5 ± 3.4 m) when compared to match play. Furthermore, moderate effect size was observed between match play and 6v6.

Large effect sizes were observed during match play, when comparing high velocity distances between positions, with the only exception between fullbacks vs wide midfielders. The greatest high velocity distance covered was by fullbacks (76.2 ± 2.3 m).

Large effect sizes were observed among centre-backs between all SSGs when compared to match play. The greatest high velocity distance covered by centre-backs was during match play (40.9 ± 1 m). Large effect sizes were observed for fullbacks between SSGs and match play. The greatest distance produced was during 8v8 (100.77 ± 2.7 m) when compared to match play. Large effect sizes were observed among central midfielders between all SSGs when compared to match play. The greatest high velocity distance covered by central midfielders was during 8v8 (59.9 ± 1.3 m) when compared to match play (54.4 ± 1 m). Large effect sizes were observed among wide midfielders between 3v3 and 6v6 vs match play. The greatest high velocity distance produced by wide midfielders was during 8v8 (80.1 ± 2.2 m) when compared to match play (75 ± 2.6 m). In addition, moderate effect size was observed between 8v8 vs match play. Large effect sizes were observed among strikers between 3v3 and 6v6 vs match play. The greatest distance of high velocity produced was during 8v8 (68.± 1.8 m) when compared to match play (65.9 ± 2.7 m).

Large effect sizes were observed among total sprint distances between all playing positions during match play. Fullbacks covered the greatest amount of total sprint distance (20.95 ± 1 m) whilst centre-backs covered the least amount (6 ± 0.3 m).

Large effect sizes were observed for centre-backs when comparing total sprint distance during match play and SSGs. The greatest total sprint distance produced was during match play (6 ± 0.3 m). Large effect sizes were observed among fullbacks when comparing total sprint distance between match play and SSGs. The greatest sprint distance produced was during match play (21 ± 1 m). Large effect sizes were observed among central midfielders when comparing total sprint distance between match play and SSGs. The greatest total sprint distance was produced by match play (8 ± 0.3 m). Large effect sizes were observed among wide midfielders when comparing total sprint distance between match play and SSGs. The greatest sprint distance produced was during 8v8 (21.2 ± 1.1 m). Large effect sizes were observed among strikers when comparing total sprint distance during match play and SSGs. The greatest sprint distance produced was during match play (17.1 ± 0.8 m).

Large effect sizes were observed among sub-maximal accelerations between the majority of positions during match play. The greatest number of sub-maximal accelerations produced was by central midfielder (13.9 ± 0.3) with the least by centre-backs (10.1 ± 0.3). Additionally, moderate effect sizes were observed between centre-backs vs strikers, fullbacks vs wide midfielders and strikers.

Large effect sizes were observed for sub-maximal accelerations among match play and all SSGs when comparing centre-backs. The greatest number of sub-maximal accelerations produced was during 3v3 (28.5 ± 0.4). Large effect sizes were observed among fullbacks between match play and all SSGs. The greatest number of sub-maximal accelerations produced was during 3v3 (28 ± 0.4). Large effect sizes were observed among central midfielders between match play and all SSGs for the number of sub-maximal accelerations produced. The greatest number of sub-maximal acceleration produced was during 3v3 (32.2 ± 0.2). Large effect sizes were observed between match play and all SSGs for sub-maximal accelerations when comparing wide midfielders. The greatest number of sub-maximal acceleration produced was during 3v3 (26 ± 0.3). Large effect sizes were observed among strikers between match play and all SSGs. The greatest number of sub-maximal accelerations produced was during 3v3 (26 ± 0.3).

Large effect sizes were observed for maximal accelerations among the majority of positions during match play. The greatest number of maximal accelerations produced during match play was by wide midfielders (3.8 ± 0.2), with the least produced by centre-backs (2.4 ± 0.1). Furthermore, moderate effect sizes were observed between fullbacks vs strikers.

Large effect sizes were observed between match play and all SSGs for maximal accelerations when comparing centre-backs. The greatest number of maximal accelerations produced was during 8v8 (3.9 ± 0.1). Large effect sizes were observed among fullbacks between match play and all SSGs. The greatest number of maximal accelerations produced was during 3v3 (10 ± 0.3). Large effect sizes were observed among central midfielders between match play and all SSGs. The greatest number of maximal acceleration produced was during 3v3 (7.7 ± 0.1). Large effect sizes were observed between match play and all SSGs when comparing wide midfielders. The greatest number of maximal accelerations produced was during 3v3 (8.82 ± 0.2). Large effect sizes were observed among strikers between match play and all SSGs. The greatest number of maximal accelerations produced was during 3v3 (7.4 ± 0.2).
Large effect sizes were observed for RSE between several playing positions during match play. These included wide midfielders vs centre-backs, fullbacks, central midfielders and strikers. The greatest number of RSEs produced during match play

was by wide midfielders (1.3 ± 0.1), with the smallest number produced by strikers (0.6 ± 0). Additionally, moderate effect sizes were observed between fullbacks vs centre-backs and strikers.

Large effect sizes were observed among centre-backs between match play and SSGs. The highest number of RSEs produced by centre-backs was during 3v3 (1.7 ± 0.1). Furthermore, moderate effect size was observed between 8v8 vs match play. Large effect sizes were observed among fullbacks between match play and all SSGs. The greatest number of RSEs produced was during 3v3 (5.4 ± 0.2). Large effect sizes were observed among central midfielders between match play and all SSGs for the number of RSEs produced. The greatest number of RSEs produced was during 3v3 (3.3 ± 0.1). Large effect sizes were observed between match play and all SSGs when comparing wide midfielders. The greatest number of RSEs produced was during 3v3 (5.1 ± 0.1). Large effect sizes were observed among strikers between match play and all SSGs. The greatest number of RSEs produced was during 3v3 (4.1 ± 0.1).

No large effect sizes were observed among % HR_{max} during match play. Fullbacks (81 ± 4.2), central-midfielders (81 ± 7.7) and wide midfielders (81 ± 10.5) produced the highest % HR_{max} during match play, with the lowest by strikers (75 ± 8). Furthermore, no large or moderate effect sizes were observed between match play and SSGs.

Two large effect sizes were observed for RPE during match play, including wide midfielders vs central midfielders and strikers. The greatest perceived RPE during match play was by strikers (7 ± 0), with the lowest perceived RPE from wide midfielders (6 ± 0). Furthermore, a number of moderate effect sizes were observed between playing positions during match play (centre-backs vs wide midfielders and strikers, fullbacks vs wide midfielders and strikers).

No large effect sizes were observed among centre-backs when comparing RPE between match play and SSGs. The greatest perceived RPE was during match play (6.5 ± 0.5). However, moderate effect sizes were observed between match play vs 6v6 and 8v8. No large effect sizes were observed among fullbacks between match play and SSGs. The greatest perceived RPE was during 3v3 (7.7 ± 0.5). Additionally, moderate effect sizes were observed between match play vs 3v3 and 6v6. No large effect sizes were observed among central midfielders between match play and SSGs. The greatest perceived RPE was during match play (6.8 ± 0.4). Nonetheless, a moderate effect size was observed between match play vs 6v6. No large effect sizes were observed among wide midfielders between match play and SSGs. The greatest perceived RPE was during match play (6 ± 0). However, a moderate effect size was observed between match play vs 6v6. Large effect sizes were observed among strikers between match play and SSGs (match play vs 3v3 and 6v6). The greatest perceived RPE was during match play (7 ± 0). In addition, a moderate effect size was observed between match play vs 8v8.

CHAPTER 5

5.0 DISCUSSION

The purposes of the study were (1) to compare total distance, total distance covered at high velocity, total number of repeated sprints efforts, sprint distance, number of submaximal accelerations and number of maximal accelerations (physical variables), average heart rate (expressed as a percentage of the players' maximum heart rate; physiological variable) and player RPE (perceptual variable) between SSGs with different player numbers (3v3, 6v6 and 8v8); (2) to determine the physical, physiological and perceptual differences between SSGs and match play; and (3) to measure the effect of positional differences between SSGs and match play. A main finding from this study was that significant differences in physical demands were observed between SSGs and match play. Significant differences were found between all SSGs as well as between SSGs and match play in regards to all physical variables. However, only few physiological and perceptual significant differences were found between SSGs and match play (% HR_{max} and RPE). Additional key findings include the large effect of playing position on physical variables during SSGs and match play, although no large effect sizes were identified in regards to the player % HR_{max} and few for player RPEs. Thus, HR and RPE responses were similar despite significant differences in physical requirements. The results from this study may be valuable for coaches and others involved in the development and application of SSGs during training sessions. Coaches should also take into consideration the effects of positional roles when including SSGs in training.

5.1 Small-Sided Games vs. Match Play

Research question 1 asked whether there were any (physical, physiological and perceptual) differences between SSGs with different team sizes (3v3, 6v6 and 8v8). It is fundamentally important to know what physical, physiological and perceptual demands are imposed by SSGs so that coaches can design and implement specific training sessions with the understanding of what demands each SSG will impose. Subsequently, research question 2 asked whether there were any differences or similarities between SSGs and match when measuring the physical, physiological and perceptual demands.

5.1.1 Differences in Physical Demands between Small-Sided Games and Match Play

Total distance covered during SSGs increased as pitch size and player number was reduced (see Appendix F). Players on average (per 10 min) covered 1319.9 ± 22.4 m during 3v3, which was a greater distance than during 6v6 (1249.6 ± 59.7 m) and 8v8 (1244.1 ± 81.3 m). This is contradictory to results found in the study of Casamichana & Castellano (2010), who found that players covered a greater total distance in larger SSGs. It can be suggested that these conflicting results stem from differences in study methodologies, including the different SSG formats. The smaller SSGs (3v3) encourage players to move constantly, whereas the larger SSGs (8v8) allow players recovery time due to the bigger pitch size and the football not being in their vicinity as often. Therefore, larger SSGs will produce less total distance per 10 minutes when compared to smaller SSGs such as 3v3.

The monitoring and evaluation of high intensity activities (high velocity distance and sprint distance) in professional football is essential as football matches at the highest level are characterised by large numbers of high-intensity running bouts by players. The results of the present study show a greater distance of high velocity running covered during match play and 8v8 than any of the other SSGs (see Appendix H) with a significant difference observed between 8v8 and 3v3. Additionally, moderate effect sizes were reported between match play and 3v3, as shown in Appendix J. The larger the pitch size and player number increased the distance of high-velocity running and total sprint distance, although total sprint distances during match play exceeded all demands compared to SSGs. Therefore to improve this capacity (high-velocity running), coaches should utilise 8v8 (or similar) SSGs frequently in training. Pitch size plays a significant role in the players' abilities to produce high velocity and sprint distances. The smaller pitch sizes used in 3v3 and 6v6 will limit players' abilities to produce any high intensity distances, whereas during 8v8 and match play, players have a much larger area to be able to complete a significantly higher number of high intensity movements. The present findings differ from those of Dellal et al. (2012) who reported a greater total distance covered both in high velocity running and sprinting in all playing positions during SSGs in comparison to match play. This disparity may have resulted from the sub-maximal and maximal accelerations not being measured in the Dellal et al. (2012) study, which would therefore be reduce the total distance attributed to high velocity and sprinting distances.

Repeated sprint ability (RSA) is an essential performance ability in professional football players (Glaister, 2005; Spencer et al., 2005). In the present study, significant differences were found between 3v3 and 8v8, as well as 3v3 and match play (see Appendix L) for RSA. Although a greater number of repeated sprint efforts (RSE) were performed in 3v3 per 10 minutes than in 8v8 and match play, it should be remembered that the total number of RSEs would still be greater in 8v8 and match play due to games being much longer in duration. With these results, it can be suggested that 8v8 would be more specific in helping develop a player's repeated sprint ability, but it is also clear that players will have to complete specific repeated sprint training in order to replicate the demand of match play.

Currently, there is a paucity of research describing the RSE requirements in professional football players in regards to match play performance versus SSGs. A study by Casamichana et al. (2012) was the first to monitor RSE (referred as repeated high intensity efforts in the study, RHIE) between SSGs and match play, in semi-professional football players. They reported similar results to the present study in that SSGs (from 3v3 to 8v8) elicited few RSEs and questioned whether SSGs are the correct tool to use to help replicate the demands of match play.

When examining player activity and performance during training and match play, accelerations are a fundamental aspect that has to be considered, as high intensity activities are less relevant in smaller areas associated with SSGs (Castellano & Casamichana, 2013). Sub-maximal and maximal accelerations are common, therefore the failure to monitor and evaluate them would lead to a significant underestimation of the amount of high intensity activity performed by the players (Varley & Aughey, 2012). The results of the present study show that SSGs elicited a significantly greater number of sub-maximal and maximal accelerations when compared to match play (see Appendix N and P). In addition, 3v3 produced significantly more sub-maximal accelerations than any other SSG, as well as producing the greatest number of maximal accelerations when compared to all other SSGs and match play. Additionally, results from this study clearly show that players, across all SSGs and match play, produced a far greater number of sub-maximal accelerations compared to maximal accelerations. Therefore, coaches are encouraged to implement smaller pitch sizes and reduce player numbers when using SSGs to elicit greater numbers of maximal and sub-maximal accelerations.

A recent study, the first to this author's knowledge, supports these findings by showing that the number of accelerations was greater during a 4v4 SSG compared to match play (Castellano & Casamichana, 2013). It can be suggested that accelerations are far more common in smaller areas such as SSGs as in the present study it was found that a greater number of both sub-maximal and maximal accelerations were performed in 3v3 than in match play. This can be directly linked to the lesser amount of high velocity running and sprint distance performed during smaller area SSGs, as players are more likely to accelerate into space, rather than run (jog) or sprint. Also, it is important to note that a majority of players' accelerations were at a sub-maximal intensity, which would indicate that it is essential to include such a measure when determining the acceleration profiles of players during SSGs and match play.

