Effects of high-intensity position-specific drills on physical and technical-skill performance in young soccer players

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"Where there is a will, there is a way. If there is a chance in a million that you can do something, anything, to keep what you want from ending, do it. Pry the door open or, if need be, wedge your foot in that door and keep it open" - Pauline Kael

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ABBREVIATIONS

ANOVA: Analysis of variances

CB: Center back

CF: Center forward

CM: Center midfielder

CV: Coefficient of variation

ES: Effect size

FB: Full-back

FIFA: Fédération Internationale de Football Association

GPS: Global Positioning System

HIIT: High intensity interval training

HR: Heart rate

HR_{max}: Maximal heart rate

ICC: Intraclass correlation coefficient

LSPT: Loughborough soccer passing test

PSCT: Position-specific conditioning training

RSA: Repeated sprint ability

SSG: Small sided games

WM: Wide midfielder

YYIRT1: Yo-Yo intermittent recovery test level 1

ABSTRACT

Soccer is the most widely played sport in the world, and physical preparation for soccer players has been extensively researched over the years. As the average intensity of a soccer match is close to 80-90% of maximal heart rate (HR_{max}), it is necessary to train at or above this intensity. Thus, high-intensity interval running and small-sided games are often used to improve aerobic capacity and repeated sprint ability (RSA). However, neither of these approaches consider positional variations in the frequency and type of specific technical skills required in real match situations. Thus, the purpose of this study was to investigate the feasibility, and short-term effects of a novel position-specific conditioning training (PSCT) on the physical and technical abilities of young soccer players. This study recruited 15 male Vietnamese youth soccer players (16.1 ± 0.4 years, 171.7 ± 4.8 cm, 63.9 ± 3.8 kg) who frequently played in youth national tournaments. PSCT consisted of a specific drill for attackers, defenders and wingers, respectively. The intensity and duration were designed to be the same for all three drills (i.e., 4 × 4-min at 90-95% HR_{max}, separated by 4-min active recovery at 70% HR_{max}), but differentiated by the technical and tactical actions performed during high-intensity efforts and pitch location. All players participated in a 3-week control period of high-volume training, followed by a 3-week intervention period with PSCT drills added to usual team practice and matches twice a week. Criterion measures included Yo-Yo intermittent recovery test – level 1 (YYIRT1), repeated sprint ability (RSA) assessed by the total time of 6 x 30m sprint with 30-s passive recovery, and 10m and 30m sprint time. The Loughborough soccer passing test (LSPT) was used to assess the players' technical skills in a fatigued and non-fatigued state. These measures were taken at baseline, after the control period and after the intervention period. The results showed that PSCT drills induced a desirable intensity for effective conditioning purpose (89.0 ± 2.1% HR_{max}) with low inter-player variability (CV = 2.4%). The weekly total training volume in terms of the distance covered during the control period was 45.45 ± 3.82 km, which was

11.97 km greater (P=0.017, ES= 1.82) than that of the intervention period (33.48 ± 6.40km). The distance covered in the YYIRT1 increased (P<0.05) from baseline (1757 ± 357 m) to the post-control period (1936 ± 373 m) by 10.2% (p=0.01), and increased from the post-control to post-intervention period (2112 ± 238 m) by 9.1% (p=0.03). However, the magnitude of the increase in the distance was similar (P=0.98) between the control (179 ± 203 m; ES = 0.48) and intervention periods (176 ± 225 m; ES = 0.55). No significant changes in RSA (P>0.05) were observed from the baseline (26.21 ± 0.5 s) to post-control period (26.26 ± 0.8 s) and post-intervention period (26.32 ± 0.8 s). This was also the case for 10m sprint time (baseline: 1.80 ± 0.1 s, post-control: 1.80 ± 0.1 s, post-intervention: 1.77 ± 0.1 s) and 30m sprint time (4.20 ± 0.1 s, 4.26 ± 0.1 s, 4.26 ± 0.2 s). No significant changes (p>0.05) were found for any parameter of the LSPT over time (from baseline to post-intervention) for both fatigued and non-fatigued conditions. These results confirmed the feasibility of PSCT as a novel high-intensity training for soccer players, but it did not affect the physical and technical measures investigated in the present study in the time frame. Future research should further investigate the use of PSCT as a position-specific test and/or a novel conditioning approach by comparing PSCT to small sided games (SSG) or other forms of HIIT without ball contact in longer-term interventions.

CHAPTER 1

INTRODUCTION

This chapter introduces the background of the area, the purpose, intent and significance of the study into position-specific conditioning training methods for soccer athletes. Lastly, it also outlines the specific research questions and anticipated outcomes of the study.

1.1 Background

Soccer is the most widely played sport in the world and as such physical preparation for soccer players has been extensively researched (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011; Stolen, Chamari, Castagna, & Wisloff, 2005; Stone & Kilding, 2009). Professional male soccer players typically cover a distance of 9 to 12 kilometres (km) during a match (Mohr, Krustrup, & Bangsbo, 2003) with an average intensity close to the anaerobic threshold (e.g., 80-90% of maximal heart rate [HR_{max}]) (Stolen et al., 2005). Although aerobic metabolism is responsible for most of the activities during match play (Bangsbo, 1994), players are often required to work above their anaerobic threshold to gain a tactical advantages (Orendurff et al., 2010), such as quick counter-attacking and pressing continuously to regain ball possession. These occasions are considered intensive periods, which require the players to perform repeatedly high intensity activities such as sprinting, kicking, jumping, tackling, turning annd changing pace (Stolen et al., 2005). In particular, the efficacy in which these high intensity actions are performed is often considered a key factor that can influence the match result (Bangsbo, 1994; Orendurff et al., 2010).

In this context, research into the physical preparation of soccer players typically revolves around different forms of high-intensity interval training (HIIT) (Hill-Haas et al., 2011; Stolen et al., 2005; Stone & Kilding, 2009). Specifically, SSG and high-intensity running

are the most well established in the literature (Aguiar, Botelho, Lago, Macas, & Sampaio, 2012; Engel, 2018; Kunz, 2019; Los Arcos et al., 2015). For example, a high-intensity protocol that involves 4 sets of 4-min running at an intensity of 90-95% HR_{max}, interspersed with 3 min of active recovery at approximately 70% HR_{max} has been shown to effectively improve the aerobic capacity of elite soccer players after 8 weeks intervention (Helgerud, Engen, Wisloff, & Hoff, 2001; Stolen et al., 2005). More recently, studies investigating different kinds of HIIT running programs, have also demonstrated significant positive effects on both aerobic and anaerobic performance in junior and senior soccer players, respectively (Engel, 2018; Kunz, 2019). With respect to SSG, the smaller game formats, such as 2 vs 2, 3 vs 3 and 4 vs 4 are considered an effective endurance conditioning tool and incorporate soccer-specific technical and tactical components. Moreover, SSG have potential to expose the players to intensities required to promote optimal cardiovascular adaptation (i.e. > 90% HR_{max}) (Aguiar et al., 2012; Hill-Haas, Dawson, Coutts, & Rowsell, 2009; Hissey, Blazevich, & Ma'ayah, 2014; Katis & Kellis, 2009; Los Arcos et al., 2015; Rampinini, Impellizzeri, et al., 2007). This is an important factor in the appropriate preparation of soccer players.

Although demonstrated to be effective for physical conditioning, HIIT paradigms have several limitations. For example, HIIT running programs generally lack sport-specific components, and can be psychologically challenging for players with reported lower level of enjoyment compared to other forms of high intensity technical training. Therefore, it is generally not favoured by head coaches (Selmi et al., 2017; Stolen et al., 2005). In contrast, SSG are preferred because of the ability to optimize training time by fulfilling a broad range of physical requirements, whilst also incorporating technical and tactical components of the game (Aguiar et al., 2012; Los Arcos et al., 2015). A recent investigation into 3v3 SSG has shown significant improvements in the players' technical performance after a 6-week intervention, using the Loughborough Soccer Passing Test (LSPT) (Eniseler, Sahan, Ozcan, & Dinler, 2017).

Such findings indicate that 3v3 SSG are not only effective for physical conditioning, but can also improve the players' technical skills. However, using SSG for conditioning purposes also has its limitations. These limitations include: (a) a high variability in physiological responses of the players (Hill-Haas et al., 2011), (b) the presence of "ceiling effect" for highly fit players (Buchheit et al., 2009; Hoff & Helgerud, 2004), (c) the lack of high speed and repeated sprint exposure (as demanded by real match situations) (Gabbet, Jenkins, & Abernethy, 2009; Hissey, Blazevich, & Ma'ayah, 2014), and (d) a higher risk of contact injury than other modes of exercises (Little, 2009).

Importantly, both HIIT running and SSG neglect the specific skill requirements of each playing position, even in spite of a technical and tactical component to SSG. In a game of soccer, players have to perform a wide range of tactical actions and technical skills, such as ball controlling, dribbling, shooting, heading, short and long passing (Ade, Fitzpatrick, & Bradley, 2016; Ali, 2011) and it is evident that some technical skills and movement patterns are specific to a particular playing position (Barnerat, Crevoisier, Hoek, Redon, & Ritschard, 2017). Therefore, a specific training intervention that involves high intensity running efforts and the incorporation of position-specific technical skill practice might offer more optimal transfer to real match conditions.

1.2 Purpose and Significance

Previously, based on the principle of specificity, sport scientists and professionals have generally agreed that an effective method of training to prepare athletes for competition is one that closely replicates the competitive conditions (Rushall & Pyke, 1990). For example, the Fédération Internationale de Football Association's (FIFA) official coaching manual and multiple scientific reports have shown that certain skills are more important to different playing roles (refer to Table 1), and additionally, the use of specific conditioning programs might

promote more effective transfer to real match performance (Ade et al., 2016; Barnerat et al., 2017; Bloomfield, Polman, & O'Donoghue, 2007; Di Salvo et al., 2007; Orendurff et al., 2010). However, to the best of our knowledge, no research has investigated the effects of a conditioning method that takes into account positional differences in soccer and design specific training drills for each position. Thus, this study aimed to implement and investigate the effectiveness of position-specific conditioning training (PSCT) drills, as a short-term HIIT program, on the physical and technical performance of professional young soccer players. The findings of this study may be particularly useful for strength and conditioning coaches, professionals and athletes involved in soccer and other team-based field sports.

1.3 Research Questions

1) What are the acute physical and physiological responses to the PSCT drills in elite youth soccer players?
2) What is the variability of the physical and physiological responses to PSCT drills between elite youth soccer players?
3) Is the magnitude of physical and technical training effects different between usual soccer training alone, compared to the addition of PSCT drills?
4) How does 3 weeks of high-intensity training in the form of PSCT drills affect Yo-Yo intermittent recovery test 1 (YYIRT1), sprinting speed and repeated sprint ability (RSA)?
5) How does 3 weeks of PSCT drills affect technical skill performances assessed by LSPT performance and penalty time under fatigued and non-fatigued conditions?

1.4 Research Hypotheses

1) PSCT would induce the physiological response of equal or above 90% of each individual HR_{max} and a substantial amount of high intensity running distance.
2) PSCT drills would have low variability (%CV) in both physiological and physical responses amongst the players.
3) PSCT drills would induce greater magnitude of physical and technical training effects than that of the control condition.
4) A short-term use of PSCT drills twice per week would significantly improve the players physical abilities (YYIRT1, Sprinting Speed and RSA).
5) A short-term use of PSCT drills twice per week would significantly improve the players' LSPT performance under fatigued condition, but not under non-fatigued state.

CHAPTER 2

LITERATURE REVIEW

This chapter provides a thorough examination of the previous literature that influenced the study design for the thesis. The content of this chapter involves discussion of the physical, physiological and technical demands of soccer, the physical, technical skill assessments and the existing conditioning methods that are widely established and used in practice.

2.1 Physical and Physiological Demand of Soccer

Fundamentally, soccer is a highly intermittent sport where a player's performance relies on a combination of physical, technical, tactical and cognitive abilities (Aguiar et al., 2012; Hissey, Blazevich, & Maya'ah, 2014; Hill-Haas et al., 2011; Stolen et al., 2005; Stone et al., 2009). During a 90 minute match, professional players have been shown to run 9 to 12 kilometres (km) (Mohr et al., 2003), with an average intensity equal to 80-90% of maximal heart rate (HR_{max}) (Stolen et al., 2005). This range is close to most players' anaerobic threshold (Stolen et al., 2005), which is defined as a work rate that anaerobic metabolism becomes the main source of energy supply, causing a sustained accumulation of lactate and hydrogen ions (Wasserman, 1986). Exceeding this threshold has been shown to significantly reduce a player's immediate endurance capacity (Wasserman, 1986). Despite the high average HR, approximately 80-90% of the match involves low to moderate intensity activities (walking/jogging), with the aerobic system being a dominant source of energy supply (Bangsbo, 1994). However, there are also times when players are required to work above their anaerobic threshold (>90% HR_{max}) to gain a tactical advantage (Orendurff et al., 2010). These occasions are considered intensive periods, which involve high intensity actions, e.g. sprinting, kicking, jumping, tackling, turning, changing pace, and performing forceful muscular contractions (Stolen et al., 2005). Although only occupying approximately 10-20% of total

energy consumption of a soccer match (Bangsbo, 1994), these intensive periods rely on the anaerobic system to supply energy and are often a key factor that can influence the match result (Bangsbo, 1994; Orendurff et al., 2010). Therefore, specific conditioning strategies that expose the players to above game intensity and facilitate similar demands of the most intensive anaerobic periods of the match (>90% HR_{max}) may assist players to optimally prepare for real competition.

2.2 Physical Tests for Soccer Players

Over the years, researchers have established various valid and reliable tests to measure the physical qualities of soccer players that correlate with real game physical performances. Therefore, conditioning strategies often aim to develop at least one, or a combination of these qualities to effectively improve the players' physical capabilities and assist with the overall performance.