Current research has indicated that match play performance indicators can significantly differ between games (Gregson, Drust, Atkinson & Salvo, 2010). Systems such as GPS have been used to show significant between-game differences with time-motion analysis results involving high velocity running (Randers, Mujika, Hewitt, Santisteban, Bischoff & Solano, 2010). Therefore, this present study identifies this as a limitation in the comparison on SSGs and match play. Furthermore, all physical variables can be affected by situational factors during match play and SSGs, including the match score, team formation alterations, substitutions, tactical changes, which will directly influence the overall workload of the team, making it hard to establish consistent trends.

5.1.2 Differences in Physiological and Perceptual Demands between Small-Sided Games and Match Play

SSGs have been described as a football conditioning activity that allows an improvement in the aerobic capacity of players (Dellal, Chamari, Pintus, Girard, Cotte & Keller, 2008; Kelly & Drust, 2009). The present study revealed no significant differences between SSGs and match play in regards to $\%HR_{max}$ (see Appendix R), which is similar to the results of Dellal et al. (2008) who found no differences between SSGs and match play. In contrast, Dellal et al. (2012) and Allen, Butterfly, Welsh and Wood. (1998) found HR during SSGs to be significantly higher than match play in all positions. This disparity could be due to differences in methodology (i.e. pitch sizes). Although no significant difference was reported between SSGs and match play in the present study, $\%HR_{max}$ was higher during SSGs with 8v8 producing a higher $\%HR_{max}$ among all players than during 3v3. These results suggest that SSGs illicit a higher $\%HR_{max}$ in players when compared to match play, but $\%HR_{max}$ was not significantly different.

In contrast, Owen et al. (2011) reported significant differences between 3v3 and 9v9, with 3v3 producing a higher HR. This could be due to different time durations of SSGs and recovery periods in-between bouts. However, HR monitoring is not considered to be the best indicator of physiological demands in SSGs and match play, as it should be used in collaboration with time-motion analysis to provide a comprehensive analysis of training and match play loads.

RPE is often used as an alternative indicator of a player's training load (Rampinini et al., 2007). The results of this present study showed RPE to be similar between 3v3 SSG and match play, but a significant difference was found between 3v3 and 6v6, as well as match play and 6v6; 3v3 and match play produced higher values than any other SSG (see Appendix T). Comparable results were reported by Dellal et al. (2012) who found similar RPE values between a 4v4 SSG and match play. It would be expected from these results that 3v3 and match play were perceived by the players to induce a higher intensity of play than 6v6 and 8v8. With respect to match play (90 min plus added time), it is likely that the total playing time was a major factor influencing the perceived exertion; the RPE scale used in the present study does not provide information in regard to the influences of exercise intensity versus duration (i.e. volume).

5.2 Effect of Playing Position on Small-Sided Games and Match Play

Research question 3 asked how the physical, physiological and perceptual demands of SSGs vary with player position, and how these compare to the demands of match play. It is important for coaches, sport scientists and others understand the impact of playing position on a player's activity profile during match play and training sessions, specifically SSGs. Furthermore, the formation of the team, in this case 1-4-2-3-1, can considerably alter the demands on the players in their playing position. For example, in the 1-4-2-3-1 formation, a fullback will be required to join in attacking plays as well as defend, whereas in a 4-4-2 formation they would be expected to hold their defending position but not join in attacks (see Appendix V).

5.2.1 Effect of Playing Position on Physical Demands

Due to the distances travelled during match play by all players (~9-13 km) (Stolen et al., 2005) a high degree of aerobic endurance is required in professional football (Dellal et al., 2011). In the present study it was found that central midfielders covered the greatest total distance during SSGs and match play when compared to other positions (see Appendix G), with the greatest total distance (on average every 10 min) being covered during 3v3 SSGs. Nonetheless, central defenders were found to cover the least total distance during SSGs and match play. Di Salvo et al. (2007) found similar results, with central midfielders covering a greater overall distance than any other position. This is because central midfielders have been reported to cover the greatest distance of moderate velocities during match play due to their tactical role, as they are always moving and are expected to join in attack and assist in defence. In contrast, Dellal et al. (2011) found significant differences between wide midfielders and central midfielders in regards to total distances covered (in a study comparing the English Premier League and the Spanish La Liga). They reported that wide midfielders covered a greater total distance than central midfielders and other players. It can be suggested that these differences exist with the present study due to players from different leagues being analysed, with the English Premier League and Spanish La Liga known to be among the most competitive leagues in the world.

In the present study wide midfielders and fullbacks were found to cover the greatest distance at high intensity (i.e. high velocity distance, sprint distance and maximal accelerations) in both SSGs and match play (see Appendix I, K, O and Q), whilst central defenders consistently covered the least distance at high intensity. Studies have reported similar results with respect to high velocity movement and acceleration profiles between playing positions (Varley & Aughey, 2012). It is common for centre-backs and central midfielders to perform fewer sprints when compared to other positions (Bradley et al., 2009a; Di Salvo et al., 2010; Di Salvo, Gregson, Atkinson, Tordoff & Drust, 2009; Hopkins, Marshall, Batterham & Hanin, 2009). This is possibly due to the congestion on the pitch in these playing positions, which would therefore leave insufficient distance for high velocity movement and maximal accelerations to be accomplished. The fullbacks are typically required to perform both defensive and offensive responsibilities, which would result in the players performing backwards and forwards movement continuously, which would explain the high number of high-velocity runs, maximal accelerations and total sprint distance in SSGs and match play (Varley & Aughey, 2012). A study by Carling et al. (2008) revealed similar results, with wide midfielders accumulating the greater high velocity and sprint distance, although, Dellal et al. (2011) found attackers (strikers) to cover the greater high intensity distances when monitoring match play in the English Premier League and Spanish La Liga. A study by Wehbe et al. (2013) also found that defenders covered less high intensity and sprint distance than midfielders and attackers, and that defenders produced a high frequency of medium-intensity accelerations and decelerations and an even greater number of maximal decelerations compared to attackers. This suggests that although defenders do not cover an equal or greater distance in regards to high velocity and sprint distance, the physiological stress imposed during match play and SSGs may not necessarily be less. Such findings as these, in addition to those of the present study, highlight the importance of position-specific conditioning.

Furthermore, wide midfielders and fullbacks tend to cover a greater high intensity distance than any other playing position due to their tactical roles, as they are required to work up and down the field of play to help in attack and then get back into position as fast as possible when the ball has been turned over to the opposition. However, this varies somewhat relative to the team's playing formation during match play, 1-4-2-3-1. This modern-day formation (utilised by teams including; Arsenal, Manchester City, Real Madrid and Bayern Munich) would have a substantial effect on the tactical roles of players and their positions. These results, along with other studies, would therefore suggest high velocity and sprint conditioning would be more beneficial to fullbacks, wide midfielders and strikers than any other playing position.

Previous research has clearly demonstrated no decrement was in a player's performance when short-duration sprints (approximately 5.5 s) are repeated every 120 s (Balsom, Seger, Sjodin & Ekblom, 1992). Furthermore, when recovery rate was reduced to 90 s, a significant reduction in player performance was only evident after a large number of sprints were performed (Balsom et al., 1992). However, due to the unpredictability of team sports, sprint running is not evenly dispersed throughout a match, and intense phases of RSEs are critical to the team's performance, and most importantly, the outcome of the match (Spencer et al., 2004). Nonetheless, there is currently limited research in football on RSE in regards to match play and SSG demands, when comparing playing positions. The results of the current study suggest that fullbacks and wide midfielders to produce the highest number of RSEs when compared to all other playing positions during SSGs and match play (see Appendix M). This would suggest significant differences in high relation in regards to high velocity and sprint distances covered between playing positions with respect to RSEs.

5.2.2 Effect of Playing Position on Physiological and Perceptual Demands

Monitoring during training allows the evaluation of the players' overall workloads, including SSGs. This type of monitoring helps in the understanding of exercise intensity during training drills and match play, relative to the team's physical, physiological and perceptual performances. It also provides valuable real-time information to help coaches determine whether specific goals are met during the training sessions (Sassi, Reilly & Impellizzeri, 2005). In the present study, all playing positions produced similar % HRmax as no large effect sizes were reported. However, wide midfielders did account for the highest % HRmax, with the peak % HRmax being produced during 8v8 SSGs (see Appendix S). This suggests that SSGs provide an increased intensity compared to match play across all playing positions. Previous studies (Dellal et al., 2012) have also reported that SSGs produced a greater % HR_{max} than compared to match play in all playing positions. In addition, the study of Dellal et al. (2012) found wide midfielders to have a higher % HR_{max} (than other positions) during SSGs as well as one the highest during match play. In relation to the present study, this can be linked to the large demand of high intensity activities that are associated with this position. Therefore, the application of SSGs in training do elicit a demand greater than match play (in regards to % HRmax) and these physiological demands do vary between positions, so it is essential to recognise that wide midfielders and fullbacks will produce a greater % HRmax than centre-backs, central midfielders and strikers due to their positional role (greater number of high intensity running).

The perceptual measure of RPE can indicate a player's internal load. The present study suggest that a player's RPEs tends to be similar across the majority of playing positions, apart from fullbacks and strikers who reported a large effect size during 3v3 (ES = 0.89) as well as strikers during 3v3 and 6v6 vs match play. The highest RPE reported was by fullbacks during 3v3 SSGs and strikers during match play, with wide midfielders reporting lower RPE values during match play than other positions (see Appendix U). It can be suggested that, due to the high number of maximal accelerations and high intensity activities, fullbacks perceived SSGs and match play as very demanding. Wide midfielders reported low RPEs, indicating that they were well conditioned for the demands of SSGs and match play, and were therefore able to effectively produce the high intensity activities required of them. RPE appears to be a good indicator of the differences in intensity between playing positions during SSGs and match play. Casamichana and Castellano (2010), dissimilar results were found to the present study, as the lowest RPEs were recorded for the smaller SSGs, which related to the observed physiological and physical responses in SSGs, and similar results have been reported by others (Rampinini et al., 2007). It can be suggested that RPE values found in the present study differ to others because player position was not considered previously and because RPE values were recorded after each training session (i.e. after other training drills were completed), which may have affected RPE values, recorded presently. This limitation should be overcome in future studies, as is therefore a limitation to the study. Therefore, the use of RPE can help determine how different playing positions perceive the demands in SSGs and match play, and it can also indicate whether players are fatigued when used alongside HR and TMA monitoring.

5.3 Conclusions

Overall, the results of the present study, and others, suggest that SSGs offer training stimulus to professional football players, which may exceed (or replicate) the demands of match play (Barbero, Soto, Barbero & Granda, 2008; Gabbett, 2008; Gabbett, Jenkins & Abernethy, 2009; Rodrigues, Mortimer, Condessa, Coelho, Soares, & Garcı´a, 2007). The SSGs used in the present study (3v3, 6v6 and 8v8) allow specific physical and physiological variables (variables that are considered important in the profile of a professional football player) to be focused on more than others dependent on the size of the SSG. This study is novel as it also described the differences in sub-maximal and maximal accelerations as well as RSEs in SSGs and match play.

The results also suggest that SSGs with goalkeepers (i.e. examined in the present study) play a significant role in the overall activity of players during SSGs. Players would revert to their tactical positions when a goalkeeper is used. This is due to defenders protecting their goal, whilst midfielders and attackers will attack to try create and score goals, similar to match play. This is why the structure of SSGs is paramount when a coach decides to incorporate them into the training session. The inclusion of goalkeepers creates a more match play-specific scenario. This is displayed in the results of the present study as centre-backs covered less distance and high intensity distances compared to fullbacks and wide midfielders, and central midfielders covered a greater sub-maximal total distance and number of sub-maximal accelerations compared to all other positions, comparable to the demands of match play. Additionally, factors such as tactics, quality of opponents, environment and coaches instructions all play a vital role in the players' overall demand during SSGs and match play.

The main findings of the present study demonstrate that smaller SSGs do not produce adequate sprint distances and high velocity distances (high intensity movements) compared to match play. This can be detrimental to a player's conditioning and increase the risk of injury if a player is not exposed to the high intensity demands of match play, particularly in fullbacks and wide midfielders. Furthermore, this also suggests that the sprint distances in RSEs are also being insufficiently produced during SSGs due to the insufficient number of high intensity running. Nonetheless, SSGs did produce a greater number of accelerations (sub-maximal and maximal) when compared to match play, ensuring players are being exposed to a greater number of accelerations (per 10 min). Accelerations during SSGs also elicit position-specific responses, as central-midfielders produced a greater number of sub-maximal accelerations compared to all other positions (directly linked to the greater demand of sub-maximal running during match play), as well as wide midfielders and fullbacks producing a greater number of maximal accelerations (directly linked to the greater demands of high intensity running during match play). The results of the present study clearly indicate that the smaller SSGs produced the greater number of accelerations (i.e. 3v3).

5.4 Recommendations for Future Research

There are areas that warrant further investigation. One notable omission from this study is that technical demands during SSGs and match play were not described. Although previous research has described the technical demands of match play and SSGs separately, there is a lack of knowledge regarding the technical demands of SSGs (with goalkeepers as additions) compared to match play. Additionally, further analysis of SSGs and match play is required in regards to RSEs. There are no studies, to the author's knowledge, examining the time points at which RSEs occur during SSGs and match play. This may then lead to specific training drills that combine RSEs with the correct match play situation (specificity). The simultaneous use of video analysis and TMA can achieve this.

5.5 Practical Applications

In summary, the present study adds to the limited information regarding training and match play demands of professional footballers in Australia. The physical, physiological and perceptual demands described in this study can be used to make comparisons with other professional football leagues, whilst also providing fundamental information on the demands of SSGs and how specific SSGs might used for the development of important attributes. Furthermore, the present data may be useful for coaches who do not have access to the monitoring tools used in this study, since a picture of physical, physiological and perceptual demands has been described. Novel information regarding RSE characteristics in professional footballers in Australia has been presented. RSEs and total sprint distance are position specific and appear to require a targeted training approach rather than the use of SSGs in isolation. Therefore, it is suggested that coaches include drills or modify SSGs to focus on these specific physical capacities.

CHAPTER 6

REFERENCES

Allen, J. D., Butterfly, R., Welsh, M. A., & Wood, R. (1998). The physical and physiological value of 5-a-side soccer training to 11-aside match play. *Journal of Human Movement Studies, 34*, 1–11.

Ali, A., & Farrally, M. (1991). Recording soccer players' heart rates during matches. *Journal of Sports Sciences, 9*(2), 183-189.

Astrand, P., & Rodahl, K. (1986). *Textbook of Work Physiology* (3 ed.). New York: McGraw-Hill.

Aughey, R. J. (2011). Applications of GPS technologies to field sports. *International Journal of Sports Physiology & Performance*, *6*(3), 295-310.

Balsom, P., Seger, J., Sjodin, B., & Ekblom, B. (1992). Maximal-intensity intermittent exercise: effect of recovery duration. *International Journal of Sports Medicine, 13,* 528-533.

Bangsbo, J. (1994a). The physiology of soccer: With special reference to intense intermittent exercise. *Acta Physiologica Scandinavica, 619,* 1-155.

Bangsbo, J. (1994b). Physiological demands. In B. Ekblom (Ed.), *Football (Soccer)* (pp. 43-59). London: Blackwell Scientific.

Bangsbo, J., Norregaard, L., & Thorso, F. (1991). Activity profile of competition soccer. *Canadian Journal of Sports Science, 16*(2), 110-116.

Barbero-Álvarez, J. C., Coutts, A., Granda, J., Barbero-Álvarez, V. B., & Castagna, C. (2009). The validity and reliability of a global positioning satellite system device to assess speed and repeated sprint ability (rsa) in athletes. *Journal of Science and Medicine in Sport, 13*(2), 232-235.

Barbero, J. C., Soto, V. M., Barbero, V., & Granda, J. (2008). Match analysis and heart rate of futsal players during competition. *Journal of Sport Sciences, 26,* 63-73.

Bishop, D. (2003). Predictors of repeated sprint ability in elite female hockey players. *Journal of Science and Medicine in Sport, 6,* 199–209.

Bloomfield, J., Polman, R., & O'Donoghue, P. (2007). Physical demands of different positions in FA Premier League soccer. *Journal of Sports Science and Medicine, 6,* 63-70.

Bompa, T. (1983). *Theory and methodology of training.* Dubusque, Iowa: Kendall/Hunt.

Bradley, P. S., Carling C., Archer, D., Roberts, J., Dodds, A., Di Mascio, M., Paul, D., Diaz, A. G., Peart, D., & Krustrup, P. (2011). The effect of playing formation on high-intensity running and technical profiles in English FA Premier League soccer matches. *Journal of Sports Sciences, 29*(8), 821-830.

Bradley, P. S., Mascio, M. D., Peart, D., Olsen, P., & Sheldon, B. (2009b). High-intensity activity profiles of elite soccer players at different performance levels. *Journal of Strength and Conditioning Research, 24*(9), 2343-2351.

Bradley, P. S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P., & Krustrup, P. (2009a). High-intensity running in English FA Premier League soccer matches. *Journal of Sports Sciences, 27*(2), 159-168.

Buchheit, M., & Mendez-Villanueva, A. (2013). Supramaximal intermittent running performance in relation to age and locomotor profile in highly-trained young soccer players. *Journal of Sports Sciences, 31*(13), 1402-1411.

Buchheit, M., Mendez-Villanueva, A., Simpson, B. M., & Bourdon, P. C. (2010). Repeated-sprint sequences during youth soccer matches. *International Journal of Sport Medicine, 31*(10), 709-716.

Burgess, D. J., Naughton, G., & Norton, K. I. (2006). Profile of movement demands of national football players in Australia. *Journal of Science and Medicine in Sport, 9*(4), 334-341.

Carling, C., Bloomfield, J., Nelsen, L., & Reilly, T. (2008). The role of motion analysis in elite soccer: Contemporary performance measurement techniques and work rate data. *Sports Medicine, 38*(10), 839-862.

Carling, C., Williams, A., & Reilly, T. (2005). *Handbook of soccer match analysis: A systematic approach to improving performance*. Abingdon: Routledge.

Casamichana, D., & Castellano, J. (2010). Time-motion, heart rate, perceptual and motor behaviour demands in small-sides soccer games: Effects of pitch size. *Journal of Sports Sciences, 28*(14), 1615–1623.

Casamichana, D., Castellano, J., & Castanga, C. (2012). Comparing the physical demands of friendly matches and small-sided games in semi-professional soccer players. *Journal of Strength and Conditioning Research, 26*, 837-843.

Castagna, C., Belardinelli, R., Impellizzeri, F. M., Abt, G. A., Couttse, A. J., & D'Ottavioa, S. (2007). Cardiovascular responses during recreational 5-a-side indoor-soccer. *Journal of Science & Medicine in Sport, 10*(2), 89-95.

Castellano, J., & Casamichana, D. (2013). Differences in the number of accelerations between small-sided games and friendly matches in soccer. *Journal of Sports Science and Medicine, 12*, 209-210.

Cavagna, G. A., Komarek, L., & Mazzoleni, S. (1971). The mechanics of sprint running. *Journal of Physiology, 217,* 709-721.

Clemente, F., Couceiro, M. S., Martins, F. M. L., & Rui Mendes. (2012). The usefulness of small-sided games on soccer training. *Journal of Physical Education and Sport, 12*(1), 93-102.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2 ed.). New York: Academic Press.

Coutts, A. J., Rampinini, E., Marcora, S. M., Castagna, C., & Impellizzeri, F. M. (2007). Heart rate and blood lactate correlates of perceived exertion during small-sided soccer games. *Journal of Science and Medicine in Sport, 12,* 79-84.

Day, M. L., McGuigan, M. R., Brice, G., & Foster, C. (2004). Monitoring exercise intensity during resistance training using the session RPE scale. *Journal of Strength and Conditioning Research, 18*(2), 353-358.

Dellal, A., Chamari, K., Wong, D. P., Ahmaidi, S., Keller, D., Barros, R., et al. (2011). Comparison of physical and technical performance in European soccer match-play: FA Premier League and La Liga. *European Journal of Sport Science, 11*(1), 51-59.

Dellal, A., Lago-Penas, C., & Chamari, K. (2011). Effect of the number of ball contacts within bouts of 4 vs. 4 small-sided soccer games. *International Journal of Sports Physiology & Performance, 6*(3), 322-333.

Dellal, A., Owen, A., Wong, D. P., Krustrup, P., van Exsel, M., Mallo, J. (2012). Technical and physical demands of small vs. large sided games in relation to playing position in elite soccer. *Human Movement Science*, 31, 957-969.

Dellal, A., Wong, D. P., Moalla W. M., & Chamari, K. (2010). Physical and technical activity of soccer players in the French first league: With special reference to their playing position. *International SportMed Journal, 11*(2), 278-290.

Dellal, A., Chamari, K., Pintus, A., Girard, O., Cotte, T., & Keller, D. (2008). Heart rate responses during small-sided games and short intermittent running training in elite soccer players: A comparative study. *Journal of Strength Conditioning and Research, 22*, 1449–1457.

Di Salvo, V., Baron, R., Gonzalez-Haro, C., Pigozzi, F., & Bachl, N. (2010). Sprinting analysis of elite soccer players during European Champions League and UEFA Cup matches. *Journal of Sports Sciences, 28*, 1489-1494.

Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in premier league soccer. *International Journal of Sports Medicine*, *30*, 205-212.

Di Salvo, V., Baron, R., Tschan, H., Calderon Montero., F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine, 28*(3), 222-227.

Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi1, F. (2006). Performance Characteristics According to Playing Position in Elite Soccer. *International Journal of Sports Medicine, 28*(3), 222-227.

Di Salvo, V., Collins, A., McNeill, B., & Cardinale, M. (2006). Validation of Prozone: A new video-based performance analysis system. *International Journal of Performance Analysis in Sport, 6*(1), 108-119.

Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in premier league soccer. *International Journal of Sports Medicine 30*(1), 205-212.

Dobson, B. P., & Keogh, J. W. L. (2007). Methological issues for the application of time-motion analysis research. *Strength and Conditioning Journal, 29*(2), 48-55.

Drust, B., Atkinson, G., & Reilly, T. (2007). Future perspectives in the evaluation of the physiological demands of soccer. *Sports Medicine, 37*(9), 783-805.

Drust, B., Reilly, T. & Cable, N. (2000). Physiological responses to laboratory-based soccer-specific intermittent and continuous exercise. *Journal of Sports Sciences, 18*, 885–892.

Eniseler, N. (2005). Heart rate and blood lactate concentrations as predictors of physiological load on elite soccer players during various soccer training activities. *Journal of Strength & Conditioning Research, 19*(4), 799-806.

Esposito, F., Impellizzeri, F. M., Margonato, V., Vanni, R., Pizzini, G., & Veicsteinas, A. (2004). Validity of heart rate as an indicator of aerobic demand during soccer activities in amateur soccer players. *European Journal of Applied Physiology, 93(2), 167-172.*

Foster, C., Florhaug, J. A., Franklin, J., Gotschall, L., Hrovatin, L. A., Parker, S., Doleshal, P., & Dodge, C. (2001). A new approach to monitoring exercise training. *Journal of Strength and Conditioning Research, 15*(1), 109-115.

Foster, C. (1998). Monitoring training in athletes with reference to overtraining syndrome. *Medicine and Science in Sports and Exercise, 30*(7), 1164-1168.

Foster, C., Hector, L. L., Welsh, R., Schrager, M., Green, M. A., & Snyder, A. C. (1995). Effects of specific versus cross-training on running performance. *European Journal of Applied Physiology and Occupational Physiology, 70*(4), 367-372.

Gabbett, T. J. (2008). Do skill–based conditioning games offer a specific training stimulus for junior elite volleyball players? *Journal of Strength Conditioning Research, 22*, 509–517.

Gabbett, T. J., Jenkins, D., & Abernethy, B. (2009). Game–based training for improving skill and physical fitness in team sport athletes. *International Journal of Sports Science Coaching, 4*, 273–283.

Gabbett, T. J., & Mulvey, M. J. (2008). Time-motion analysis of small-sided training games and competition in elite women soccer players. *Journal of Strength & Conditioning Research, 22*(2), 543-553.

Glaister, M. (2005). Multiple sprint work: physiological responses, mechanisms of fatigue and the influence of aerobic fitness, *Journal of Sports Medicine, 35*, 757-777.

GPSports' SPI Elite & Team AMS. (n.d.). Retrieved August 25, 2013, from http://www.gpsports.com/

Gregson, W., Drust, B., Atkinson, G., & Salvo, V. D. (2010). Match-to-match variability of high-speed activities in premier league. *International Journal of Sports Medicine, 31*, 237‐242.

Hill-Haas, S. V., Dawson, B., Impellizzeri, F. M., & Coutts, A. J. (2011). Physiology of small-sided games training in football: a systematic review. *Sports Medicine, 41*(3), 199-220.

Hill-Haas, S. V., Dawson, B. T., Coutts, A. J., & Roswell, G. J. (2009). Physiological responses and time–motion characteristics of various small-sided soccer games in youth players. *Journal of Sports Sciences*, *27*(1), 1-8.

Hill-Haas, S. V., Rowsell, G. J., Dawson, B. T., & Coutts, A. J. (2009). Acute physiological responses and time-motion characteristics of two small-sided training regimes in youth soccer players. *Journal of Strength and Conditioning Research, 23*(1), 111-115.

Hill-Haas, S., Coutts, A., Rowsell, G., & Dawson, B. (2008). Variability of acute physiological responses and performance profiles of youth soccer players in small-sided games. *Journal of Science and Medicine in Sport*, *11*(5), 487-490.

Hoff, J., WislØff, U., Engen, L. C., Kemi, O. J., & Helgerud, J. (2002). Soccer specific aerobic endurance training. *British Journal of Sports Medicine*, *36*(3), 218-221.

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise, 41*, 3-13.

Iaia, F. M., Rampinini, E., Bangsbo, J. (2009). High-intensity training in football. *International Journal of Sports Physiology & Performance*, *4*(3), 291-306.

Impellizzeri, F., Marcora, S. M., Castagna, C., Reilly, T., Sassi, A., & Iaia, F. (2006). Physiological and performance effects of generic versus specific aerobic training in soccer players. *International Journal of Sports Medicine, 27*, 483–492.

Impellizzeri, F. M., Rampinini, E., & Marcora, S. M. (2005). Physiological assessment of aerobic training in soccer. *Journal of Sports Sciences, 23*(6), 583-592.

Impellizzeri, F. M., Rampinini, E., Coutts, A. J., Sassi, A., & Marcora, S. M. (2004). Use of RPE-based training load in soccer. *Medicine and Science in Sports and Exercise, 36*(6), 1042-1047.

Jones, S., & Drust, B. (2007). Physiological and technical demands of 4 v 4 and 8 v 8 games in elite youth soccer players. *Kinesiology, 39*(2), 150-157.

Jozak, R., Perić, A., Bradić, A., & Dizdar, D. (2011). Position-related differences in the amount, intensity and speed of movement in elite football players. *Homo Sporticus, 13*(2), 16-22.

Kelly, D. M., & Drust, B. (2009). The effect of pitch dimensions on heart rate responses and technical demands of small-sided soccer games in elite players. *Journal of Science and Medicine in Sports, 12*, 475–479.

Krustrup, P., Mohr, M., Steensberg, A., Benck, J., Kjaer, M., & Bangsbo, J. (2006). Muscle and blood metabolites during a soccer game: Implications for sprint performance. *Medicine & Science in Sports & Exercise, 38*(6), 1165-1174.