2.2.1 Aerobic Capacity

The Yo-Yo Intermittent Recovery Test - Level 1 (YYIRT1) was used to examine a player's ability to perform repeated intermittent running with maximum aerobic capacity (Bangsbo, Iaia, & Krustrup, 2008; Krustrup et al., 2006). With a high level of specificity to intermittent exercise, the YYIRT1 is one of the most extensively researched and applied tests of aerobic capacity for team sports athletes (Bangsbo et al., 2008; Krustup etl al., 2006). In addition to endurance testing, another use of YYIRT1 is to determine an individual's maximal heart rate (bpm). It has been reported that the YYIRT1 can induce HR values corresponding to 99 ± 1% of HR_{max}, which is similar to that obtained with a gold-standard laboratory treadmill test (Bradley et al., 2011). In soccer, studies have shown that the YYIRT1 can predict the ability to perform high intensity activities during a match and differentiate players based on

competitive levels (e.g., novice, sub elite and elite) (Bangsbo et al., 2008; Karakoc, Akalan, Alemdaroglu, & Arslan, 2012; Krustrup et al., 2006). It is reported that international-elite soccer players cover, on average, 2420 m in the YYIR1 test, whereas the moderate-elite (second division players) players achieved 2190 m (Krustrup et al., 2006). In the elite youth category, U17 players (16.2 ± 0.6 years; 173.9 ± 4.9 cm; 61.8 ± 8.4 kg) of a professional Belgian soccer team had an average YYIRT1 result of 2404 ± 347 m (Deprez, Fransen, Lenoir, Philippaerts, & Vaeyens, 2015).

2.2.2 Anaerobic Power

Sprinting speed over short to medium distances (5-40m) is considered an important characteristic contributing to successful soccer performance and as such, is widely used in talent identification (Reilly, Williams, Nevill, & Franks, 2000). In an elite level soccer match, a player performs approximately 220 high-speed efforts (Mohr et al., 2003), with peak values of over 32km/h having been reported (Bangsbo, Mohr, & Krustrup, 2006). A 30m sprint test with 10m lap time, using photoelectric timing gates located at 0m, 10m, 20m, 30m is a widely used protocol in soccer (Reilly et al., 2000).These distances represent those that are most commonly performed during an 'in-match' sprinting effort (Wisloff, Castagna, Helgerud, Jones, & Hoff, 2004). Specifically, elite soccer players are generally faster than amateur players over the first 10m (acceleration phase) of the 30m sprint test (Djaoui, Chamari, Owen, & Dellal, 2017).

In addition, repeated sprint ability (RSA), known as 'speed-endurance' is another important trait in modern soccer (Stolen et al., 2005). RSA refers to the ability to repeatedly produce short, maximal or near-maximal efforts (≤10s), interspersed with brief recovery periods (≤60s) consisting of passive rest or low-to-moderate intensity activities (Bishop, Girard, & Mendez-Villanueva, 2011). Several studies have suggested that improving RSA alone contributes to greater physical performance in various team sports, including soccer (Bishop et

al., 2011; Rampinini, Bishop, et al., 2007). In elite soccer, RSA significantly correlates with very high speed ($r = -0.60$; $p < 0.01$) and total sprinting distance ($r = -0.65$; $p < 0.01$) (Rampinini, Bishop, et al., 2007), which are considered two of the most important parameters that have potential to influence a match result and differentiate players based on competitive level (Mohr et al., 2003).

2.3 Technical Demands of Soccer

Passing, controlling, dribbling and shooting are fundamental soccer skills (Ali, 2011). In addition, other frequently used skills, such as a header (make contact with ball by the head), a trick (perform ball skills before, during or after dribbling) and a long pass (pass over a distance of ≥30m) have been described in a previous study of elite professional players (Ade et al., 2016). Specifically, Ade et al. (2016) attempted to quantify technical actions associated with high intensity running efforts, with results indicating that the frequency of performing these skills varies dependent on playing position. For example, it has been shown that the number of high intensity efforts in contact with the ball were greater in wide midfielders (WMs) than central backs (CBs), central midfielders (CMs) and central forwards/strikers (CFs). Further, after high intensity running efforts, CBs perform long passes more frequently than WMs and CFs (ES: 0.7, $p < 0.05$), whilst WMs execute more tricks than CMs and CFs in an attempt to seek tactical advantages (ES: 1.2-1.3, $p < 0.05$) (Ade et al., 2016). Moreover, it is not surprising that following high intensity running bouts, CFs and CMs make most shooting attempts whilst full backs (FBs) and WMs make most crosses into the penalty box due to efforts commonly finishing in wide attacking area of the pitch (ES: 1.1-2.0, $p < 0.05$) (Ade et al., 2016; Hughes, 2012). The most distinctive, typical and perhaps, tactically important movements of the CBs are moving laterally and directly backwards (backpedalling) at high speed (Bloomfield et al., 2007; Rienzi, Drust, Reilly, Carter, & Martin, 2000) to maintain observation of opponents and

react accordingly. CFs and CBs have been shown to perform the most jumping activities in a match to perform a 'header', with CBs performing significantly more backward jumping (Bangsbo, 1994; Bloomfield et al., 2007). The FIFA coaching manual (Barnerat et al., 2017) has also provided information about the specific skill sets required for each playing position (rể to Table 1). From this information, it is evident that some technical skills and movement patterns are more relevant to certain playing positions than to others. Therefore, specific training interventions that allow the practice of certain skills for each playing position might facilitate more optimal transfer to real match conditions.

2.4 Technical Skill Tests

Various soccer technical skill tests have been reported in the literature (for detailed review refer to (Ali, 2011). It is suggested that isolating one aspect of the game, such as shooting or passing in a static position may make it a test of technique, rather than skill *per se* (Ali, 2011). To be categorised as a skill test, a player must be required to utilize the decision making process to select and perform the correct technique in response to the demands of the dynamic, pre-determined environment (Ali, 2011; Knapp, 1963). In light of this definition, the Loughborough Soccer Passing Test (LSPT) has been shown to have acceptable test-retest reliability and good validity to assess the multifaceted aspect of soccer technical skills, including passing, controlling, dribbling and decision making under time pressure (Ali, Williams, Hulse, et al., 2007). It has been established that both speed and accuracy can influence the overall performance of the skill, and there is a trade-off relationship between these two factors (Fitts, 1967). In other words, less technically proficient players might sacrifice one aspect (e.g. speed) to preserve the other (e.g. accuracy). This may be even more prevalent under fatigue as suggested in other studies (Ali, Williams, Nicholas, & Foskett, 2007; Rampinini et al., 2008). Specifically, in terms of passing skill, Rampinini et al. (2008) reported no difference in the time

taken to finish the LSPT of the junior soccer players during fatigued and non-fatigued state. However, the penalty time incurred by the players whilst fatigued was significantly higher ($p < 0.05$), indicating the sacrifice of accuracy to maintain speed under fatigued conditions.

Fatigue is multifaceted and complex. Specifically, neuromuscular fatigue refers to an exercise-induced reduction in the ability of the muscle(s) to produce force (Gandevia, 2001). In particular, the decrement in force capacity of lower body muscles may impair joint stability, negatively affect movement functions and thus, may help explain the reduction in physical and technical performance of soccer players in the latter stages of a match (Goodall et al., 2017). Fatigue can also result from a succession of intense efforts (transient fatigue), previous studies of elite players have shown that high intensity running and sprinting actions are significantly reduced during the second half (Mohr et al., 2003; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007; Rampinini, Impellizzeri, Castagna, Coutts, & Wisloff, 2009), and following the most intense 5-min of the game (Mohr et al., 2003). Further, research conducted in top elite Italian soccer players showed that the development of fatigue from the first to the second half of the match not only affects high intensity physical actions, but also technical skill performance, such as an involvement with the ball and short passing ability (Rampinini et al., 2009). This is of considerable importance because involvement with the ball, short passing frequency and accuracy are the skills that have been shown to differentiate more versus less successful teams in the same league (Rampinini et al., 2009). In brief, the collective evidence suggests that fatigue negatively impacts important technical skills of soccer players during competition. Therefore, the assessment of technical skills during a fatigued state may provide more specific evidence regarding the player's technical ability, which is likely to be closely associated with the technical skill demands of real competition.

2.5 Existing Conditioning Training Methods for Soccer Players

In the literature, the two most well documented conditioning methods for soccer are HIIT running and small-sided games (SSG) (Hill-Haas et al., 2011; Stone & Kilding, 2009). As such, the strengths and weaknesses of both approaches have been identified. For example, a HIIT running protocol that involves 4 sets of 4-min running at an intensity of 90-95% HR_{max}, interspersed with 3 min of active recovery at ~70% HR_{max} is considered an effective method to improve the aerobic capacity of elite level senior soccer players (0.5-0.75% increase in VO_2max per session) (Helgerud et al., 2001; Stolen et al., 2005). Another study that prescribed a HIIT running program (two additional sessions per week for 10 weeks) at 120% of maximum aerobic speed and repeated sprints of 40m also showed significant improvements in anaerobic power and aerobic capacity, based on maximal aerobic speed values (+8.1 ± 3.1%; $p < 0.001$) (Dupont, Akakpo, & Berthoin, 2004). In the youth (under 17) category, Impellizzeri and colleagues (2007) investigated the effects of a 4-week high intensity intervention, using the aforementioned 4 x 4-min running protocol at 90-95% HR_{max}. The findings of this study demonstrated that there were 12% and 4% increments in YYIRT1 performance and VO_2max values, respectively, after the intervention period. At the younger age group (under 14), Sperlich and colleagues (2011) investigated the effects of HIIT training at close to 90% of HR_{max} and reported significant improvements in VO_2max values, after 5 weeks of training (Sperlich et al., 2011).

Although effective to improve the aerobic capacity across different age groups and competitive levels, HIIT running does not involve any technical or tactical component, and therefore, may not be considered soccer specific. Helgerud et al. (2001) reported significant improvements in VO_2max, lactate threshold, running economy, distance covered in a match and the total number of sprint efforts. However, from a technical perspective, the HIIT running intervention did not show any significant effects on the players' shooting and passing qualities

(Helgerud et al., 2001). In addition, HIIT running may even result in reduced motivation due to poor perception of the conditioning approach, negative mood changes, and more boredom compared to with-the-ball approaches (Stolen et al., 2005), and as such is not generally favoured by head coaches. A recent study has confirmed that HIIT running has negative effects the players' mood compared to a game-based conditioning approach (Selmi et al., 2017). This suggests a lack of player satisfaction with this type of training and raises concerns about the lack of variety, long-term motivation and adherence.

Conversely, SSG are widely accepted in practice as they can optimize training time by simultaneously fulfilling a broad range of physical requirements and incorporating technical and tactical components of the game (Aguiar et al., 2012; Los Arcos et al., 2015). Moreover, the parameters of SSG can be manipulated in order to modulate the physiological responses. Generally, it is suggested that smaller SSG formats with fewer players can induce greater physiological responses than larger SSG formats (Hill-Haas et al., 2009; Hissey et al., 2014; Katis & Kellis, 2009; Rampinini, Impellizzeri, et al., 2007). In particular, 2v2, 3v3 and 4v4 SSG have been shown to record some of the highest HR readings , with the average percent HR_{max} closest to the desirable range of 90-95% for optimal cardiovascular adaptations (Aguiar et al., 2012; Hill-Haas et al., 2009; Hissey, Blazevich, & Maya'ah, 2014; Katis & Kellis, 2009; Los Arcos et al., 2015; Rampinini, Impellizzeri, et al., 2007). From a technical standpoint, the 3v3 format of SSG has demonstrated a higher number of technical actions, such as short passing (~44 vs 33), kicking (~4 vs 2), dribbling (~8 vs 6) and goal scoring (~12 vs 7) activities per player than the 6v6 format (all $p < 0.05$) (Katis & Kellis, 2009). Therefore, it is not surprising that a recent investigation on the 3v3 SSG has shown significant improvements in the LSPT performance after a 6-week intervention (Eniseler et al., 2017), indicating that 3v3 SSG is not only effective for physical conditioning, but may also improve the players' short passing ability. Another benefit of using SSG as a conditioning method is that the players tend to perceive this

mode of training as easier and more enjoyable than HIIT running, even when exercising at similar intensities (Los Arcos et al., 2015; Selmi et al., 2017).

Despite several benefits, SSG do have limitations (Hill-Haas et al., 2011). For example, due to the individual player differences in physical attributes and technical abilities, SSG tend to result in a high variability (high % CV) of physiological responses amongst the athletes. As a consequence, highly-fit or -skilled players may not experience as much physiological stress (i.e. ceiling effect) during SSG (Hill-Haas et al., 2011). Specifically, players with high aerobic capacity and/or superior technical/tactical abilities in the team may not achieve the sufficient intensity (>90% HR_{max}) to elicit optimal aerobic adaptations (Hoff & Helgerud, 2004). One possible explanation for this discrepancy is that SSG are more intermittent than HIIT running due to a continuous reset of activities. The technical/tactical constraints of the games can also reduce the cardiac output and prevent a sustained stroke volume to be achieved (Hoff & Helgerud, 2004). To support this point, previous research has demonstrated that players with the highest VO_2peak values achieved the lowest percentage of VO_2peak during SSG (Buchheit et al., 2009). These findings indicate that the aerobic energy system is not placed under as much stress during SSG for athletes with an already high aerobic capacity and/or good skill levels, (Stone & Kilding, 2009). A further limitation of SSG is that they do not always stimulate the high intensity, repeated-sprint demands of the most intense periods of real competition (Gabbet et al., 2009). For example, the highest intensity formats of SSG (2v2; 3v3; 4v4), involve play in smaller, confined areas. Thus, do not replicate the physical, technical and tactical actions experienced in real game situations, which often involve repeated 20-30m sprints, heading, shooting and crossing into the box. The larger formats of SSG, such as 6v6, can add variety to skill performance by allowing more technical actions like long pass or header, but they tend to induce lower physiological responses and thus, may not be considered optimal for aerobic development (Hill-Haas et al., 2009; Katis & Kellis, 2009; Rampinini, Impellizzeri, et al.,

2007). Importantly, the insufficient amount of high- to very-high speed running efforts associated with smaller SSG can also be detrimental to the overall conditioning effect and increase the risk of injury due to inadequate exposure to the typical high speed distance covered in a match, especially for wingers (Hissey, Blazevich, & Maya'ah, 2014). Lastly, due to the competitive nature of SSG, they may carry a higher risk of contact injuries than other conditioning approaches (Little, 2009), which may be an important factor for coaches and professionals to consider.