Larsson, P. (2003). Global positioning systems and sport-specific testing. *Sports Medicine, 33*(15), 1093-1101.

Little, T. (2009). Optimizing the Use of Soccer Drills for Physiological Development. *Strength & Conditioning Journal, 31*(3), 67-74.

Little, T., & Williams, A. G. (2007). Measures of exercise intensity during soccer training drills with professional soccer players. *Journal of Strength & Conditioning Research, 21*(2), 367-371.

Little, T., & Williams, A. G. (2006). Suitability of soccer training drills for endurance training. *Journal of Strength & Conditioning Research, 20*(2), 316-319.

Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *Journal of Strength and Conditioning Research, 19*(1), 76-78.

Lucchesi, M. (2001). *Coaching the 3-4-1-2 and 4-2-3-1.* Città di Castello: Reedswain Publishing.

Martin, D. T., Andersen, M. B., & Gates, W. (2000). Using profile of mood states (POMS) to monitor high-intensity training in cyclists: group versus case studies. *Sport Psychologist, 14*, 138-156.

Macleod, H., & Sunderland, C. (2007). Reliability and validity of a global positioning system or measuring player movement patterns during field hockey. *Medicine and Science in Sports and Exercise, 39*(5), 209-210.

Mallo, J., & Navarro, E. (2008). Physical load imposed on soccer players during small-sided training games. *The Journal of Sports Medicine and Physical Fitness, 48*(2), 166-171.

McGuigan, M. R., & Foster, C. (2004). A new approach to monitoring resistance training. *Journal of Strength and Conditioning Research, 26*(6), 42-47.

McMillan, K., Helgerud, J., Macdonald, R., & Hoff, J. (2005). Physiological adaptations to soccer specific endurance training in professional youth soccer players. *British Journal of Sports Medicine, 39*(5), 273–277.

Mohr, M., Krustrup, P., Andersson, H., Kirkendal, D., & Bangsbo J. (2008). Match activities of elite women soccer players at different performance levels. *Journal of Strength & Conditioning Research, 22*(2), 341-349.

Mohr, M., Krustrup, P., & Bangsbo, J. (2005). Fatigue in soccer: A brief review. *Journal of Sports Sciences, 23*(6), 593-599.

Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences*, *21*(7), 519-528.

Noble, B. J., & Robertson, R. J. (1996). *Perceived Exertion.* Champaign, Illinois: Human Kinetics.

Osgnach, C., Poser, S., Bernardini, R., Rinaldo, R., & Di Prampero, P. E. (2010). Energy cost and metabolic power in elite soccer: a new match analysis approach. *Journal of Medicine Science and Sports Exercise*, *42,* 170-178.

Owen, A., Twist, C., & Ford, P. (2004). Small-sided games: the physiological and technical effect of altering field size and player numbers. *Insight, 7*(2), 50-53.

Pereira Da Silva, N., Kirkendall, D. T., & Leite De Barros Neto, T. (2007). Movement patterns in elite Brazilian youth soccer. *Journal of Sports Medicine and Physical Fitness, 47*(3), 270-275.

Preen, D., Dawson, B., & Goodman, C. (2001). Effect of creatine loading on long-term sprint exercise performance and metabolism. *Medicine and Science in Sports and Exercise, 33,* 814–821.

Randers, M.B., Mujika, I., Hewitt, A., Santisteban, J., Bischoff, R., & Solano R. (2010). Application of four different football match analysis systems: A comparative study. *Journal of Sport Sciences, 28,* 171‑182.

Rampinini, E., Bishop, D., Marcora, S. M., Ferrari Bravo, D., Sassi, R., & Impellizzeri, F. M. (2007). Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *International Journal of Sports Medicine, 28*(3), 228-235.

Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance. *International Journal of Sports Medicine, 28*(12), 1018-1024.

Rampinini, E., Impellizzeri, F. M., Castagna, C., Abt, G., Chamari, K., Sassi, A., & Marcora S. M. (2007). Factors influencing physiological responses to small-sided soccer games. *Journal of Sports Sciences, 25*(6), 659-666.

Reilly, T. (2005). An ergonomics model of the soccer training process. *Journal of Sports Sciences, 23*(6), 561-572.

Reilly, T., Drust, B., & Clarke, N. (2008). Muscle fatigue during match play. *Sports Medicine, 38*(5), 357-367.

Reilly, T., & Ekblom, B. (2005). The use of recovery methods post-exercise. *Journal of Sports Science, 23*(6), 619-627.

Reilly, T., & White, C. (2004). SSG as an alternative to interval training for soccer players. *Journal of Sports Sciences, 22*(6), 559-561.

Reilly, T., & Thomas, V. (1976). A motion analysis of work-rate in different positional roles in professional football match play. *Journal of Human Movement Studies, 2*, 87-97.

Rienzi, E., Drust, B., Reilly, T., Carter, J. E., & Martin, A. (2000). Investigation of anthropometric and work-rate profiles of elite South American international soccer players. *Journal of Sports Medicine and Physical Fitness, 40*(2), 162-169.

Rodrigues, V., Mortimer, L., Condessa, L., Coelho, D., Soares, D., & Garcı´a, E. (2007). Exercise intensity in training sessions and official games in soccer. *Journal of Sport Science and Medicine, 6,* 57–58.

Ross, A., Leveritt, M., & Riek, S. (2001). Neural influences on sprint running: training adaptations and acute responses. *Sports Medicine, 31*(6), 409-425.

Sampaio, J., Abrantes, C., & Leite, N. (2009). Power, heart rate and perceived exertion responses to 3x3 and 4x4 basketball small-sided games. *Revista de Psicologia del Deporte, 18* suppl, 463-467.

Sassi, R., Reilly, T., & Impellizzeri, F. (2005). A comparison of small-sided games and interval training in elite professional soccer players. In T. Reilly, J. Cabri & D. Arújo (Eds.). *Science and Football V* (pp. 341-343). London: E & FN Spon.

Spencer, M., Bishop, D., Dawson, B., & Goodman, C. (2005). Physiological and metabolic responses of repeated-sprint activities: specific to field based team sports. *Journal of Sports Medicine, 35,* 1025-1044.

Spencer, M., Dawson, B., Goodman, C., Dascombe, B., & Bishop, D. (2008). Performance and metabolism in repeated sprint exercise: effect of recovery intensity. *European Journal of Applied Physiology, 103,* 545-552.

Spencer, M., Lawrence, S., Rechichi, C., Bishop, D., Dawson, B., & Goodman, C. (2004). Time-motion analysis of elite field hockey, with special reference to repeated-sprint activity. *Journal of Sports Sciences, 22,* 843-850.

Spencer, M., Pyne, D., Santisteban, J., & Mujika, M. (2011). Fitness determinants of repeated-sprint ability in highly trained youth football players. *International Journal of Sports Physiology and Performance, 6*, 497-508.

Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. (2005). Physiology of soccer: An update. *Sports Medicine, 35*(6), 501-536.

Strudwick, T., & Reilly, T. (2002). Anthropometric and fitness profiles of elite players in two football codes. *Journal of Sports Medicine and Physical Fitness, 42*(2), 239-242.

Svensson, M., & Drust, B. (2005). Testing soccer players. *Journal of Sports Sciences, 23*(6), 601-618.

Terrier, P., & Schutz, Y. (2005). How useful is satellite positioning system (GPS) o track gait parameters? A review. *Journal of NeuroEngineering and Rehabilitation, 2,* 28.

Tessitore, A., Meeusen, R., Piacentini, M. F., Demarie, S., & Capranica, L. (2006). Physiological and technical aspects of “6-a-side” soccer drills. *The Journal of Sports Medicine and Physical Fitness, 46*(1), 36-43.

Varley, M. C., & Aughey, R. J. (2012). Acceleration profiles in elite Australian soccer. *International Journal of Sports Medicine,* 1-6.

Vigne, G., Gaudino, C., Rogowski1, I., Alloatti, G., & Hautier, C. (2010). Activity profile in elite Italian soccer team. *International Journal of Sports Medicine, 31*(5), 304-310.

Wall, M., & Côte, J. (2007). Developmental activities that lead to dropout and investment in sport. *Physical Education and Sport Pedagogy, 12*(1), 77-87.

Wehbe, G. M., Hartwig, T., & Duncan, C. S. (2013). Movement analysis of Australian national league soccer players using global positioning system technology. *Journal of Strength and Conditioning Research,* Retrieved August 7, 2013, from Pub Med database.

Withers, R. T., Maricic, Z., Wasilewski, S., & Kelly, L. (1982). Match analysis of Australian professional soccer players. *Journal of Human Movement Studies, 8,* 159-176.

Zubillaga, A., Gorospe, G., Mendo, A. H., & Villaseñor, A. B. (2007). Analysis of high intensity activity in soccer highest level competition [abstract]. *Journal of Sports Science and Medicine, 6*(Suppl. 10), 10.

APPENDICES

APPENDIX A

INFORMATION LETTER TO PARTICIPANTS

Project Title

Comparison of the physical, physiological and perceptual demands of small-sided games and match play in professional football players.

Purpose

To date, no research has compared the physical (e.g. total distance; distance travelled at low, moderate and high velocity; sprint distances; number of repeated sprints; total number of accelerations), physiological (e.g. heart rate) and perceptual (e.g. RPE) demands of SSGs against match play performances in professional footballers. By monitoring these variables it can be determined whether SSGs provide a sufficient physical demand for the players during training. Thus, the purpose of the research is to specifically investigate relationship between the physical, physiological and perceptual demands (technical demands will not be examined) imposed in various SSGs, with those obtained during competitive match play data, in players of different playing positions in a professional football team.

Procedures

As a participant in this study, you performed a number of the following assessments at various time points throughout your pre-season training and competitive season. It is important to note that all of these tests were no more strenuous or fatiguing than what you typically encountered in a hard training session. You were thoroughly instructed on the correct technique and procedures prior to testing, completed adequate warm-up and cool down procedures and were supervised by certified professionals during all testing sessions.

SESSION MONITORING

- Global Positioning Systems (GPS): Physical variables involving total distance (m), high velocity running (speed > 4.16 $m \cdot s^{-1}$), total number of sprints, repeated sprints (≥3 sprints with <21-s inter-sprint recoveries), sprint distance (speed > 6.93 $m \cdot s^{-1}$), and number of accelerations (acceleration > 2.78 $m \cdot s^{-2}$) was measured by GPS systems throughout training and pre-season matches.
- Heart Rate Monitors: Heart rate was used in conjunction with the GPS units and recorded each player's heart rate (HR) responses (maximum HR and HR as a percent of maximum) during training and match play.

MONITORING SCALES

- Session Rating of Perceived Exertion – Involved filling out a single question questionnaire assessing the athletes rating of the intensity of the training session. This was completed 15-30 minutes after every training session throughout the season.
- Feeling Scale - Involved filling out a single question questionnaire assessing how the athlete felt during each training session. This was completed 15-30 minutes after every training session throughout the season.

- Total Quality Recovery Scale – Involved filling out a single question questionnaire rating the recovery from the previous training session. This was completed 15-30 minutes before every training session throughout the season.
- Sleep, Stress, Fatigue, Muscle Soreness Scale – Involved filling out a four question questionnaire in which the athlete rates their quality of quality of sleep, level of stress, fatigue and muscle soreness. This was completed 15-30 minutes before every training session throughout the season.

Risks

There were no inherent risks involved with this investigation. However, there was the possibility of muscle pulls or strains associated with training, common to any type of physical activity. Adequate warm-up procedures were followed and monitored by competent personnel.

Benefits

Participation in this study will provide you with a detailed report of your physical, physiological and perceptual training and match performance. The results obtained from the proposed research will improve our understanding of the physical, physiological and perceptual demands of SSGs and their relation to competitive match play. The knowledge gained will allow for a more informed use of SSGs in the training of elite players. All study activities are provided at no cost to the participants.

Confidentiality

Your results will be kept as confidential as is possible by law. All data will be kept in the possession of the investigators. If the results of the study are published in a scientific journal, your identity will not be revealed. Participants will not be referred to by name during research reports or study discussions. All records will be stored in a locked filing cabinet with restricted access for an undetermined amount of time. All computer records are restricted by password.

Contacting the Investigators

We are happy to answer any questions you may have at this time. If you have any queries later, please do not hesitate to contact Steve Hissey at 0420401065, email shissey@ecu.edu.au. If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact: Research Ethics Officer, Human Research Ethics Officer, Edith Cowan University, 270 Joondalup Drive, JOONDALUP WA 6027, Phone: (08) 6304 2170. Email: research.ethics@ecu.edu.au

Approval by the Human Research Ethics Committee

This project is being conducted by Stephen Hissey, as part of a Masters by Research qualification. The ECU Human Research Ethics Committee has approved this project.

Feedback

All participants will be provided with test results as soon as they are available. A summary of study results will be made available to all interested participants upon completion of the trial.

Voluntary Participation

Whether you decide to participate in the study or not, your decision will not prejudice you in any way. If you do decide to participate, you are free to withdraw your consent and discontinue your involvement at any time.

Privacy statement

The conduct of this research involved the collection, access and/or use of your identified personal information. The information collected is confidential and will not be disclosed to third parties without your consent, except to meet government, legal or other regulatory authority requirements. A de-identified copy of this data may be used for other research purposes. However, your anonymity will at all times be safeguarded.

APPENDIX B

INFORMED CONSENT FORM

Project Title

Comparison of the physical, physiological and perceptual demands of small-sided games and match play in professional football players.

I have read the information sheet and the consent form. I agree to participate in the study entitled "Comparison of the physical, physiological and perceptual demands of small-sided games and match play in professional football players" and give my consent freely. I understand that the study will be carried out as described in the information sheet, a copy of which I have retained. I realise that my participation in this research study is voluntary and whether or not I decide to participate is solely my decision. I also realise that I can withdraw from the study at any time and that I do not have to give any reasons for withdrawing. I have had all questions answered to my satisfaction. I agree that research data gathered for the study may be published provided my name or other identifying information is not disclosed.

Participant:

______________________ ______________________

Name Signature Date

Parent or guardian (if participant is under 18 years of age):

______________________ ______________________

Name Signature Date

Researcher:

______________________ ______________________

Name Signature Date

APPENDIX C

Moderate effect sizes for all physical, physiological and perceptual variables between SSGs and match play.

Variable Measure	Game Types	Effect Size
Total Distance	3v3 vs 6v6	0.57
High Velocity Distance	3v3 vs Match Play	0.75
Sprint Distance	3v3 vs 6v6	-0.60
	6v6 vs 8v8	0.53
RSE	3v3 vs 6v6	0.57
	6v6 vs Match Play	0.72
	8v8 vs Match Play	0.60
% HR_{max}	3v3 vs Match Play	0.65
	6v6 vs Match Play	0.62
RPE	6v6 vs 8v8	-0.60

APPENDIX D

Moderate effect sizes for all physical, physiological and perceptual variables between playing positions.

Game Type	Variable Measure	Positions	Effect Size
Match Play	Total Distance	CB vs CM	0.50
		CM vs ST	0.77
		WM vs ST	-0.73
	Sub-Maximal Accelerations	CB vs ST	-0.65
		FB vs WM	-0.78
		FB vs ST	0.64
	Maximal Accelerations	FB vs ST	0.70
	RSE	CB vs FB	-0.67
		FB vs ST	0.72
	RPE	CB vs WM	0.57
		CB vs ST	-0.57
		FB vs WM	0.57
		FB vs ST	-0.57
8v8	Total Distance	FB vs ST	0.74
	Sprint Distance	CM vs ST	-0.6
	Sub-Maximal Accelerations	CB vs CM	-0.68
		CB vs WM	0.73
		CB vs ST	0.74
		FB vs WM	0.56
		FB vs ST	0.63
	Maximal Accelerations	CB vs CM	0.76
		FB vs ST	0.79
		WM vs ST	0.69
	% HR_{max}	CB vs WM	-0.50
		CM vs ST	0.53
		WM vs ST	0.59
6v6	Total Distance	FB vs WM	-0.60
	RSE	FB vs WM	-0.53
3v3	Total Distance	CB vs FB	0.71
	High Velocity Distance	CM v ST	-0.74
		WM vs ST	-0.56
	Sprint Distance	CM v ST	0.67
		WM vs ST	0.66
	Maximal Accelerations	CM vs ST	0.74
	RSE	FB vs WM	0.58
	RPE	CB vs FB	-0.76
		CB vs ST	0.51
		FB vs CM	0.70
		FB vs WM	0.69

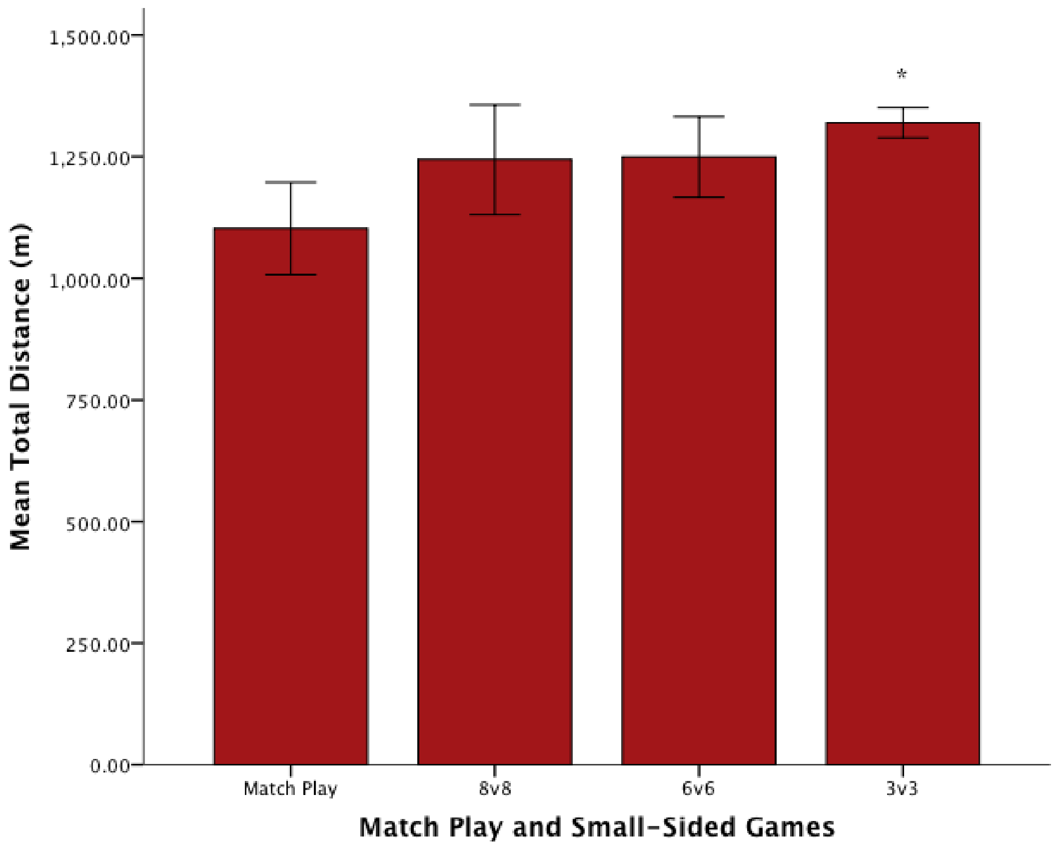
APPENDIX E

Moderate effect sizes for all positions between small-sided games and match play.

Position	Measure	Game Type	Effect Size
CB	Sub-maximal accelerations	6v6 vs 8v8	0.62
	RSE	8v8 vs Match play	0.57
	RPE	6v6 vs Match play	-0.63
		8v8 vs Match play	-0.70
FB	Total Distance	6v6 vs 8v8	0.76
	RPE	3v3 vs 6v6	0.78
		3v3 vs 8v8	0.62
		3v3 vs Match Play	0.76
CM	Total Distance	6v6 vs 8v8	0.79
	RPE	6v6 vs Match Play	-0.72
		8v8 vs Match Play	-0.54
WM	Total Distance	3v3 vs 8v8	0.50
	High Velocity Distance	8v8 vs Match Play	0.72
	RPE	6v6 vs Match Play	-0.64
ST	Total Distance	6v6 vs 8v8	0.55
		6v6 vs Match Play	0.64
	RSE	6v6 vs 8v8	0.61
	RPE	8v8 vs Match Play	-0.71

APPENDIX F

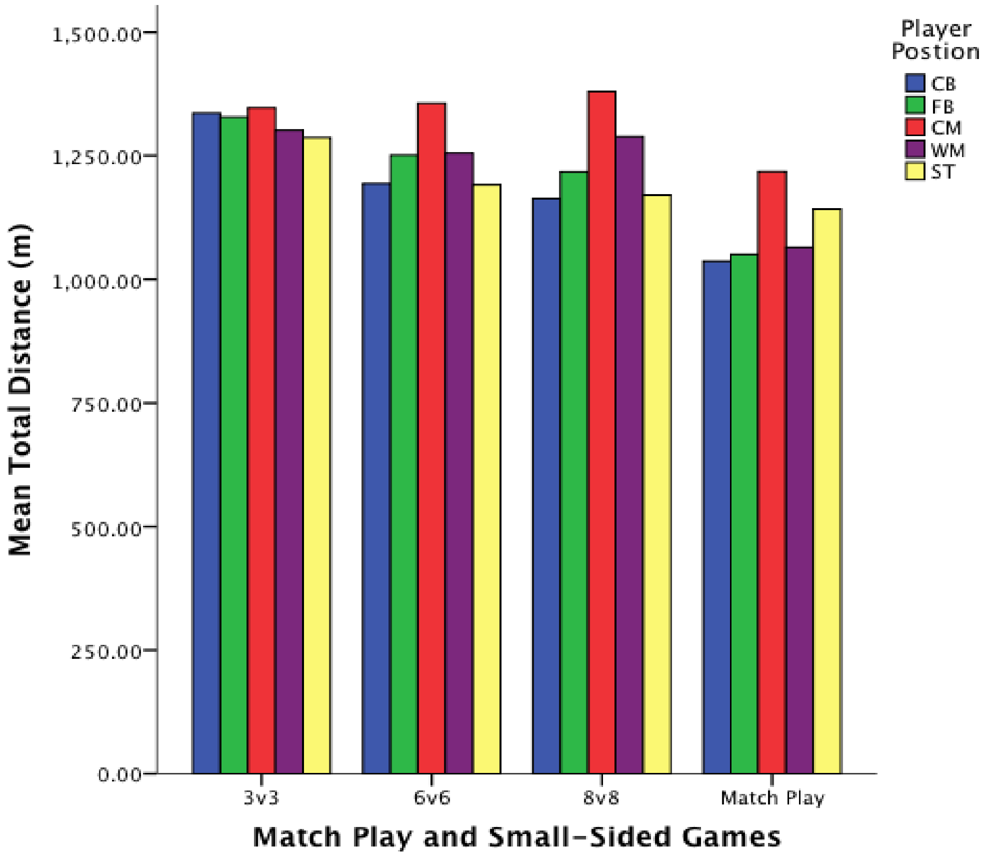
Mean total distance in match play and small-sided games from all playing positions.



* Significant difference ($p < 0.05$) between 3v3 and match play

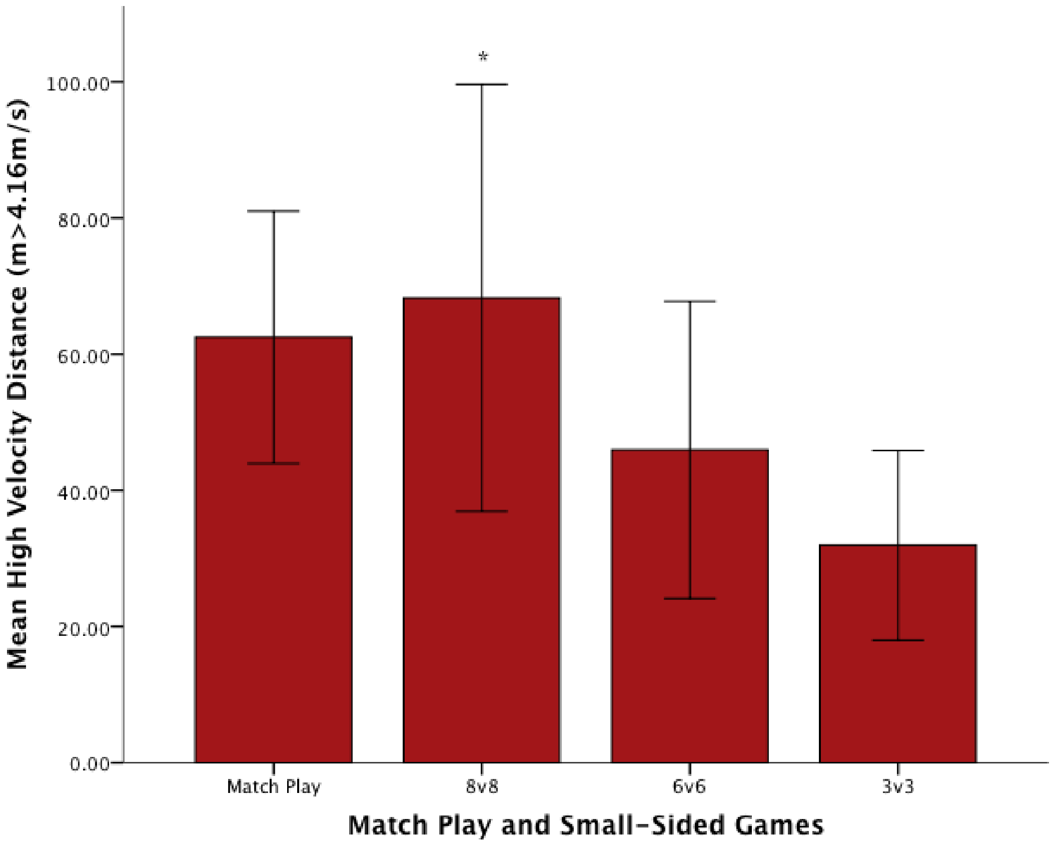
APPENDIX G

Mean total distance in match play and small-sided games between playing positions.