This research will investigate the effects of a position-specific conditioning training (PSCT) method. This PSCT method is designed to expose the players to the above game intensity (>90% HR_{max}), whilst incorporating the practice of position-specific technical actions that they most likely to perform during a match. Ultimately, PSCT has the potential to cover the weaknesses associated with HIIT and SSG by inducing the substantial amount of high to very high-speed distance, reducing the variability in physiological responses and allowing position-specific technical skill practice.

2.6 Summary of Literature Review

In the aforementioned review of the physical, technical demands and conditioning methods in soccer, there are several key points to highlight:

- Although soccer is an intermittent sport mostly based on aerobic metabolism, there are multiple occasions during a match that rely on anaerobic metabolism to provide energy for high to very high intensity activities.
- Importantly, these occasions when the players required to exceed the anaerobic threshold (>90% HR_{max}), are often key periods that can influence the overall match result.

- High intensity intermittent exercise that involves work intervals above anaerobic threshold (>90%HR_{max}), and rest intervals below anaerobic threshold (~70%HR_{max}) are proven effective for soccer endurance conditioning.
- Passing, controlling, dribbling, heading and shooting are fundamental skills in soccer. However, the frequency and emphasis of performing a specific skill, or a set of skills varies depending on playing position.
- The official FIFA coaching manual and previous scientific reports have identified specific technical requirements for each playing position and suggested that position-specific practice might offer positive transfer to real games.
- Most well-established and widely used approach for soccer conditioning are HIIT running and SSG (2v2 – 3v3 – 4v4). However, neither take into account the specific technical requirements of each playing position.

CHAPTER 3

METHODS

The aim of this chapter is to describe research methodology designed and implemented in this study in order to answer the questions posed. Specifically, this chapter will explain the setup of the study, the players' characteristics, the design of the intervention (PSCT), the assessments used to quantify the training effects and statistical analysis.

3.1 Experimental Approach to the Problem

This study consisted of three identical testing periods (with the exclusion of anthropometric measurements) to establish the baseline, post-control and post-intervention measurements, separated by a 3-week control and intervention training period (see Figure 1). The players had 1 familiarisation session to all tests before commencing the project. Each testing period included two testing days separated by 48 hours. The first testing day was used to assess repeated sprint ability (RSA), 10m, 30m sprinting speed and technical skill performance using the LSPT in a normal, non-fatigued state. The second testing day involved the assessment of aerobic capacity using the YYIRT1, and technical skill performance in a fatigued state using LSPT immediately after a 5-min soccer-specific high intensity running simulation. During the 3-week control period, players completed usual team practice and competition, whereas during the 3-week intervention period, players had two additional conditioning sessions per week, using PSCT drills, on top of usual team practice and competition. The usual team practice consisted of a 30min warm up with and without the ball, followed by pass-move/attacking/defending/possessing technical drills, medium and/or large-sided games and cool down activities such as slow jogging and stretching to finish. There was no structured team practice or competition during the testing weeks. Apart from serving as the

testing period, this period was also designed as a de-load week to avoid accumulated fatigue, which could potentially affect the subsequent training and testing activities. The training effects of the intervention period are compared to that of the control period.

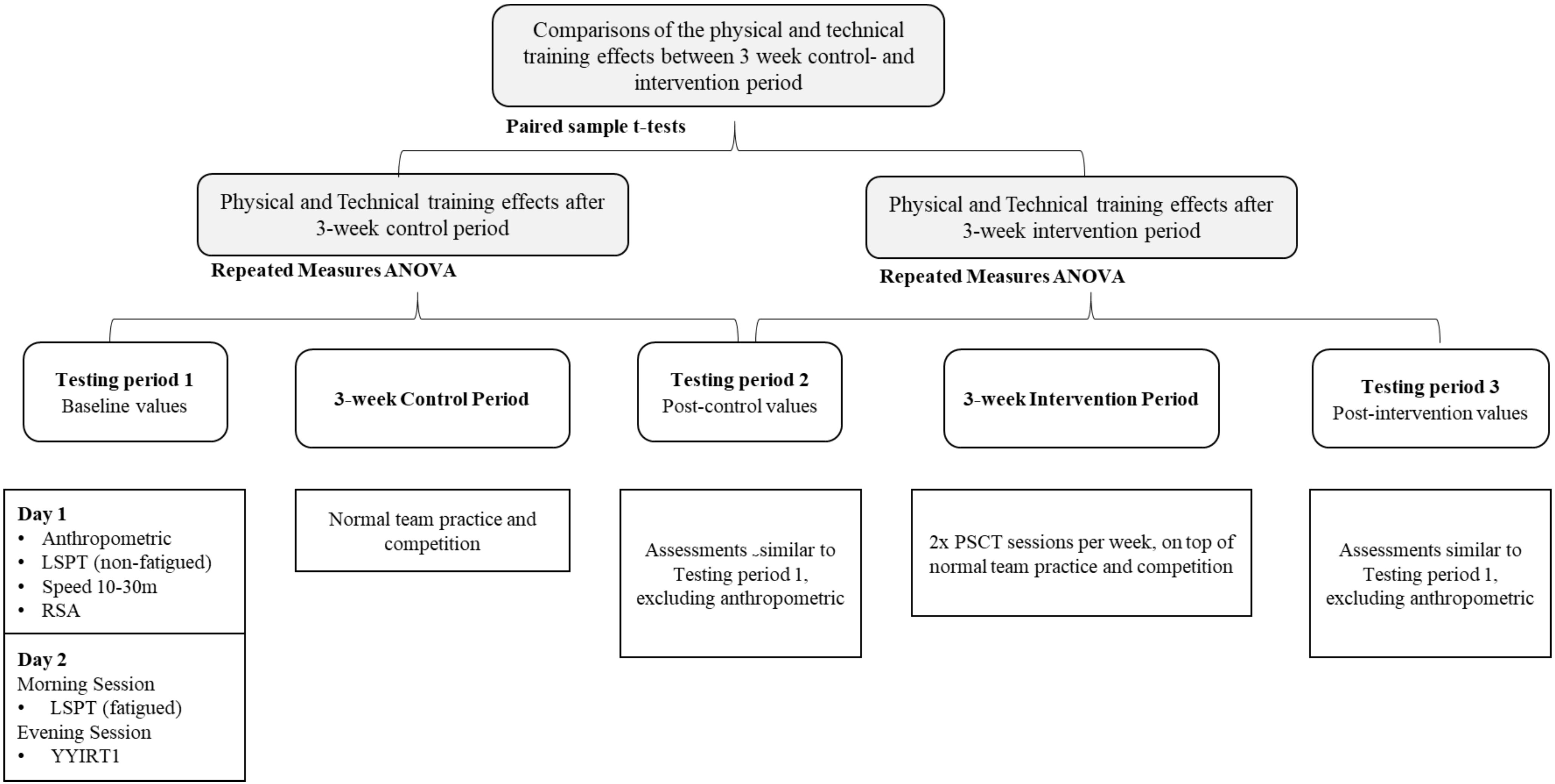

Figure 1. Study design illustration showing the testing and experimental periods (control and intervention). LSPT: Loughborough soccer passing test, PSCT: Position specific conditioning training, RSA: Repeated sprint ability, YYIRT1: Yo-Yo intermittent recovery test – Level 1.

Players were required to wear a portable Global Positioning System (GPS) device (SPI HPU, GPSports, Australia) during team practice, competition, additional conditioning training sessions (PSCT drills) and the YYIRT1 to collect the physiological responses (HR) and physical data (total and high-speed distance) for workload quantification. Baseline, post-control and post-intervention testing sessions were conducted at the same time of day ± 1h to avoid potential diurnal effects on performance. To avoid confounding bias, no new modes of exercise, such as strength or power resistance training were introduced during the experimental period.

3.2 Participants/Players

Fifteen Vietnamese male academy soccer players (16.1 ± 0.4 years, 171.7 ± 4.8 cm, 63.9 ± 3.8 kg) participated in the study. All players had been involved in professional soccer training and national youth competition for at least two years and were free from any medical condition or musculoskeletal injury that would limit their participation in this study. The players were assigned to either attacking (5 players), defending (4 players) or winger drill (6 players) based on their usual playing position. The sample size was determined a priori using G*power with the following criteria (a < 0.05, power = 0.8, calculated sample size n=12). Permission to conduct research at the academy was approved by the general director and ethical approval provided by the Edith Cowan University Human Research Ethics Committee (Project No. 21709). All players and their parent(s) and/or guardian(s) were given an information letter (Appendix A) outlining the research study, requirements, risks and benefits of the research. They then had the opportunity to ask questions relating to any aspect of the research. Written informed consent (Appendix B) were obtained from the players' parent(s) and/or guardian(s) prior to commencement. All documents were written in English, however, to ensure all research procedures and risks were understood by the players and guardians, a Vietnamese version was

made available (Appendices C and D). This was translated by a certified translator to ensure the highest level of understanding for non-English speaking players.

3.2 Development of The Position-Specific Conditioning Training Drills

The intervention consisted of three different drills for attackers (strikers and attacking midfielders), defenders (central defenders and defensive midfielders) and wingers (fullbacks and wing players), respectively. All drills were designed in the form of HIIT with the same intensity and duration for each drill, i.e. 4 x 4-min work bouts at an average intensity of 90-95% HR_{max}, separated by a 4-min active recovery at 70% HR_{max}. During recovery, players remained active by jogging, juggling the ball or collecting and passing the balls back to the server. However, each drill was differentiated by the unique technical actions according to the playing positions, as outlined in FIFA manual (Barnerat et al., 2017) and previous research (Ade et al., 2016; Bloomfield et al., 2007). For example, the attackers had to perform a set of skills involving ball control, short passing, heading and goal shooting. Specifically, heading and shooting actions were performed after a high intensity running effort. Moreover, the training drills also replicated the pitch location that the players typically spend most of times on in real matches, according to their playing positions. For example, the attacking drill (Figure 2a) required players to start and finish their efforts between the middle third and attacking third of the pitch, in the central area, facing goals. The defensive drill (Figure 2b) had players start and finish their efforts between the middle and defensive third of the pitch, in the central area, facing away from goals. Finally, the winger drill (Figure 2c) had players start and finish their efforts between the middle and attacking third, in wide areas of the field. All drills were developed based on the tactical, technical actions, and pitch locations according to each playing position to ensure good ecological validity. Table 1 presents a summary table of information used to develop the PSCT drills.

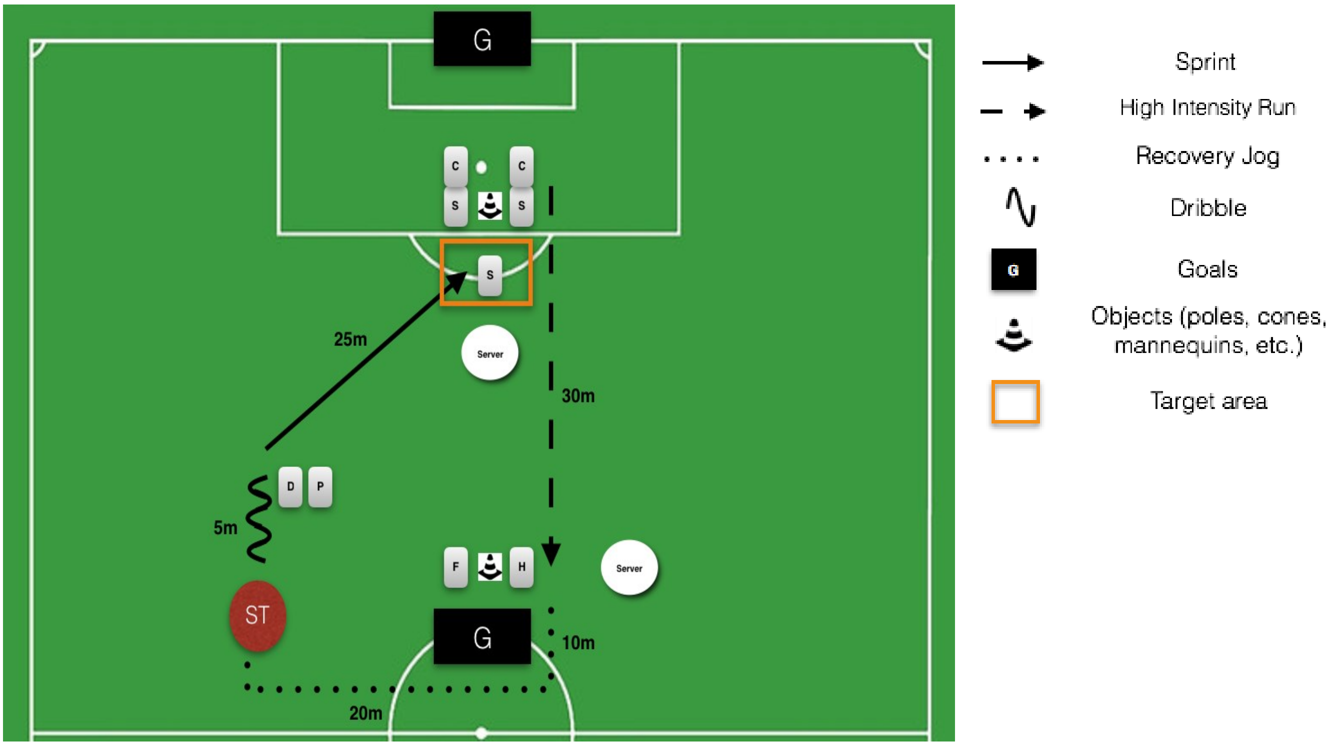

Figure 2a. Attacker drill. The aim of drill is to exercise at the highest intensity, as many reps as possible in each 4-min bout.
C = Control (receiving ball/first touch); D = Dribble; F = Finish; H = Header; P = Pass; S = Shoot.