APPENDIX H

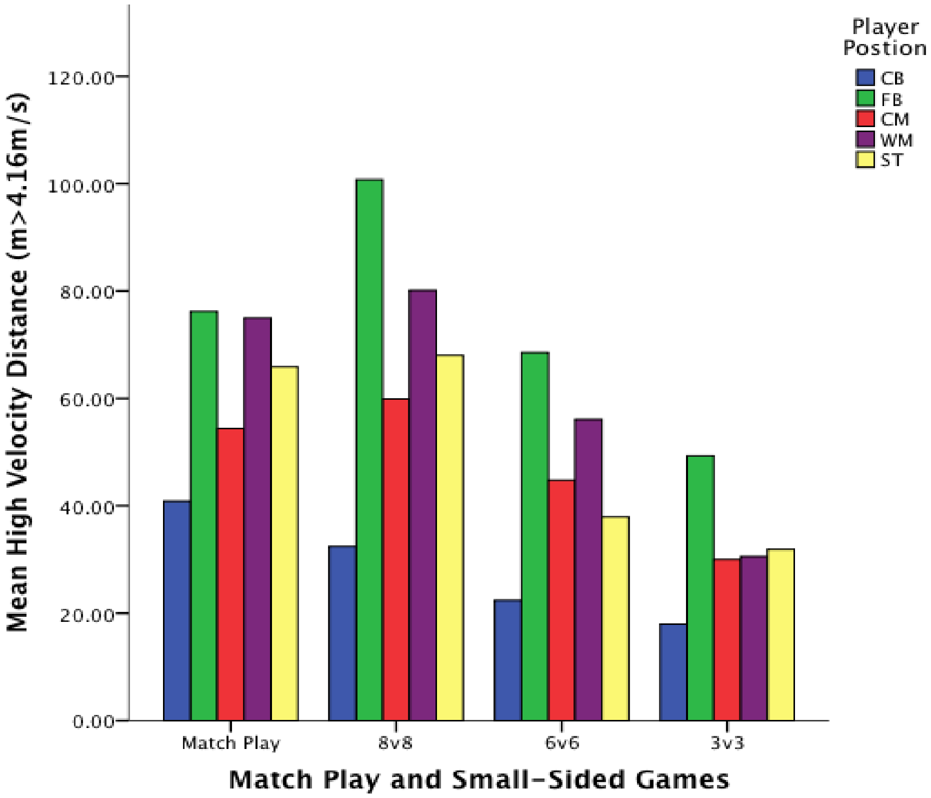
Mean high velocity distance in match play and small-sided games from all playing positions.



* Significant difference ($p < 0.05$) between 8v8 and 3v3

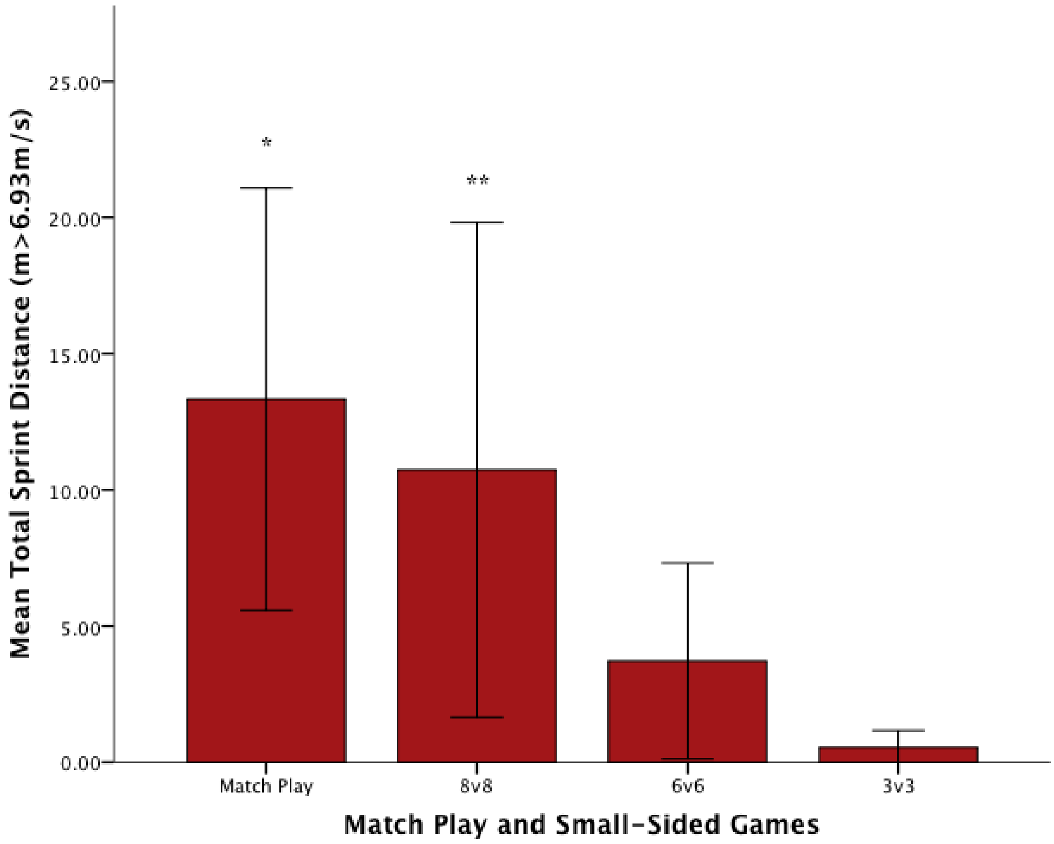
APPENDIX I

Mean high velocity distance in match play and small-sided games between playing positions.



APPENDIX J

Mean sprint distance in match play and small-sided games from all playing positions.

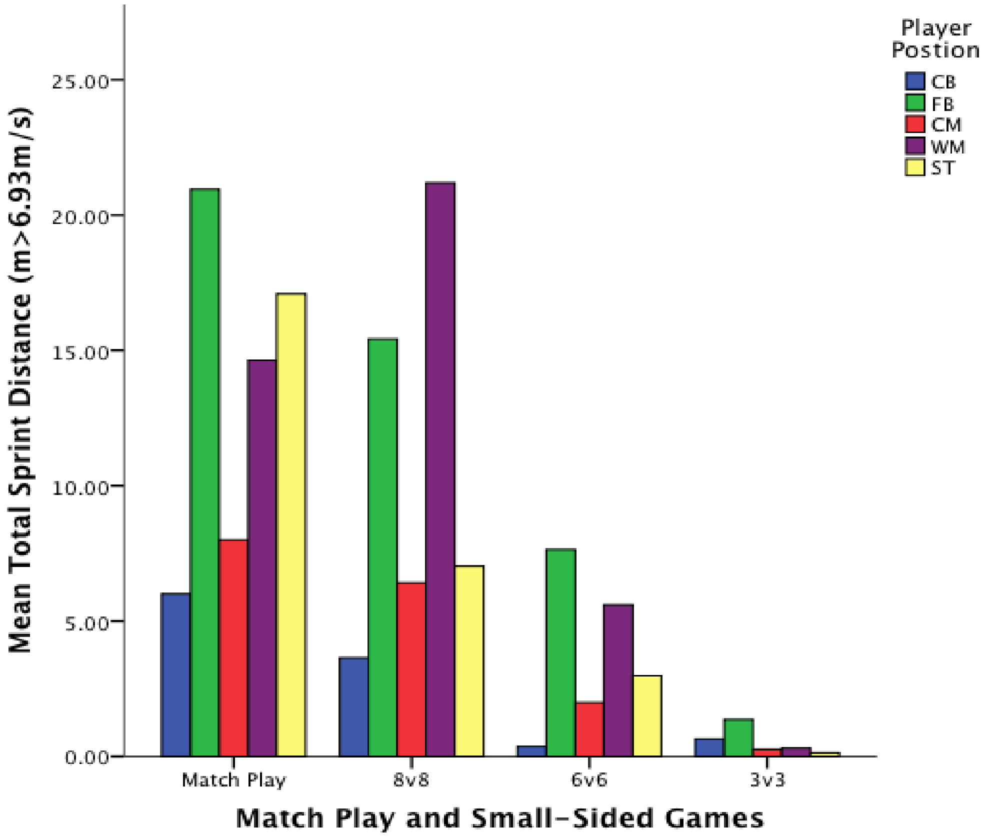


* Significant difference ($p < 0.05$) between match play and 3v3

** Significant difference ($p < 0.05$) between 8v8 and 3v3

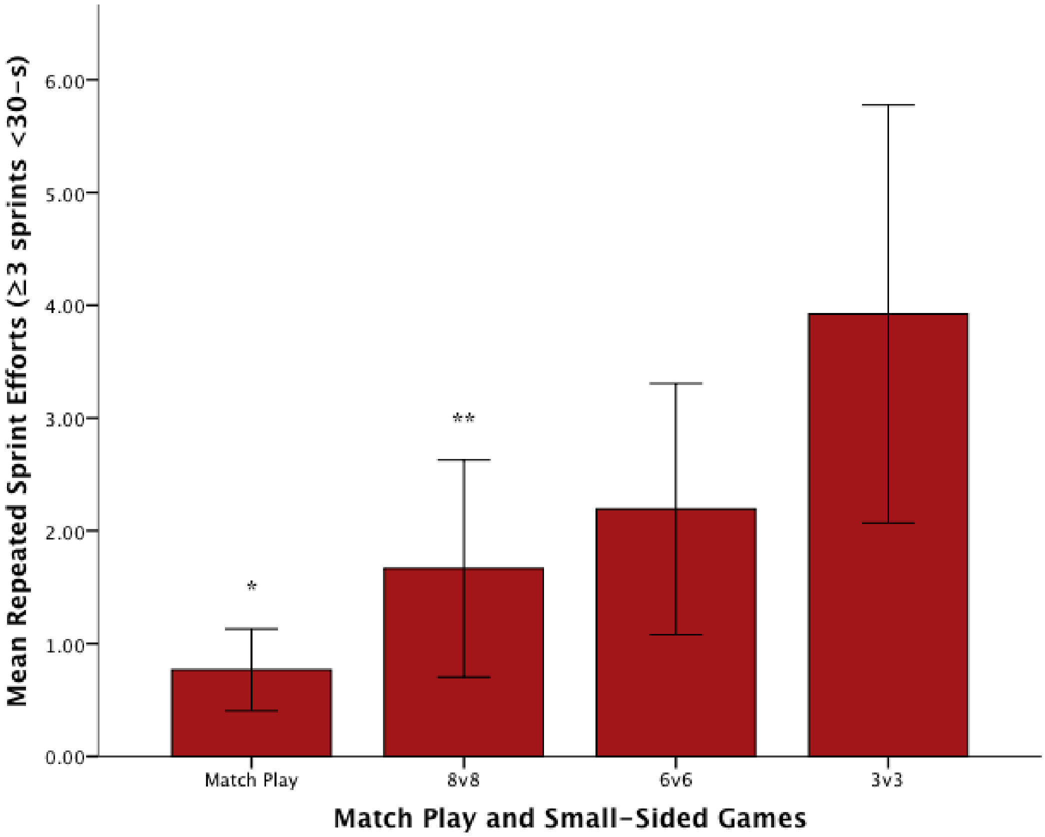
APPENDIX K

Mean sprint distance in match play and small-sided games between playing positions.



APPENDIX L

Mean number of RSE in match play and small-sided games from all playing positions.

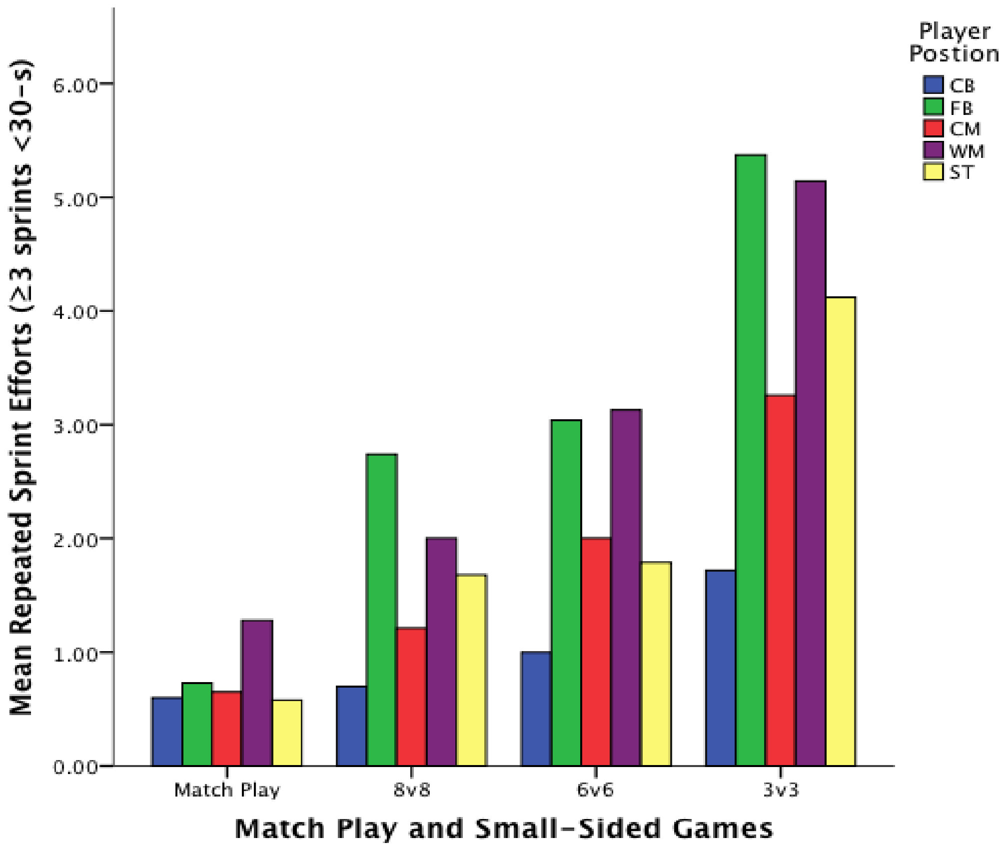


* Significant difference ($p < 0.05$) between match play and 3v3

** Significant difference ($p < 0.05$) between 8v8 and 3v3

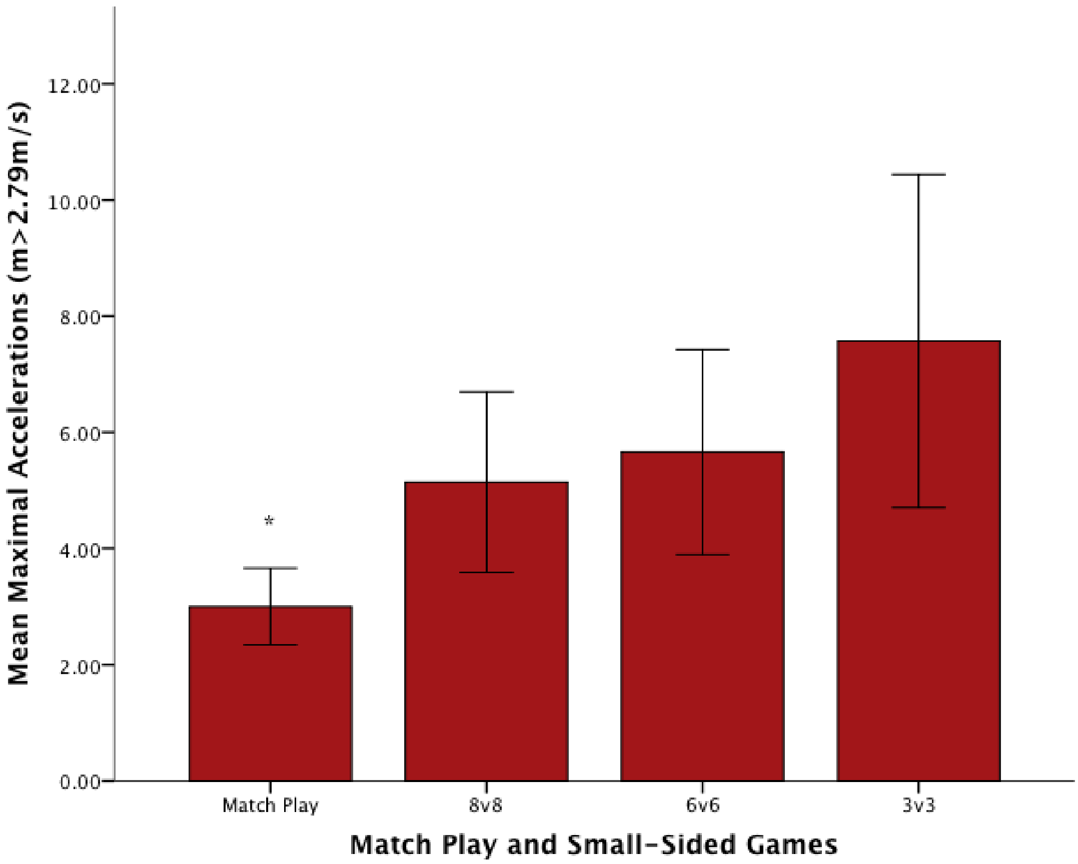
APPENDIX M

Mean number of RSE in match play and small-sided games between playing positions.



APPENDIX N

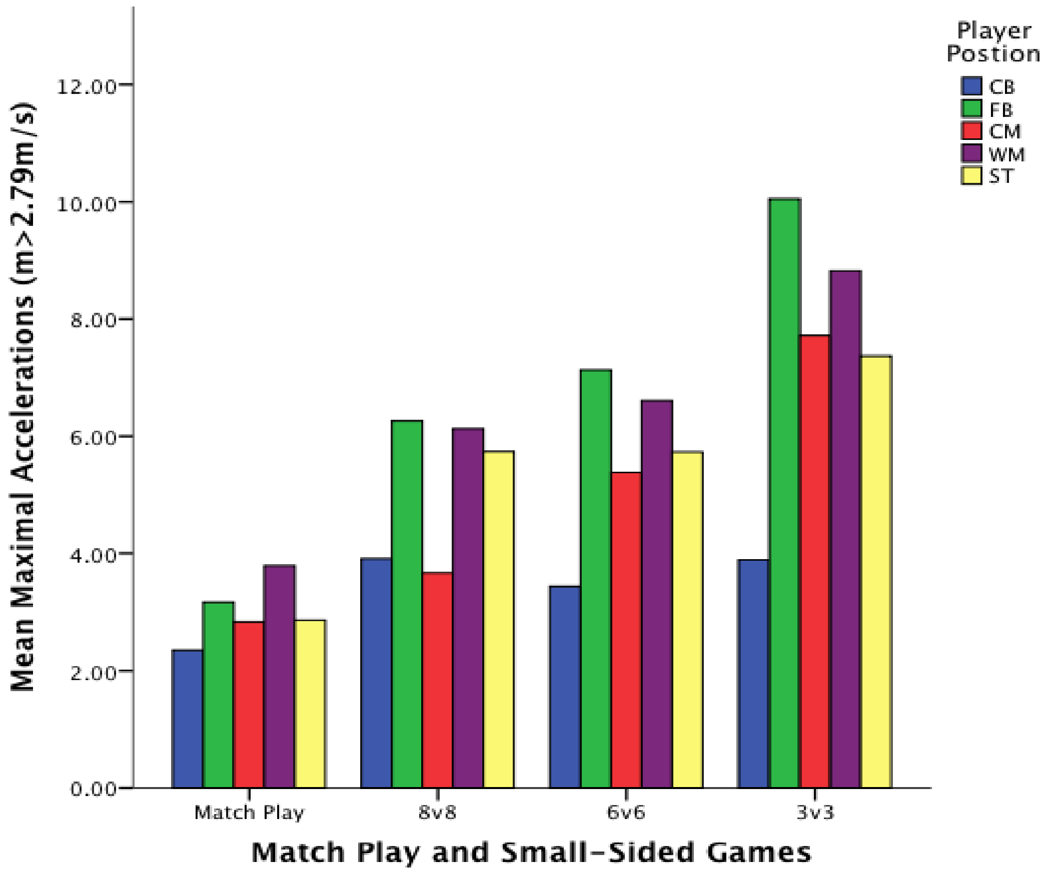
Mean number of maximal accelerations in match play and small-sided games from all playing positions.



* Significant difference ($p < 0.05$) between match play and 3v3

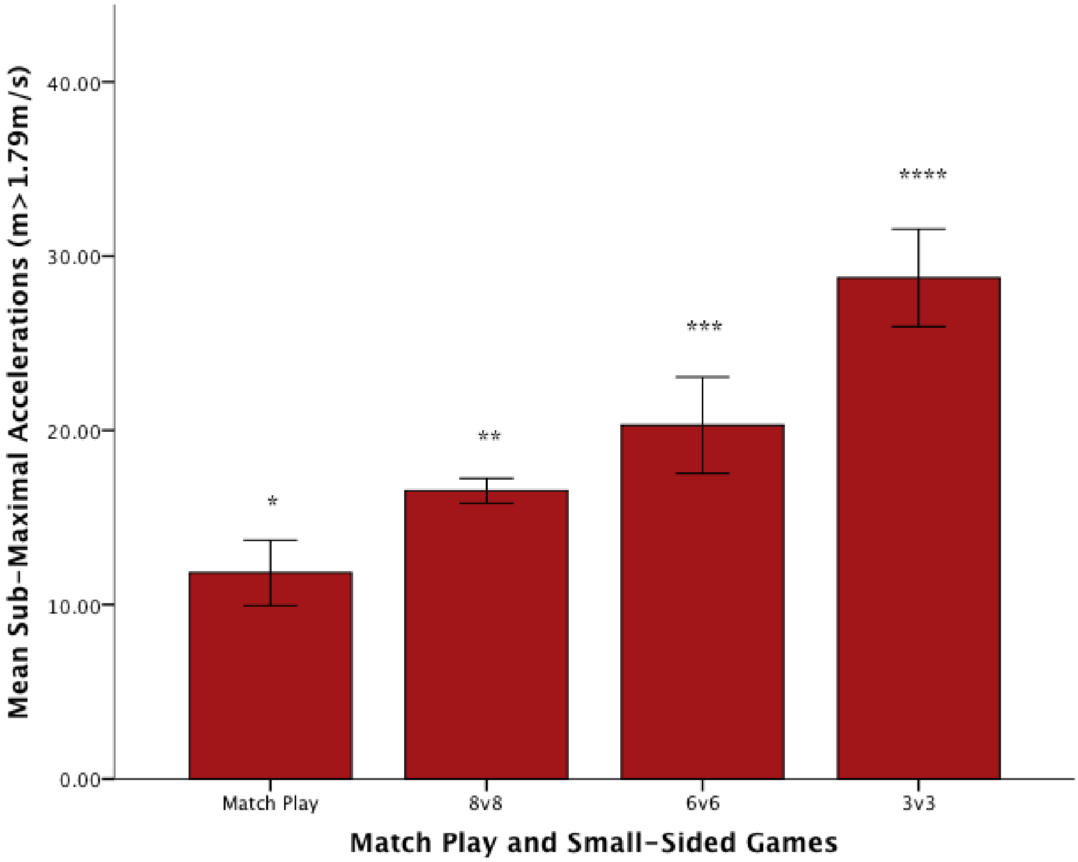
APPENDIX O

Mean number of maximal accelerations in match play and small-sided games between playing positions.



APPENDIX P

Mean number of sub-maximal accelerations in match play and small-sided games from all playing positions.



* Significant difference ($p < 0.05$) between match play and 8v8, 6v6 and 3v3

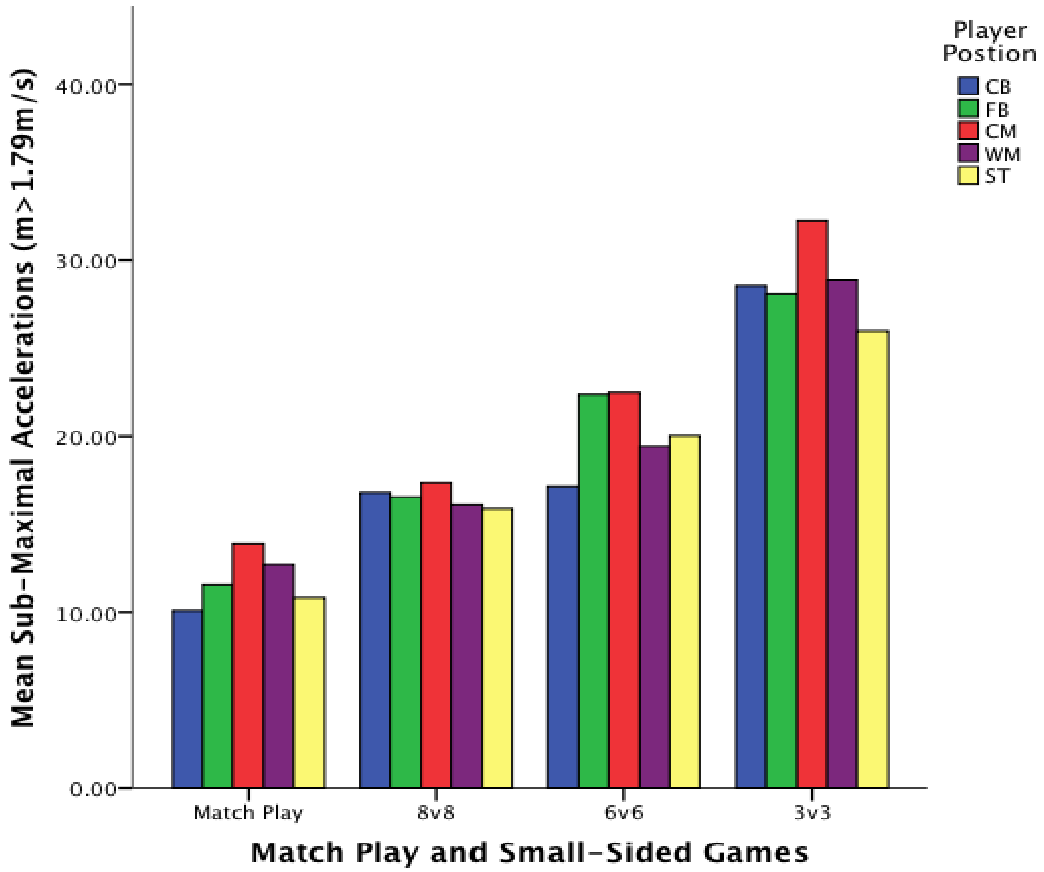
** Significant difference ($p < 0.05$) between 8v8 and match play, 6v6 and 3v3

*** Significant difference ($p < 0.05$) between 6v6 and match play, 8v8 and 3v3

**** Significant difference ($p < 0.05$) between 3v3 and match play, 8v8 and 6v6

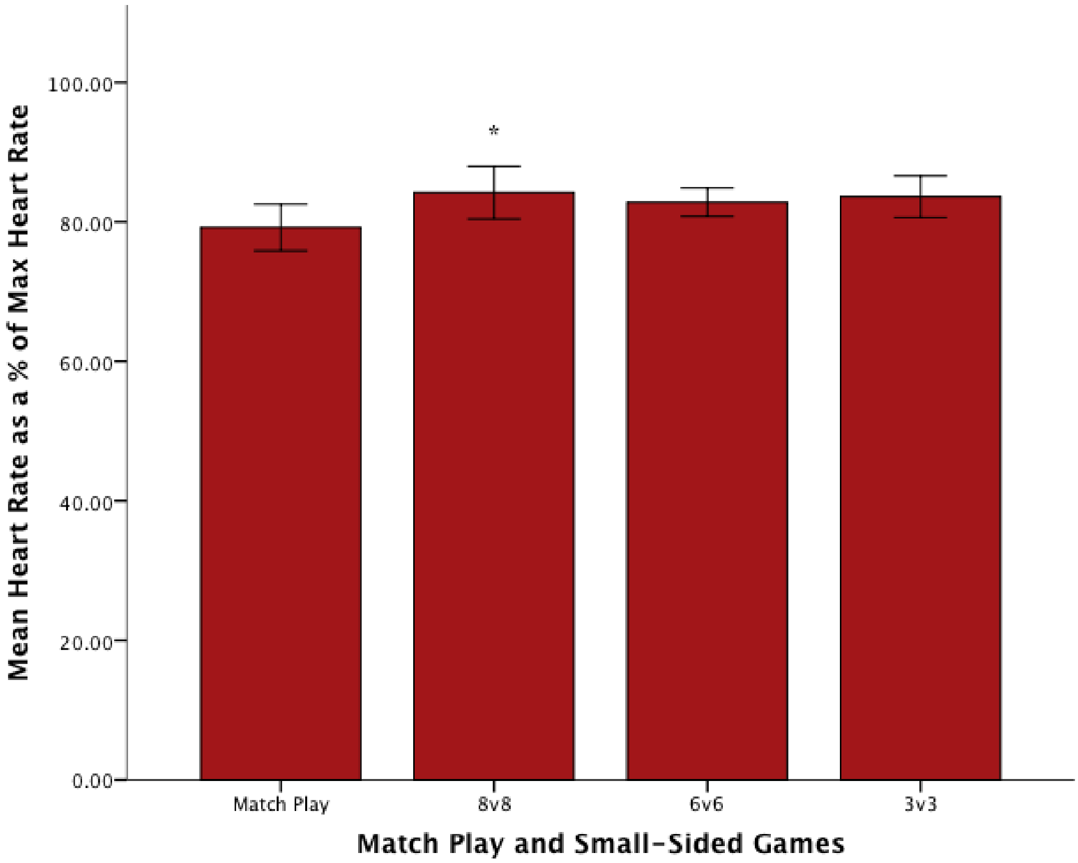
APPENDIX Q

Mean number of sub-maximal accelerations in match play and small-sided games between playing positions.