1. The attacker starts dribbling through the cones in 5-m length.
2. The attacker then passes the ball to the server 1, who will receive & release the ball immediately to the target area (marked by cones).
3. The attacker sprints 25-m to the target area and takes a long shot.
4. The attacker comes and turns his back on the mannequin located 5-m away from the center of shooting target area, facing away from the goal.
5. The server 1 passes another ball to the attacker.
6. The attacker controls the ball (first touch) so that it falls to the left as he turns and shoots immediately.
7. The attacker returns to the backing-mannequin position facing away from goal and repeat the similar technical action but on the right.
8. The attacker makes a 30m high intensity run to the other goal.
9. The second server delivers 2 balls, one at a time:
    a. To the front of the mannequin
    b. To the back of the mannequin
10. The attacker performs a header in front of the mannequin, back off, and another finish behind the mannequin.
11. The attacker jogs 30m back to the starting position.

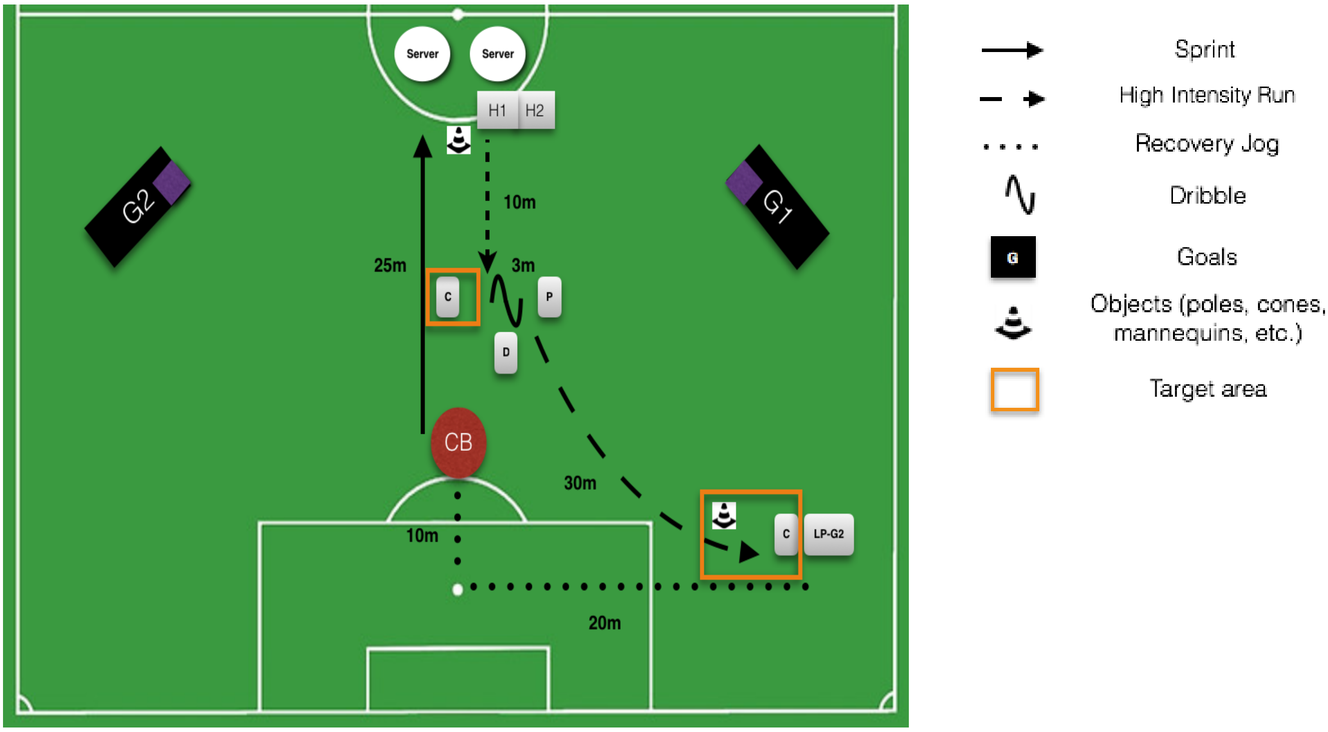

Figure 2b. Defender drill. The aim is to exercise at the highest intensity, as many reps as possible in each 4-min bout.
C = Control (receiving ball/first touch); D = Dribble; P = Pass; LP = Long Pass

1. For this drill, each of the server is in charge of serving the ball on each side.
2. The defender starts with 25-m linear sprinting from static position to the mannequin.
3. The server throws the first ball so that the defender has to jump off the ground to head the ball back to the server.
4. The server throws that the ball to the back so that the defender has to jump backward (feet off the ground) to perform the header.
5. After 2 headers, the defender performs the high intensity backpedaling (running backwards) in 10m to the target area (marked by cones).
6. The server passes the ball on the ground as the defender is approaching the target area, forcing him to receive/control the ball in backwards motion.
7. After controlling the ball, the defender dribbles through the cones in 3m length and make a short pass to the mini goal located at the corner of the big goal 1 (G1).
8. The defender then turns 90 degrees and make a high intensity acre run over the mannequin while keeping an eye on the server
9. The server makes a pass to the further target area (the server can come closer to the target area to make sure the ball is passed accurately).
10. After the high intensity acre run over the mannequin, the defender controls the coming ball from the server, in a way that is most convenient for him to make a diagonal, long pass (over 30m) to the big goal 2 (G2).
11. The defender jogs 30m back to the starting position.
12. The next attempt is on the opposite side, with balls served by the second server.

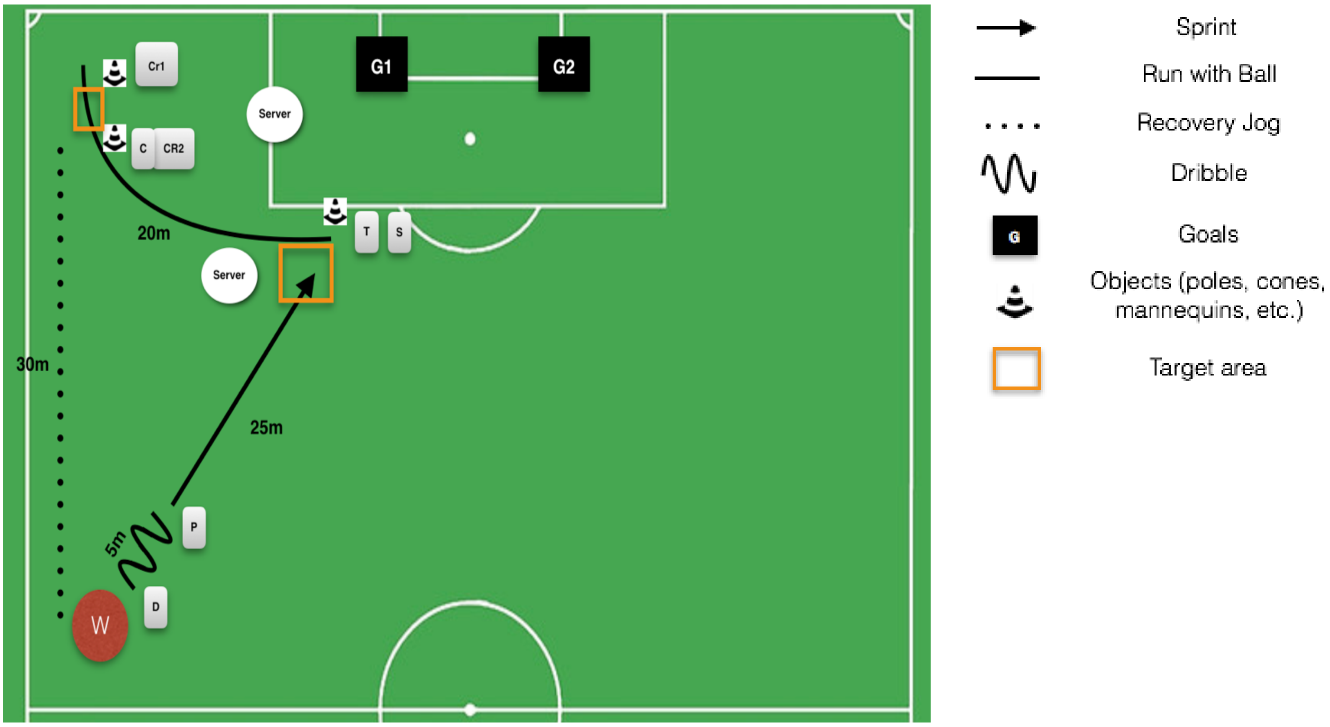

Figure 2c. Winger drill. The aim is to exercise at the highest intensity, as many reps as possible in each 4-min bout.
Cr = Cross; C = Control (receiving ball/first touch); D = Dribble; P = Pass; S = Shoot; T = Trick

1. The winger starts dribbling through the cones in 5-m length
2. The winger then passes the ball to the server 1, who receives and releases the ball immediately to the target area (marked by cones).
3. The winger sprints 25-m to the target area.
4. The winger takes the ball to attempt a trick over the mannequin and take a shot to the goal.
5. The server 1 releases another ball to the target area.
6. The winger takes the ball and performs the acre run with the ball at high intensity for 20m, to the furthest pole before low-crossing the ball to the target goal 1 (G1).
7. The server 2 passes another ball to the winger (in the area between the 2 poles, separated by 3m) as soon as the winger finishes the first cross.
8. The winger controls the ball, makes a trick over the second pole and immediately delivers a second cross to the target goal 2 (G2)
9. The winger jogs 30m back to the starting position

Table 1. Information used to develop a position-specific conditioning training model. Break into the box = Player enters the opposition penalty box; Drive through the middle = Player runs with or without the ball through the middle of the pitch; Run in behind = Player aims to beat the opposition offside trap to the opposition goal; Push up the pitch = Player moves up the pitch to support the play or play offside (defensive third to middle third of the pitch only); Run the channel = Player runs with or without the ball down one of the external areas; Drive inside = Player runs from external area with or without ball to the central area (Ade et al., 2016). HI = High intensity

Positions/Characteristics	**Technical Skill Requirements by FIFA (Barnerat et al., 2017)**	**Technical Actions & Tactical Meanings Associated with High Intensity (HI) Running Efforts (in possession) (Ade et al., 2016)**	**Other Typical Actions (Bloomfield et al., 2007)**	**Pitch Location of High Intensity Efforts (in possession) (Ade et al., 2016)**
Attackers Striker Attacking Midfielder	Shooting Heading Dribbling Short Passing Control (receiving balls/first touch)	Technical Actions Post-HI Run Shoot Header Tactical Meanings of HI Run Break into the box Drive through the middle Run in behind	Jumping	Middle to Attacking 1/3 Central area
Defenders Central Defenders Sweepers Defensive Midfielder	Heading Long & Short passing Dribbling in small area Control	Technical Actions Post-HI Efforts Long Pass Header Tactical Meanings of HI efforts Push up the pitch	Jumping Jumping backward Running backwards (backpedal)	Middle to Defensive 1/3 Central area
Wingers Fullbacks Wing Midfielder	Running with the ball Passing Dribbling Crossing Shooting Control	Technical Actions Post-HI Run Cross Trick Tactical Meanings of HI Run Run the channel Drive inside	/	Middle to Attacking 1/3 Wide area

It has been reported in an elite junior cohort that players take 1-2-min to reach 90-95% of their HR_{max} and this period is part of the 4-min work bout (Helgerud et al., 2001). In this study, the PSCT drills were designed to allow the players to achieve the desirable intensity via a combination of maximal sprinting, high intensity running, position-specific technical actions and intra-set recovery jogging, performed as many times as possible in each 4-min work bout. All players were informed of the requirements of the drills and encouraged to participate in the training drill with maximal intent. As the work: rest ratio of the drills is equal (4:4), four to six players could participate in a drill at a time. While two players performed the exercise, the other two would actively rest by collecting balls or performing light movements and vice versa. The ball-serving activity for these drills only involved simple soccer skills such as receiving short passes, throwing or passing the ball over short to medium distances (no longer than 20 metres). Thus, the servers were anyone proficient with passing a soccer ball, or those who had at least a year of playing experience, including assistant coaches, a researcher, junior players and players who were not participating in the drills.

3.3 Aerobic Capacity

Aerobic capacity was evaluated by the YYIRT1 which has been shown to be a reliable and valid assessment for soccer players (Bangsbo et al., 2008; Krustrup et al., 2006). The YYIRT1 consisted of repeated 2 × 20m runs at a progressively increasing speed, guided by the audio beep sound. Between each running bout, the players had a 10-s active rest period where they moved to the cone located 5-m away before returning to the starting line. The test started at 10 km/h, increased 2 km/h after the first stage and 1 km/h after the second stage. The speed continued to increase by 0.5 km/h each stage until exhaustion. The test was terminated when the players failed to reach the line on time for two consecutive occasions despite strong verbal encouragement or by voluntary withdrawal. Players were given verbal warning after one failed

occasion. The score was collected based on the distance covered up to the last successful attempt. Less than 10 players performed the test at a time to ensure appropriate monitoring and correct data collection.

3.4 Loughborough Soccer Passing Test

The LSPT consisted of 16 passes; eight short passes to the red and white targets located 3.5 m away from the passing area, and eight slightly longer passes to the green and blue targets located 4 m away from the passing area (see Figure 3). Four colored targets (0.3 m × 0.6 m) were painted on the center of the wooden board. A white column (0.1 m × 0.15 m) was painted in the center of the target to provide an aim for a successful pass. Target orders were generated randomly into four sequences using Microsoft Excel and then written on a piece of paper held by the examiner. During each trial, the examiner had two duties: (1) start timing with a stopwatch as soon as the player began with the ball in the center and stop timing following the final pass when the ball contacted the target area, and (2) call out the next colored target just before the player received the ball bouncing back. Players were informed that passes could only be made from within the passing area and the ball must be taken through and out of the central box before the next pass was executed. Players were also informed that the LSPT is a timed test, and thus encouraged to perform the test as quickly as possible whilst avoiding penalties.