APPENDIX R

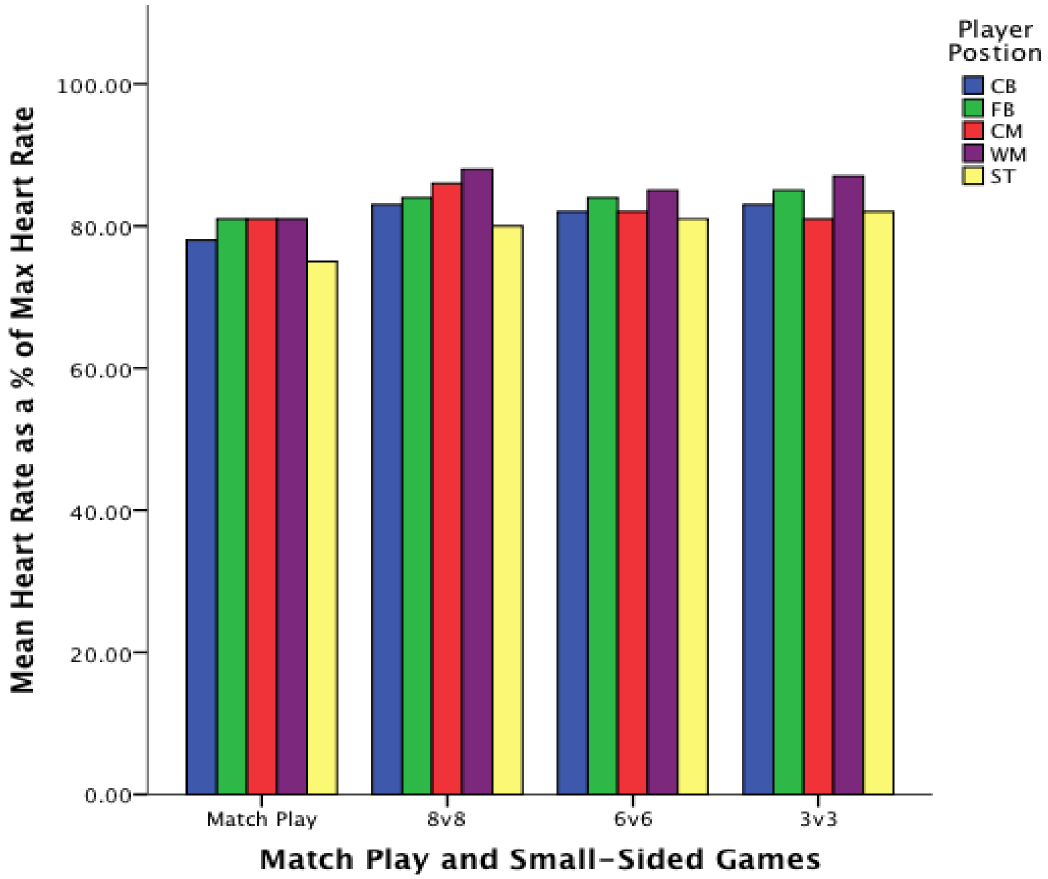
Mean % HR_{max} in match play and small-sided games from all playing positions.



* Significant difference ($p < 0.05$) between match play and 8v8

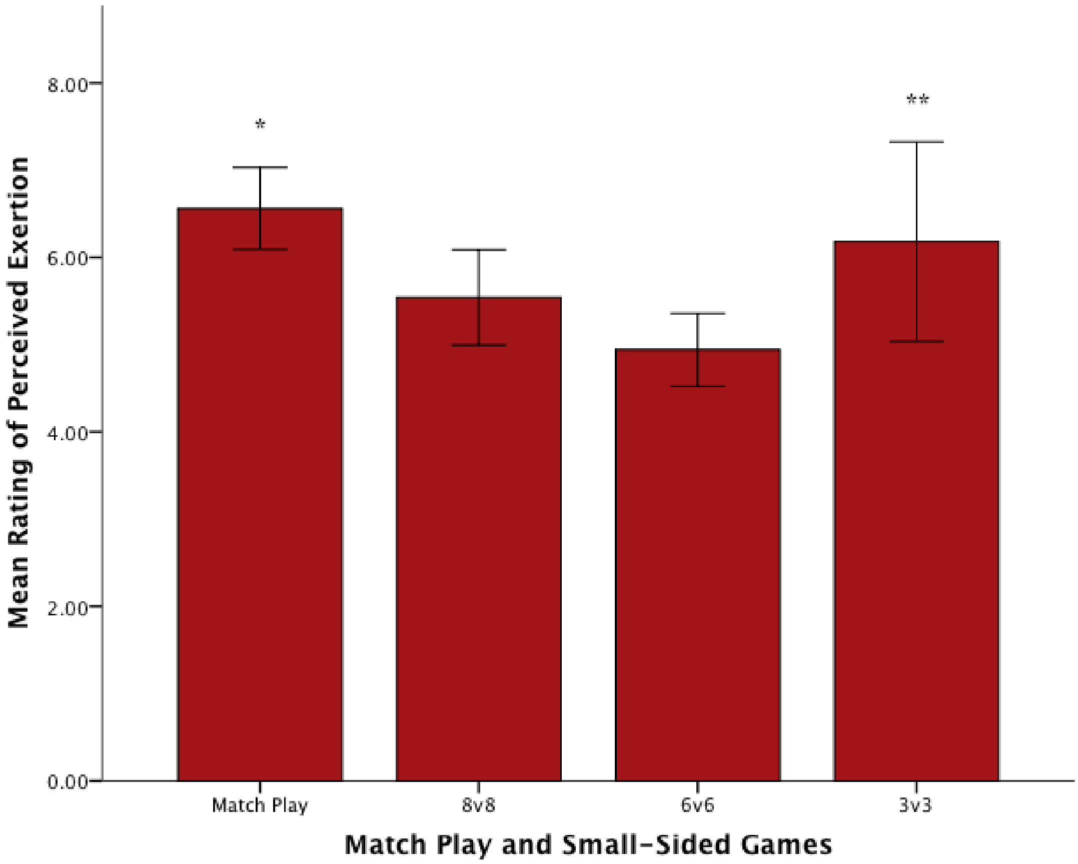
APPENDIX S

Mean % HR_{max} in match play and small-sided games between playing positions.



APPENDIX T

Mean RPE in match play and small-sided games from all playing positions.

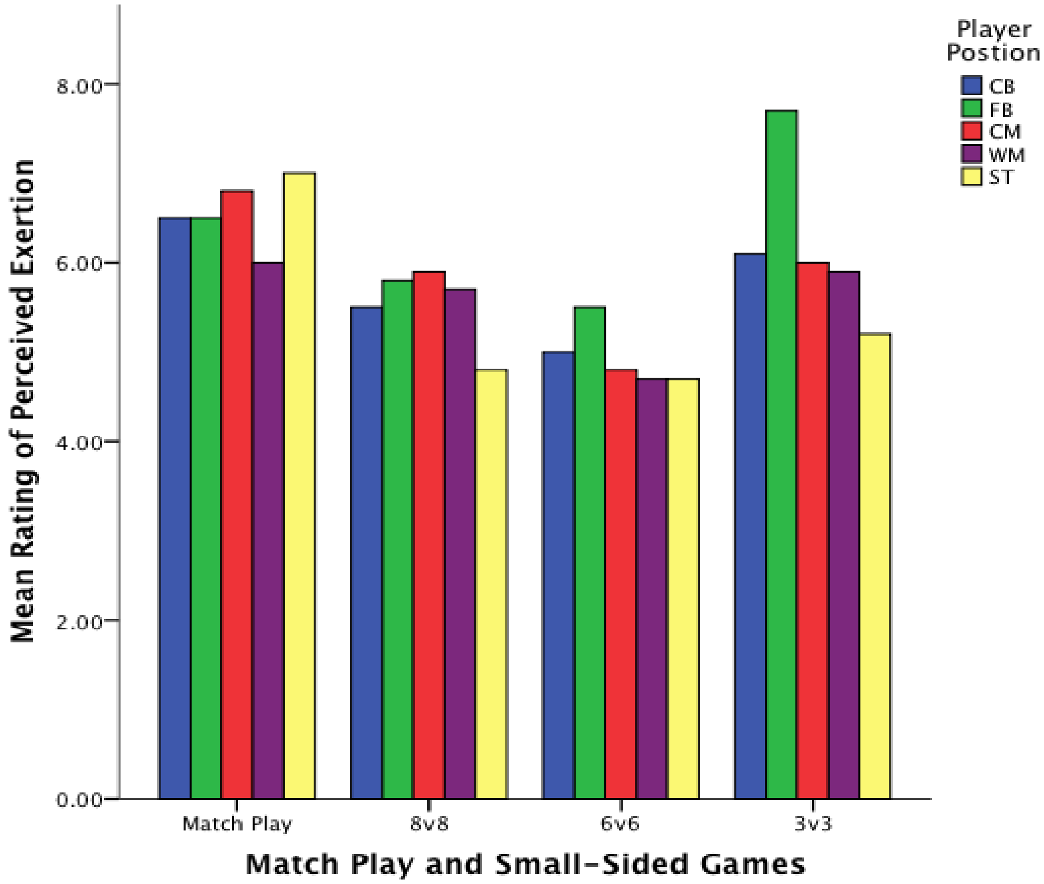


* Significant difference ($p < 0.05$) between match play and 6v6

** Significant difference ($p < 0.05$) between 3v3 and 6v6

APPENDIX U

Mean RPE in match play and small-sided games between playing positions.



APPENDIX V

The fullback in a defence made up of four players is given more responsibility in the attacking phases of play in the formation 4-2-3-1. This means that they have more importance when the team is in possession of the ball and provide penetrating forward runs down the wing to help overload the attack. It is important to note that the tactical responsibilities for the fullback remain the same during the defensive phase of play such as stopping the supply to the centre forward from the opposition's wingers (Lucchesi, 2001).

The central midfielders need to have great versatility, in that they need to be effective in both the offensive and defensive phases of play. It is essential that the two players have good positional sense in order to protect the back four correctly. One of the two midfielders is mostly used as a defensive midfielder, with the other focusing on distribution in a more deep lying playmaker role. The midfielders must retain possession of the ball in attacking phases of the game and make themselves available for the defenders to pass the ball out from the back, and then provide the necessary distribution to the attacking players. In the defensive phases of play, the midfielders need to be aware of their position and cover a greater distance in width compared to formations such as 4-4-2 and 4-3-3 to stop opposition attacks by protecting the four defenders and controlling the middle of the pitch (Lucchesi, 2001).

The wingers otherwise referred to as 'wide attacking midfielders' main tasks include making themselves available to receive the ball during the team's offensive phase of play. This can be achieved by making penetrating runs into available space in between the opposition's defence and midfield, or by opening up space by moving out wide near the sideline. Once the winger has the ball, they become an essential segment of the teams attack. The player must be encouraged to attempt to take the ball past the oncoming defender and cross the ball into an area that could create a goal-scoring opportunity, cut inside the defender and then look to either shoot, depending on how far out they are or use their vision to play a key pass to a teammate making a run. During the defensive phase the wingers must ensure they track the opposition fullback if they have made a forward run, also they must offer support to their own fullback and this can be done by closing down space between the opposition's fullback and winger. Due to the wingers dropping back the formation could look more like a 4-4-2 or 4-4-1-1. The central attacking midfielder is one of the most important, if not the key player when it comes to the offensive phase of play for the team. This is mainly because the success of the teams attack is due to the quality of the central attacking midfielders decision-making and creativity. It is vital this player is free to receive the ball during the attack and it is the players key task to decide when to play a through ball to the centre forward, attack an empty space and have a shot or retain the ball to allow more players to get forward. During the defensive phase of play, the role of the central attacking midfielder is dependent on the formation of the opposition. If the opposition is using a formation that with that is similar or the same to the formation 4-2-3-1 then the central attacking midfielder is required to track back and overload the midfield and limit space for the opposition. If the opposition is not using a similar formation, the player can be encouraged to remain in an advanced position and aid the centre forward in pressurising the defenders who are in possession of the ball (Lucchesi, 2001).

The striker (centre-forward) during the offensive phase of play is a key point of reference for the team. The ability of the player to receive the ball and pass it to another player in an attack (often quoted as the ‘wall pass’) is fundamental in creating significant chances to score a goal. In addition, the centre forward must ensure they are constantly available for a cross from the attacking midfield players in the opponent’s penalty area and continually looking to be on the receiving end of a through ball played by one of the midfielders during a counter attack. Defensively the centre forward must either pressurise the opposition defender and force them into playing in a certain direction or area of the pitch, this is referred to as ‘guided pressure’, or close down and attempt to tackle the opposition defender who has possession of the ball (Lucchesi, 2001).