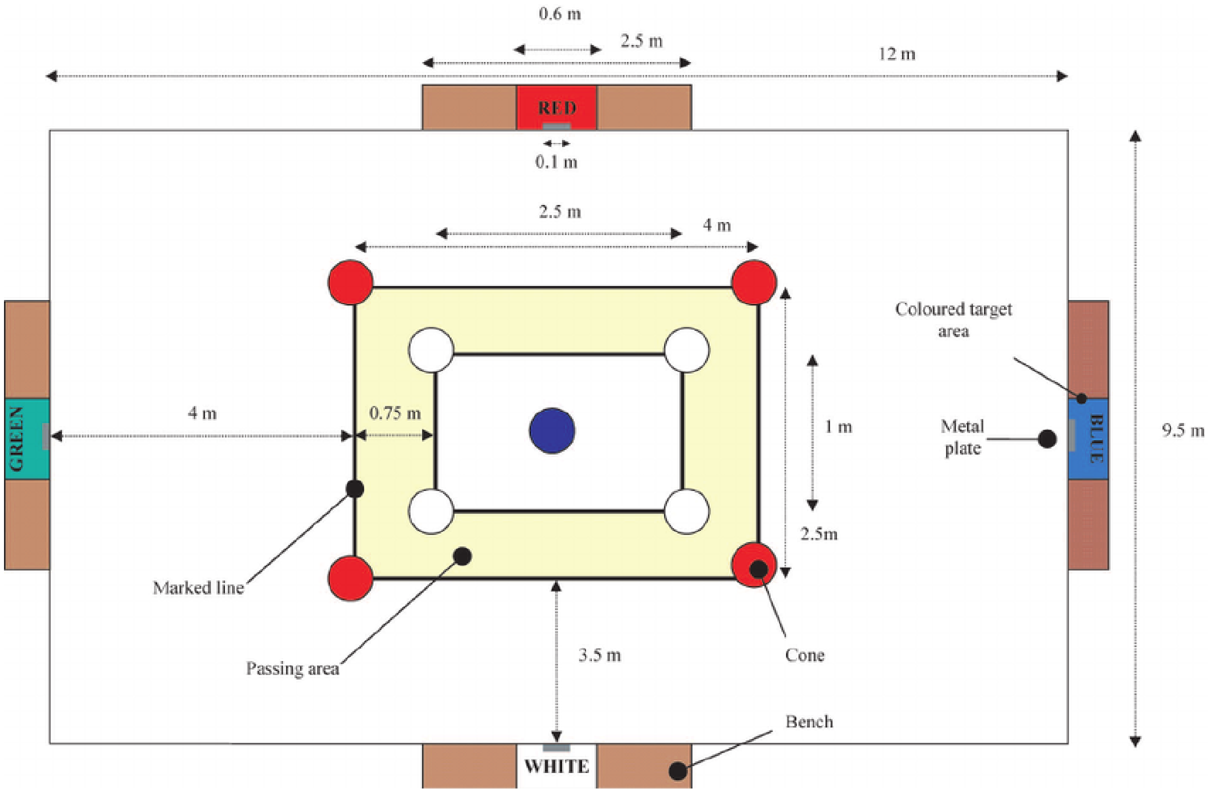

Figure 3. Loughborough Soccer Passing Test set-up illustration. Coloured tapes (red, blue, green and white) = the passing targets. Small grey tapes = reward for a successful past. White circles = dribbling area. Red circles = passing/receiving ball area.

Penalties were given for the following errors: (i) 5 s for completely missing the bench or hitting the wrong colored target, (ii) 3 s for missing the colored target area, (iii) 3 s for handling the ball, (iv) 2 s for making a pass outside of the passing zone, (v) 2 s for touching any cones with the ball, and (vi) 1 s for every additional second over 43 s (i.e. total time). An award of a 1 s was deducted from the total time for each pass that successfully hit the 10 cm white column in the center of each colored target. No coaching or feedback was given during the trials. Due to the fast nature of the test with a complex scoring scheme, two cameras were placed at opposite corners of the set-up to capture the full footage for accurate post-hoc calculation of awards/penalties and overall scoring. The time taken, added award/penalty time and overall performance time were assessed post-test by analyzing the recorded footage in slow motion. Only one examiner was responsible for conducting the test and analyzing the results to

eliminate the inter-tester variability. All players were blinded to their result during each trial across the data collection period.

3.5 High Intensity Simulation – Fatigue Protocol

Accumulated fatigue throughout a soccer match (90 min game) is subject to many factors and not always possible to reproduce for research purposes. Rampinini and colleagues (2008) have developed a 5-min high-intensity simulation to serve as a fatigue protocol prior to the LSPT to examine the acute effect of fatigue on the players technical skills. This simulation is intended to mimic the most intense period(s) of a soccer match (Mohr et al., 2003) based on the previous finding that such periods typically involve 11 consecutive high intensity running efforts with a work: rest ratio of approximately 1:3.1 (Withers, Maricic, Wasilewski, & Kelly, 1982). The result of Rampinini's study (2008) demonstrated a significant decrease in the players' technical performance on the LSPT immediately after the fatigue protocol. This finding indicates that short-passing ability is not only affected by the accumulated fatigue throughout the match, but can also be reduced following the relatively short bouts of high intensity activities and thus, may be a sensitive measure of changes in soccer performance with fatigue.

Prior to the second bout of the LSPT, players completed a 5-min high intensity simulation, consisting of 10 consecutive 40m high-intensity shuttle runs (five at 16 km/h and five at 19 km/h) with a 180 degree turn every 20 m following an audio signal. Each running bout was separated by a 25-s recovery period, alternating between standing (0 km/h), walking (5 km/h) and jogging (7 km/h) to obtain a work: rest ratio of 1:3. This high intensity simulation has been reported to induce an average intensity equivalent to 90 ± 4% HR_{max}, with low inter-subject variability (coefficient of variation [CV] = 1.5%) (Rampinini et al., 2008). A 5-s countdown at the end of the recovery period was given to ensure that the players had enough time to get ready and position themselves for the next shuttle run. After completing the fatigue

protocol, the player immediately commenced the LSPT assessment. One player went through the fatigue protocol and LSPT at a time to ensure consistency between the end of the fatigue protocol and start of the LSPT for all players.

3.6 Repeated Sprint Ability and Linear Sprinting Speed

Players completed a repeated sprint protocol comprised of six maximal 30m sprints separated by 30-s of recovery. This protocol has been shown to have excellent test-retest reliability to measure the linear sprinting speed over 10m (intraclass correlation coefficient [ICC] = 0.79; CV = 2.2%) and 30m (ICC = 0.91; CV = 1.51%), and the RSA of players in team sports (ICC = 0.94; CV = 1.34%) (Glaister et al., 2007). The players were instructed to reach maximum velocity as quickly as possible. The last 10 and 5-s of the active recovery periods were verbally noticed so the players had enough time to prepare for the next effort. Strong verbal encouragement was delivered by the research team during the test to ensure athletes performed maximally throughout the assessment. Photocell timing gates (Microgate, Bolzano, Italy) were placed at the starting line, 10 and 30m away at a height of 1 m. The players started from a static position, 30cm behind the photocell gates. Time was recorded to the nearest 0.01-s when the players intercepted the photocell beam. The fastest 10 and 30m time, and total time (RSA_{total}) of all six sprints, in seconds, were collected and analyzed.

3.7 Time-Motion Characteristics

The running profile of each player was measured using a portable GPS device operating at a sampling frequency of 15Hz (SPI HPU, GPSports, Australia). GPS devices sampling at or greater than 10 Hz have previously demonstrated good reliability and low variability (CV = 1.9-5.3%) in team sport athletes (Varley, Fairweather, & Aughey, 2012). Recording took place during all usual training sessions and PCST drills during the research study. Following

recording, the data of total distance (global load) and high-speed distance (high intensity load) (> 18 km/h) (Ade et al., 2016) were downloaded and analyzed using SPI IQ software (SPI IQ, GPSports, Australia). Training load comparisons were made between the 3-week control period to the 3-week intervention period using these two variables.

3.8 Physiological Profile

The physiological response to PSCT drills were recorded via a telemetric device (Polar H10, Polar Electro Oy, Finland). Exercise intensity was expressed based on the individual maximum heart rate (i.e. HR_{max}) obtained from the YYIRT1 (Krustrup et al., 2003) after each testing session. The training intensity of the PSCT drills were calculated by dividing the average HR obtained during each 4-min work bout by the individual's HR_{max}. The intensity of PSCT drills was calculated as the average of the intensity of the four, 4-min work bouts.

3.9 Statistical analysis

All data was inputted into Microsoft Excel (Excel; Version 2010; Microsoft, Washington, US) and analysed using SPSS statistical software (SPSS; Version 25.0; IBM Corporation, New York, US). All data was screened for normality using a Shapiro-Wilk test. Descriptive statistics (mean ± standard deviation [SD]) were calculated for all outcome measures. The total training load and high intensity training load of the 3-week control period were compared to that of the 3-week intervention period using paired samples t-tests. Changes in 10 and 30m sprint speed, RSA, YYIRT1 and LSPT performances were assessed with separate one-way repeated measure analysis of variances (ANOVA) with time points: Baseline, Post-control and Post-intervention. Where significance was detected, a Bonferroni post-hoc correction was applied to assess differences between baseline, control and intervention periods. An alpha level of ≤ 0.05 was required for significance. Additionally, effect sizes (ES) were

calculated using Hedge's method (small ES = 0.20-0.49; medium ES = 0.50-0.79 and large ES > 0.80) (Hedge, 1981). The inter-player coefficient of variation (CV), expressed as a percentage, was also calculated to assess the variability of physiological responses to PSCT drills amongst the players: CV < 10%, 10-20%, 20-30% and >30% were classified as low, medium, high and very high, respectively (Reed, Lynn, & Meade, 2002).

CHAPTER 4

RESULTS

This chapter presents the data collected and results of the statistical analyses, including the training load of the control and intervention periods, changes in the physical and technical assessments in response to the intervention (i.e. PSCT) in comparison to the control period. This chapter aims to provide a numerical foundation for further discussion and interpretation in the subsequent chapter.

4.1 Training Load

The weekly training volume for the control (3 weeks – Week 1-3) and intervention (3 weeks – Week 4-6) periods are displayed in Figure 4. Both the total distance and high-speed (>18 km/h) distance decreased over weeks, showing a shorter distance in the intervention than the control period. The ratio between the high-speed to the total distance in percentage for week 1 to week 6 was 7.0%, 4.4%, 4.9%, 5.1%, 5.8%, and 4.5%, respectively, with an average of 5.4% for the control period and 5.1% for the intervention period.

Figure 5 shows the total and high-speed distance in the control period (average of the 3 weeks) and in the intervention period (average of the 3 weeks). The total average training distance per week was significantly higher (ES = 1.82, $p = 0.02$) during the control period (45.45 ± 3.82 km) than the intervention period (35.50 ± 6.40 km). With regards to the high-speed distance, no significant difference ($p = 0.15$) was evident between the control (2.51 ± 0.89 km) and intervention (1.72 ± 0.36 km) periods.

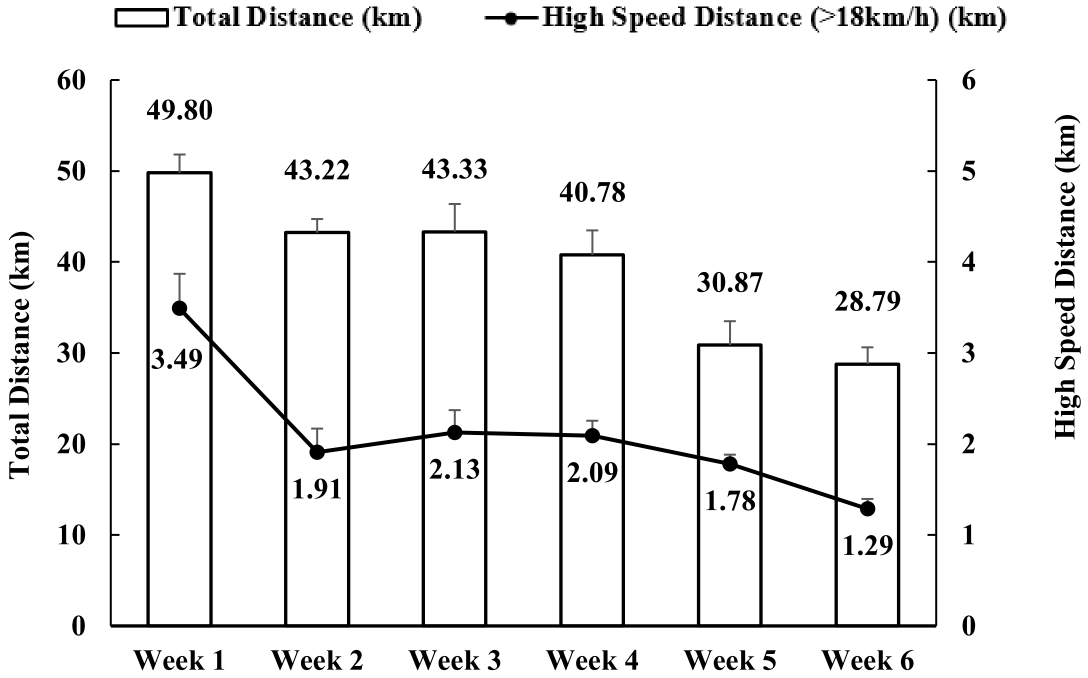

Figure 4. Weekly total distance (km) and high-speed distance (>18km/h) (km) (displayed as mean ± SD) across 6 weeks of the experiment (control period = weeks 1 – 3, intervention period = weeks 4 – 6).

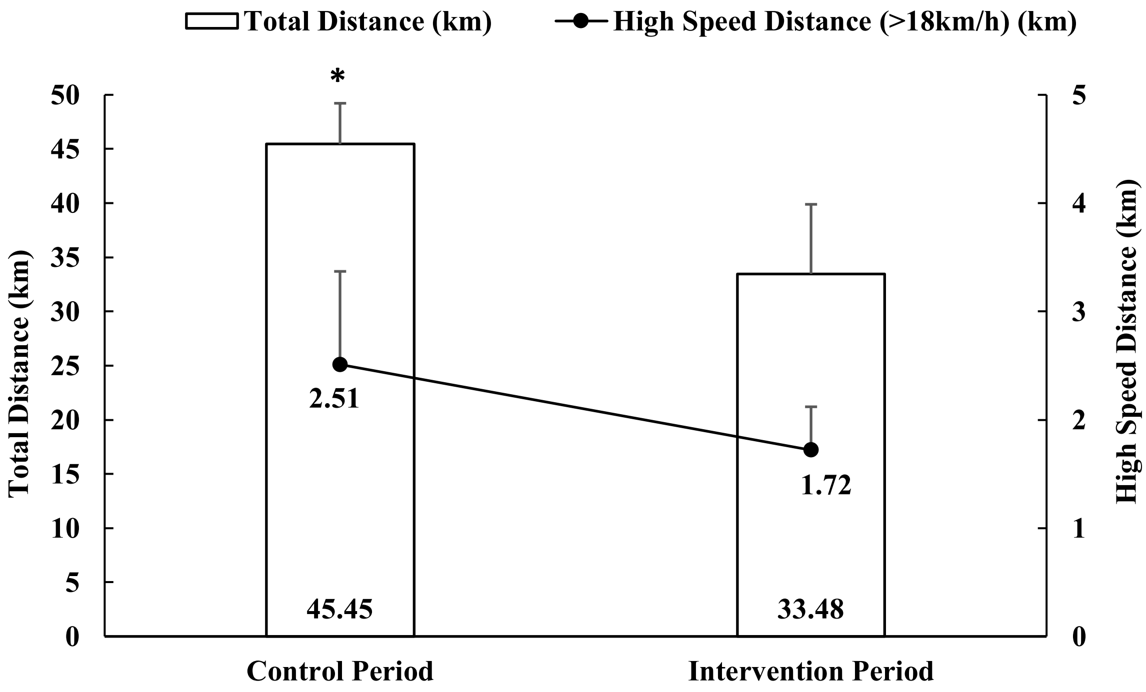

Figure 5. Average total distance (km) and high-speed distance (>18 km/h) (km) per week. (displayed as mean ± SD) between the control and intervention periods. * Significant ($p < 0.05$) difference between control and intervention periods.

4.2 PSCT drills

There were on average 5.8 PSCT sessions completed by each player during the intervention period, as two players missed one, and one player missed two PSCT sessions out of six sessions. Figure 6 shows the total and high-speed distance in the PSCT drills performed over 6 sessions (2 sessions per week for 3 weeks) in the intervention period. On average, the total distance covered in the PSCT drills was 2223 ± 104 m with an inter-player CV of 4.7% across six sessions. The average high-speed (> 18 km/h) distance was 238 ± 48 m with an inter-subject CV of 20.3% across the six sessions. No significant differences were evident amongst the sessions for both the total distance ($p = 0.30$) and the high-speed distance ($p = 0.42$). The ratio between the high-speed to the total distance in percentage for Session 1 to Session 6 was 12.1%, 9.6%, 13.9%, 12.9%, 7.7%, and 8.3%, respectively, with the average of 10.8% for all sessions.

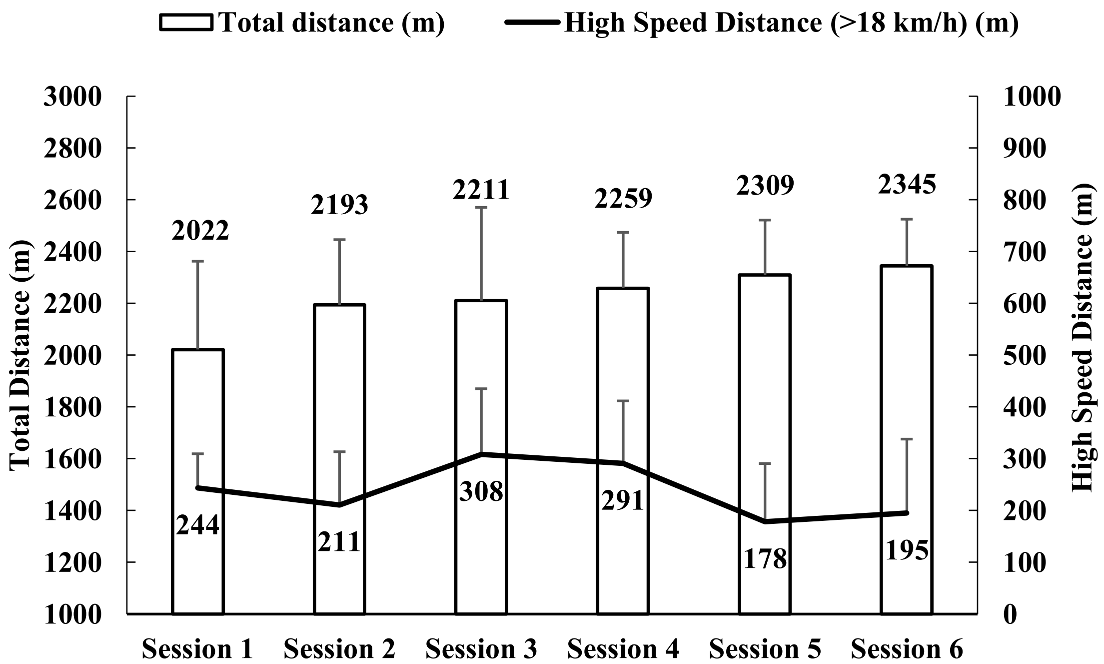

Figure 6. The total and high speed (>18 km/h) distance covered in the PSCT drills over six sessions.

As shown in Table 2, the intensity of PSCT in terms of % HR_{max} was 89.0 ± 2.1% (averaged across all drills and sessions), with a low inter-player coefficient of variation (CV) of 2.4%. There was no significant difference in HR_{max} among the PSCT sessions (p = 0.16). The average intensity of the attacker, defender and winger drills across all six sessions were 89.4 ± 2.6%, 90.2 ± 2.1% and 87.9 ± 3.5%, respectively, with a low CV of 2.9%, 2.3% and 3.9%, respectively. There were no significant differences in terms of the average intensity observed between the attacker, defender and winger drills (p = 0.10).

Table 2. The physiological responses to PSCT drills as % HR_{max} (mean ± SD) for all players. No differences were observed between drills and across sessions (Session 1 – Session 6), (p=0.10). HR_{max} = maximal heart rate

	Session 1	**Session 2**	**Session 3**	**Session 4**	**Session 5**	**Session 6**	**Average**
% HR_{max} (attacking)	89.5 ± 2.1	87.7 ± 3.0	89.2 ± 2.6	90.1 ± 2.3	89.8 ± 1.6	90.1 ± 3.9	89.4 ± 2.6
% HR_{max} (winger)	89.4 ± 3.7	91.0 ± 2.1	89.1 ± 3.0	85.6 ± 5.7	86.4 ± 3.0	85.6 ± 3.3	87.9 ± 3.5
% HR_{max} (defender)	90.4 ± 2.4	91.1 ± 1.9	89.9 ± 2.1	90.9 ± 1.5	88.3 ± 2.1	90.9 ± 2.3	90.2 ± 2.1
% HR_{max} (all drills)	89.8 ± 2.6	89.9 ± 2.7	89.5 ± 2.4	89.1 ± 3.9	88.4 ± 2.3	87.0 ± 3.0	89.0 ± 2.1

Figure 7 shows a typical example of the speed (km/h) and HR response during PSCT drills for one 4-min bout performed by a player whose HR_{max} was 195 bpm. In terms of the speed, the first peak (26 km/h) represents the sprinting action of the drills, followed by some technical actions. The second peak (18 km/h) represents the high intensity running activity of the drills, followed by another set of technical actions, and then active recovery (jogging back to the starting position). This cycle repeats as many times as possible in 4-min (the player in this example completed 4 laps, plus one sprinting action of lap 5 before the time cut). In terms

of HR, the player commenced at ~120-130 bpm, increased to ~168 bpm after the first lap, then increased above 170 bpm, and maintained this level until the end. In this example, the average intensity during the 4-min drill was 175 bpm, which was equal to 89.7% HR_{max}.

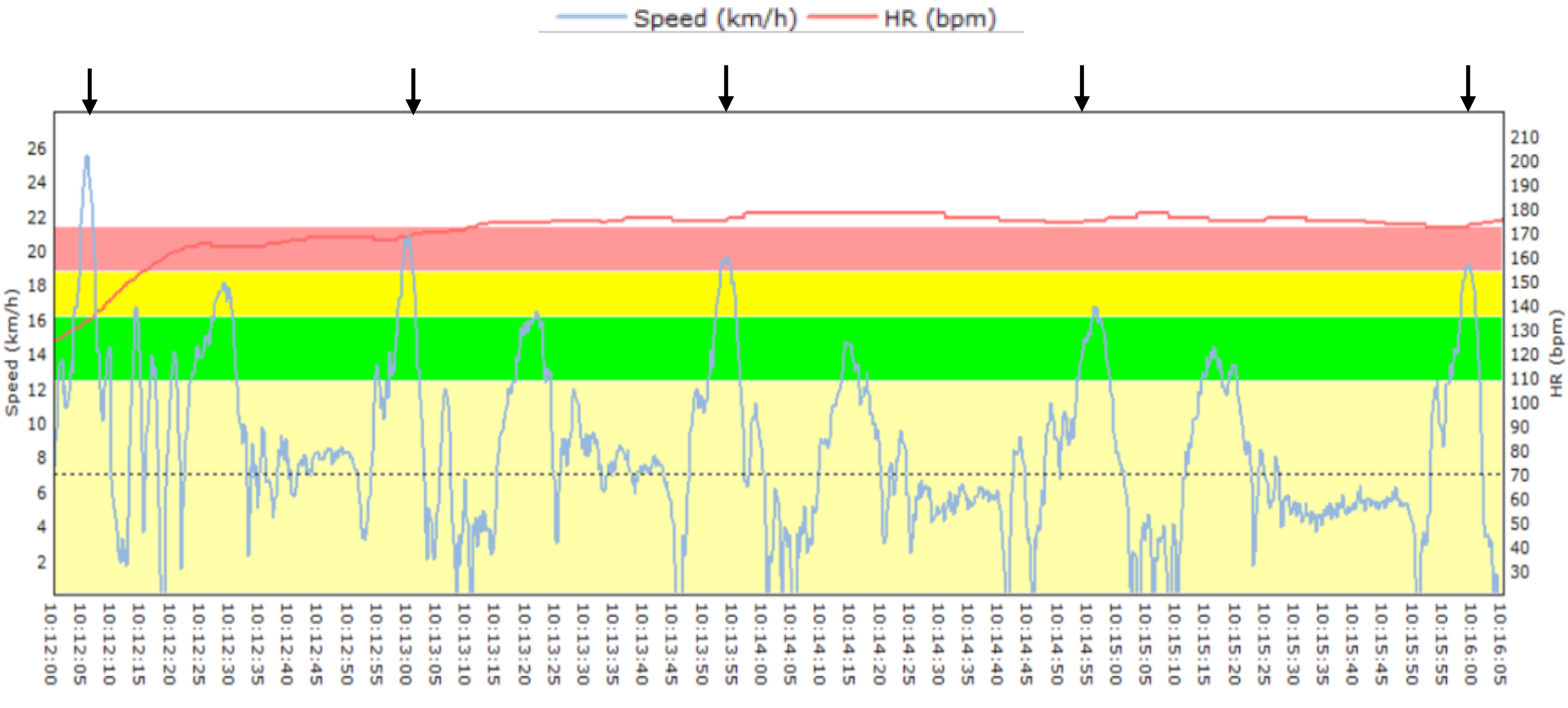

Figure 7. Example of physical (speed) and physiological (HR - bpm) responses to a PSCT drill (attacker) during a 4-min work bout (x-axis) from one player. Blue line = speed in km/h (y-left axis). Red line = HR (y-right axis). ↓ indicates start of each lap (i.e. sprinting action). Red zone = HR of 155-170 bpm; Yellow zone = HR of 135-155 bpm; Green zone = HR of 110-135 bpm.

4.3 Effects of intervention on physical performance

Table 3 shows the results of YYIRT1, 10m acceleration, 30m sprinting speed, RSA at baseline, post-control and post-intervention periods. The ANOVA showed a significant effect for YYIRT1 performance ($p < 0.01$). YYIRT1 improved by 20.2 ± 12.3% from baseline to the post-intervention period (354 ± 215 m, ES = 1.14). Post-hoc tests demonstrated an increase of 10.2 ± 11.6% ($p = 0.01$) from baseline to the post-control period (178 ± 203 m; ES = 0.48), and 9.1 ± 11.6% increase ($p = 0.03$) from the post-control period to the post-intervention period

(176 ± 225 m; ES = 0.55). However, no significant difference in the magnitude of the increase was observed between the baseline – post-control period and the post-control period – post-intervention period ($p = 0.98$).

Table 3. The physical performances across three testing periods (mean ± SD) for all players. Yo-Yo IRT1 = Yo-Yo Intermittent Recovery Test level 1; RSA_{total} = Repeated Sprint Ability (total time); * Significant difference from baseline ($p < 0.05$); # Significant difference from post-control period ($p < 0.05$).

Physical assessment	Baseline (mean ± SD)	Post-Control (mean ± SD)	Post-Intervention (mean ± SD)
Yo-Yo IRT1 (m)	1757.3 ± 357.6	1936.0 ± 373.0*	2112.0 ± 238.7#
10m sprint (s)	1.80 ± 0.65	1.80 ± 0.77	1.77 ± 0.10
30m sprint (s)	4.20 ± 0.09	4.26 ± 0.11	4.26 ± 0.16
RSA_{total} (s)	26.21 ± 0.52	26.26 ± 0.75	26.32 ± 0.82

Changes in YYIRT1 distance for individual players from baseline to post-control period, and post-intervention period are shown in Figure 8, and the absolute change in the distance from the baseline to the post-control period, and from the post-control period to the post-intervention period is shown in Figure 9. Although all players showed an increased distance from the baseline to the post-intervention period, the changes varied between the periods. For example, from baseline to post-control periods, 12 out of 15 players showed an increase whilst 3 players showed a decrease in YYIRT1 performance. From the post-control period to the post-intervention period, 11 out of 15 players showed an increase, but 2 players did not have any change whilst 2 players showed a decrease.

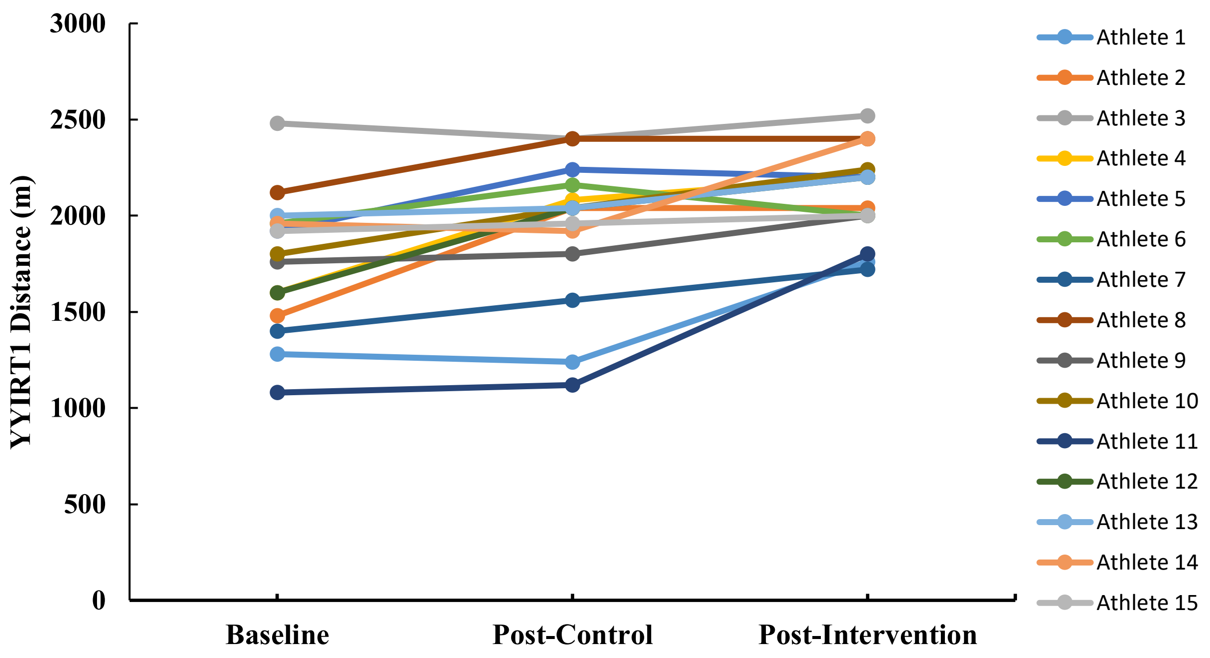

Figure 8. Individual absolute changes in YYIRT1 performance (m) from Baseline to the Post-control period, and from Post-control to the Post-intervention period, respectively.

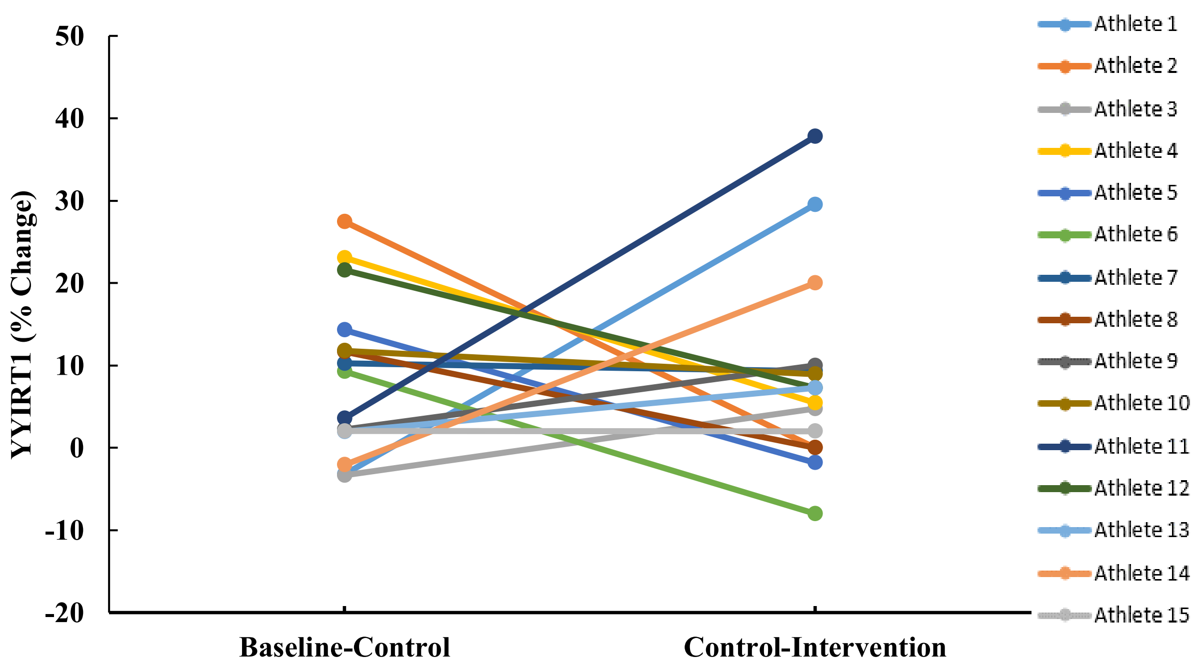

Figure 9. Individual percentage changes in YYIRT1 performance (%) following the 3-week control and intervention periods, respectively.

As shown in Table 3, no significant changes in the 10m ($p = 0.15$) and 30m sprint time ($p = 0.33$), and RSA ($p = 0.99$) were found over time. When comparing the baseline to post-control period, no significant change was evident for 10m speed (ES = 0.02; $p = 1.00$), 30m speed (ES = -0.57; $p = 0.40$) and RSA (ES = -0.07; $p = 1.00$). Likewise, no significant change from the post-control to the post-intervention periods was observed for 10m speed (ES = 0.37; $p = 0.36$), 30m speed (ES = 0.01; $p = 1.00$) and RSA (ES = -0.8; $p = 1.00$).

4.4 Technical skill performances

The LSPT results including the total score and penalty time for non-fatigued and fatigued states are presented in Table 4. In the non-fatigued (normal) condition, there was no significant difference in the total score (ES = -0.23, $p = 0.47$) and penalty time (ES = 0.10, $p = 0.76$) from the baseline to post-intervention period. Likewise, in the fatigued condition, no significant difference was observed in the total score (ES = 0.20, $p = 0.47$) and penalty time (ES = 0.15, $p = 0.62$). When comparing the fatigued and non-fatigued conditions, both the total score (ES = 0.42, $p = 0.23$) and penalty time (ES = 0.09, $p = 0.80$) were not significantly different.

Table 4. The technical skill performances (mean ± SD) across the three testing periods (Baseline, Post-control and Post-intervention). Total score: lower score indicates better performance (faster and more accurate execution); Penalty time: lower score indicates better performance (less penalties conceded). No significant differences were observed. LSPT = Loughborough Soccer Passing Test.

	Baseline (mean ± SD)	**Post-control (mean ± SD)**	**Post-intervention (mean ± SD)**
Total score			
LSPT non-fatigued (s)	43.8 ± 5.9	47.3 ± 4.7	45.0 ± 4.1
LSPT fatigued (s)	49.7 ± 7.3	50.2 ± 6.5	48.3 ± 6.4
Difference fatigue vs. non-fatigued (s)	5.9 ± 6.3	2.9 ± 9.5	3.3 ± 5.6
Penalty time			
LSPT penalty non-fatigued (s)	9.0 ± 4.1	11.3 ± 3.9	8.6 ± 3.7
LSPT penalty fatigued (s)	12.4 ± 5.8	12.5 ± 6.1.	11.6 ± 4.5
Difference fatigue vs. non-fatigued (s)	3.4 + 4.9	1.2 ± 7.2	3.0 ± 4.2

CHAPTER 5

DISCUSSION

The focus of the final chapter of this thesis will seek to answer the research questions posed by discussing the results presented in the previous chapter, offer interpretation of the findings and highlight areas for further consideration.

5.1 Research findings

The purpose of this study was to develop and examine the effects of PSCT (6 sessions over 3 weeks) on the physical and technical skill performances of professional young soccer players in comparison to the control period without the PSCT. Collectively, the results demonstrated a significant improvement in the players' YYIRT1 performance after both the control and intervention periods. When interpreting these findings, it is important to acknowledge that the control period had a significantly higher training volume than that in the intervention period. However, the magnitude of increase in YYIRT1 performance was equivalent across the control and intervention period. This may indicate that the addition of PSCT may be effective for improving YYIRT1 performance by inducing a sufficient training intensity for effective cardiovascular adaptations (approximately 90% of HR_{max}). However, other physical performance such as sprint and repeated sprint ability, and technical variables did not change significantly after either the control and PSCT intervention periods. Despite this, the PSCT drills may provide good technical practice and ecological validity by allowing the players to perform the most relevant skills to their playing positions during intense periods of work, if they are implemented in training for a longer period of time. To the best of my knowledge, this was the first study to develop and implement the PSCT drills in youth elite soccer. The findings of this study may help to inform professionals working in soccer and act

as a tool to improve the players aerobic conditioning with the PSCT drills. Moreover, this study provides a foundation to further investigate the use of PSCT as a novel conditioning approach in soccer and other field-based team sports, or as a position-specific test of physical and technical capacity.

5.1.1 PSCT drills

The PSCT drills in this study induced desirable physiological responses across all drills and sessions in terms of the intensity as evidenced by HR recording (average: 89.0 ± 2.1% HR_{max}) shown in Table 2. This response was close to the anaerobic threshold of 90% HR_{max}, which has been shown to be effective for. Previously, smaller formats of SSG (e.g. 2 vs 2, 3 vs 3, or 4 vs 4) have been shown to induce similar HR responses to what was found in the present study. However, to the best of my knowledge, this was the first study to demonstrate the efficacy of PSCT drills to elicit high HR responses in elite youth soccer players. Moreover, one major limitation of SSG is that they tend to have a high inter-player variability of HR responses (Hill-Haas et al., 2011). Conversely, the results from the current study demonstrated that PSCT drills provided similar HR responses with low variability among the players (CV = 2.4%), which is important to ensure a uniform training stimulus amongst players. This was achieved because during PSCT drills, the players executed the exercise task on their own. For example, players completed as many repetitions as possible during each 4-min work bout without any pause, reset or any tactical rule constraints (Figure 7). This means that the players didn't have to rely on other players' skills or interaction, tactical play or space confinement, thus, likely contributed to the low variability. Therefore, PSCT appears to be useful to negate potential ceiling effects for highly fit or highly skilled players which are commonly observed during SSG.

The results of the present study demonstrated that the average intensity (percentage of HR_{max}) was similar among all three PSCT drills (Table 2). Although no statistical difference was observed, the average intensity of the defender drill tended to be the highest (90.2 ± 2.1%) amongst the three drills, whilst the average intensity of the winger drill was the lowest (87.9 ± 3.5%). It may be possible that the wing players had a higher aerobic capacity than the defenders, although this was not specifically examined in the current study. If this was indeed the case, the wing players may have had more difficulty reaching and maintaining the intended exercise intensity (e.g. their HR may have decreased faster during the 4-min active recovery phase during each work bout of the drills). In support of this hypothesis, a previous study demonstrated that players with the highest VO_2peak values achieved the lowest percentage of VO_2peak during exercise (Buchheit et al., 2009).

Although there was no significant difference in both the average intensity (HR) ($p = 0.16$) and the total distance covered ($p = 0.30$) for all drills between the six PSCT sessions (Session 1 – Session 6), there was an upward trend (ES = 1.09) regarding the total distance covered as shown in Figure 6. When analysed independently, this trend can potentially be linked to a learning effect (e.g. players improved the specific technical skill actions of the drill allowing them to move through more efficiently). However, when coupled with a downward trend of the physiological responses (expressed as % HR_{max}) across the sessions as shown in Table 2, this may infer that the players improved their aerobic capacity as they progressed through the intervention period. This finding might indicate that the players could perform more work at lower level of exertion during each consecutive session.

One interesting finding was regarding the CV of high-speed distance across 6 PSCT sessions, which was 4 times larger than the CV of total distance (4.7% compared to 20.3%, respectively). This was mostly due to the two last sessions when the players reduced their high speed distance remarkably, which could possibly be attributed to the pacing strategy of the

players. As the circuit last 4-minute, the players might attempt to save their high intensity sprinting effort to not get too tired at the last moment of the round.

5.1.2 Effects of PSCT intervention on performance tests in comparison to control period

As shown in Table 3, the players increased YYIRT1 distance by 20.2% from the baseline to the post-intervention period. When converted to VO_{2max} values (formula: YYIRT1 distance multiplied by 0.0084 plus 36.4) based on Karakoc, et al. (2012), the improvement corresponded to an estimated increase of 5.8%. The increase in these variables following the 3-week intervention period alone were 9.1% and 2.8%, respectively, which was an average of a 3.0% and 0.9% increment in YYIRT1 and VO_{2max} values, respectively, per week. These values were similar to those reported in previous studies that used HIIT interventions twice per week (Dupont, Akakpo, & Berthoin, 2004; Helgerud et al., 2001; Impellizzeri et al., 2008; Stolen et al., 2005). The present study however, showed a significant improvement in the players' YYIRT1 performance after the 3-week control period and no significant difference in the magnitude of increase was observed between the control and intervention periods. These results are in contrast to the findings reported by Sperlich et al. (2011) who showed that a 5-week high-volume training period did not have any significant effect on the endurance performance of youth players, whereas the 5-week HIIT, at close to 90% HR_{max}, significantly improved the players' VO_{2max}. One possible explanation for the disparity of findings between Sperlich et al. (2011) and the current study could be due to the volume of the training. In the study by Sperlich et al. (2011), players had only four training sessions of 90 minutes and one competitive game per week. Whereas in the current study the players had on average seven sessions of 100 minutes in duration, plus one competitive game per week. Thus, even though the high-volume training control period of this study was two weeks shorter compared to Sperlich et al. (2011),

it should be noted that a significant increase in the player's aerobic capacity was evident in the present study.

No changes in sprint speed (10 and 30 m), or RSA were observed in the present study (Table 3). Although the players were required to sprint maximally during some components of PSCT drills, no significant effects on sprint performance were observed after the 3-week PSCT intervention. These finding are in line with many of previous studies (Faude, Steffen, Kellmann, & Meyer, 2014; Helgerud et al., 2001; Hill-Haas, Coutts, Rowsell, & Dawson, 2009) in which HIIT interventions were used. In particular, a majority showed meaningful improvements in aerobic capacity, but not in anaerobic-related performances such as straight sprint speed or RSA. In contrast, there are a handful of studies that have demonstrated concurrent improvements in both aerobic and anaerobic parameters (Dupont et al., 2004; Sperlich et al., 2011). For example, Dupont et al. (2004) used a HIIT program comprised of running at 120% of maximal aerobic speed and repeated 40 m sprints, twice per week for 10 weeks, and reported significant improvements ($p < 0.001$) in both aerobic capacity represented by maximum aerobic speed (post-control [16.1 ± 0.8 km/h], compared to post-intervention [17.3 ± 0.9 km/h]), and sprinting (40m speed) ability (post-control [5.55 ± 0.15 s] compared to post-intervention [5.35 ± 0.13 s]). Sperlich et al. (2011) used a more complex program with different types of exercises, ranging from 1-4-min of high intensity running to 30-s repeated sprints for the intervention group. And the results showed positive changes ($p < 0.001$) in the player's VO_2max (pre [55.1 ± 4.9 ml/min/kg], post [58.9 ± 4.7 ml/min/kg]) and 30m sprint time (pre [5.00 ± 0.25 s], post [4.78 ± 0.26 s]). The disparity in findings of these studies in comparison to the current study could be due to the mode of exercises and the length of the intervention. For example, in the current study the desired intensity was based on HR and the PSCT drills purposely incorporated specific technical and tactical skill practice, whereas the previous two studies focused on high speed running and sprinting without any ball contact. Even though the PSCT drills were

designed to incorporate some sprinting actions, the players may have placed more focus on the upcoming technical/tactical actions at the end of the sprints, rather than pure maximal sprinting itself. Furthermore, it is unlikely that the 4-min work bouts in the PSCT drills were conducive to sprint speed development due to the nature of the task (e.g. duration and intensity) and multiple foci (e.g. running and technical actions). Lastly, it is important to note that the intervention did not specifically focus on sprint technique or power development using concurrent interventions, such as resistance training, which is known to facilitate speed development (Moir, Sanders, Button & Glaister, 2007). Lastly, the 3-week duration of the intervention may have been too short to see any meaningful improvements in sprinting speed. Collectively, these findings indicate that the format of the PSCT drills employed in the present study placed more emphasis on cardiovascular intensity, and thus are not conducive to improve anaerobic-related performance.

5.1.3 Effects of PSCT intervention on LSPT performance in comparison to control period

The PSCT drills were also designed to target and facilitate the development of technical skills that are akin to those performed by players during competitive matches. In order to assess changes in technical skill performance, the LSPT was conducted in both a fatigued and non-fatigued state. The LSPT was chosen as a recent study on the physical and technical effects of 3v3 SSG has shown that short passing ability improved (pre [40 ± 4.08 s], post [33.73 ± 4.47; $p = 0.013$] using the LSPT test (Eniseler et al., 2017). Impellizzeri et al. (2008) used traditional high intensity running as the intervention method and reported no significant improvements ($p = 0.17$) in the players' LSPT performances in non-fatigued (pre [61.9 ± 4.2 s], post [59.0 ± 2.2 s]) and fatigued (pre [67.7 ± 8.5 s], post [62.2 ± 4.0 s]) states. However, in Impellizzeri's study, the penalty time of the LSPT performed during the fatigued condition was significantly reduced after the intervention ($p = 0.02$), indicating that the improved fitness might help the players to

make less technical skill errors during passing actions as the result of reduced fatigue (Impellizzeri et al., 2008). These findings contrast with the current research findings. Although the PSCT drills involved technical skill practice, there was no significant effect on LSPT performance in the non-fatigued state (Table 4). Likewise, players' endurance capacity was enhanced after both control and intervention periods, but no significant change in LSPT performance or penalty time during the fatigued trials were evident.

The disparate results between studies may be potentially explained by several possible factors. First, 3v3 SSG has been shown to involve mostly short passing and receiving actions, as well as many change of direction activities due to the small space, which share similarities with the skills tested in LSPT (Ali et al., 2007). Conversely, the skills performed in PSCT drills, even though specific to the playing position and reflective of real match scenarios (e.g. shooting, crossing and heading), are not specific to the type of skill tested in LSPT. Therefore, the LSPT may be more sensitive to skill improvements that are practiced during 3v3 SSG. However, this view is not always supported, since a recent systemic review suggests that the LSPT is not sensitive to detect changes in performance after intervention strategies (Wen, Robertson, Hu, Song, & Chen, 2018). The combined result of the previous aforementioned studies and the current study imply that the LSPT might be able to detect changes in intervention methods that share similarities to the skills tested, but not specific technical skills often performed in competitive matches, such as those targeted during the PSCT drills. In this case, it may be better that PSCT drills might be modified and adapted to become a test of technical performance for different playing positions in future research. The speed and accuracy of a player completing the drill could be used to assess competency, training related improvements and to provide a position-specific physical/technical profile for each player across playing positions.

Another explanation for conflicting results could be due to the methodological discrepancies between studies when evaluating the LSPT. Often, studies use live-scoring methods to assess LSPT performance (Ali et al., 2007; Eniseler et al., 2017; Impellizzeri et al., 2008), whereas in the current study we used camera footage and post-hoc analysis in slow motion to eliminate errors and ensure objectivity. It is possible that as LSPT has a complex scoring system with many criteria for penalties and rewards, coupled with the fast execution of the task by elite youth players, the live-scoring method might lead to a high risk of scoring error and false variability in test results. Furthermore, it is important to acknowledge that there is no evident correlation between LSPT results and in-game passing performance (Serpiello, Cox, Oppici, Hopkins, & Varley, 2017), let alone other soccer skills. Therefore, whether PSCT drills have any positive transfer effects to the skills performed in competition should be explored in future research using video analysis of real soccer games.

5.2 Limitations of the study

The limitation of the present study was mainly related to the difficulty implementing research programs in a high-performance sporting environment where there were existing schedules and commitments of the players. For example, the length of the study was constrained by the holiday period and tournament schedules. Additionally, the total workload was not be able to equate between the control and intervention period, which would be more ideal to compare specific training effects. The PSCT approach, although in its infancy, also requires some consideration. For example, PSCT requires an extra time commitment as not all players can participate at the same time and it requires several personnel for effective delivery. Moreover, this study used LSPT as an assessment for the player's technical skill, which is not ideal as a) LSPT might not be a sensitive test to quantify skill improvements; b) LSPT doesn't test the skills practiced in PSCT (e.g. shooting, header, long pass, crossing, etc.). Using video

analysis of real soccer matches might offer a better reflection for the effects of PSCT on the players technical skill.

5.3 Future research directions

Based on the current study, several areas for future investigation are warranted to provide interesting insights for research and strength and conditioning professionals alike. For example, it is necessary to develop the reliability and validity of the proposed PSCT drills as the position-specific soccer technical skill tests. As discussed earlier, other currently available skill tests may have limitations regarding the detection of improvements in soccer skills that are important in a competitive match setting. Therefore, developing the PSCT drills into the tests of specific soccer skills for each position could be meaningful for real practice. Alternatively, investigating the technical effects of PSCT intervention using video analysis of real competitive games could be useful to see any meaningful effects of PSCT in real match situations. Future research can also attempt to compare the physical and technical effects of PSCT drills to other established conditioning interventions (e.g. SSG or HIT running). This might offer a direct comparison between different training protocols and thus, might reveal the strength and weakness of each more clearly. It should be noted that the control and intervention periods were short in the present study. Thus, future studies should aim to employ PSCT over longer-durations with senior athletes or those from varying levels of competition and across different sporting disciplines.

5.4 Practical application

The findings of the present study can be used to influence players, coaches and sports scientist to design training sessions and interventions to successfully create new addition to football conditioning. The position-specific conditioning training (PSCT) can be used as new

way of conditioning in addition to previous conditioning methods such as high-intensity interval running and small-sided games. The data from the research may influence the conditioning demands for football players as well as the tactical and technical requirements needed for football players and help to evolve the conditioning process and reinforce individual training that is related to the game and to each specific position. The findings also have implications for coach education, by way of highlighting methods of success that can then be transferred into coaching courses and workshops. Current coach education could be updated or modified to incorporate some of the findings of this study to improve the current coach education literature.

Some specific training/coaching applications could include:

- The development of training that reflects position specific demands that are relevant to each position. Players can practice technical, tactical football skills with high intensity training.
- The development of training where players are coming back from injuries and have rehabilitation program and cannot train with the whole squad. Therefore, they can practice the position-specific conditioning training (PSCT) until they are ready to join the team.

5.5 Conclusion

In summary, the 3-week intervention period with the implementation of additional high intensity PSCT performed twice per week significantly improved the players YYIRT1 performance, but not other anaerobic-related physical parameters (e.g. 10m, 30m sprint performance and RSA). There was also no significant effect of PSCT on the LSPT performance of the players. The short-term use of PSCT, implemented twice per week, enhanced the players' aerobic capacity likely because it could consistently induce an average intensity of close to 90% HR_{max}. However, the hypothesis that PSCT could also improve sprinting speed and RSA was

rejected as the study design was likely not long enough to see meaningful adaptations to anaerobic-related performances. Importantly, PSCT was not intended to focus solely on repeated, or maximal sprinting actions. In particular, the combination of technical, tactical and high intensity actions did not appear to be conducive to improving sprint performance. The hypothesis that PSCT could improve the players LSPT performance when fatigued was also rejected, likely because the skills performed during PSCT were vastly different to the skills tested in LSPT. Moreover, LSPT might not be a sensitive test of global soccer skill and should be used with caution when assessing technical skill adaptations following intervention strategies aimed at improving competitive soccer performance. It was concluded that PSCT can be an effective strategy to enhance the player's endurance, but not other anaerobic-related physical or technical abilities. Collectively, the benefits of a PSCT training approach include: (i) inducing desirable physiological responses with a low variability between players in a more specific manner than traditional running, and (ii) allowing the practice of position-specific technical/tactical actions which complement an existing program or serve as an alternative to other HIIT approaches. With these strengths identified, it is recommended that PSCT may be suitable for individual training, return-to-play stage of rehabilitation and during off-season or in academy setting when time is not a constraint. Professionals working in team sports could use PSCT drills from this study to apply in practice where necessary, or adapt these drills to suit athletes in other sporting disciplines.

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APPENDICES

Appendix A. Ethics Approval Letter

21709 LE - Ethics approval

Research Ethics
Fri 12/14/2018 9:31 AM
Calvin LE; Fadi MA'AYAH; Chris LATELLA; Research Assessments; Joseph SIM

Conditions of approval.pdf
47 KB

Dear Calvin,

Project Number: **21709 LE**
Project Name: **The Effects of A Position-Specific Conditioning Training Model on Physical and Technical Abilities of Professional Soccer Players**

Student Number: **10461346**

The ECU Human Research Ethics Committee (HREC) has reviewed your application and has granted ethics approval for your research project. In granting approval, the HREC has determined that the research project meets the requirements of the *National Statement on Ethical Conduct in Human Research*.

The approval period is from 14 December 2018 to 1 Jan 2020.

The Research Assessments Team has been informed and they will issue formal confirmation of candidature (providing research proposal has been approved). Please note that the submission and approval of your research proposal is a separate process to obtaining ethics approval and that no recruitment of participants and/or data collection can commence until formal notification of both ethics approval and approval of your research proposal has been received.

NOTE: if your research proposal has not yet been approved, please contact Research Assessments or your Coordinator, Research Student Support for more details.

All research projects are approved subject to general conditions of approval. Please see the attached document for details of these conditions, which include monitoring requirements, changes to the project and extension of ethics approval.

Please feel free to contact me if you require any further information.

Kind regards

Claire

Claire Blankley, Research Ethics Support Officer
Office of Research and Innovation | Edith Cowan University
Accredited Research Manager (Foundation), ARM(F)
Tel: +61 08 6304 2332
Room 34.341
Mon & Thur 9-5pm
Tue, Wed, Fri 9-2pm
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Appendix B. Information Letter to Players

Effects of High-Intensity Position-Specific Drills on Physical & Technical-Skill Performances in Young Soccer Players

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This is the information letter sent out to the parents/guardians of all selected players regarding the upcoming football science research conducted at Viettel SC. All players are selected because of the following reasons:

- Professional soccer players at Viettel SC
- Under 18 years of age.
- Currently healthy, active and fit for training and competing at professional levels.

<u>Introduction to the Research Team</u>

This research is conducted by Cuong Le, a chief investigator as a part of the Master's Degree at Edith Cowan University, Perth, Western Australia. Other members of the research team are the principal supervisor, Dr Fadi Maya'ah and co-supervisors, Dr Christopher Latella and Dr Daniel Hiscock. Below are details of each member of the research team and relevant experience regarding this research project:

Cuong Le - BSc Exercise & Sports Science, First Aid, CPR, Sports Scientist Intern at Perth Glory NPL Team, Strength Coach Intern at Athletic Institute, experience in athletic physical testing, experience in the use of Global Positioning Systems (GPS) live and post analysis.

Fadi Ma'ayah - BHMS (Hons), MHMS, PhD, WACOT, Senior Lecturer and Course Coordinator of Sports Science and Football (Soccer) course at ECU, Advanced Coach B License Football Federation Australia/Football West, Coach Education Instructor Football Federation Australia/Football West, Accredited Level 3 Sportstec Performance Analyst.

Christopher Latella, Post-doctoral research fellow (School of Medical and Health Sciences). Bachelor Exercise Science and Human Movement (Hons), PhD, ASCA Level 1 accredited coach. National Coaching Accreditation Scheme (NCAS) qualified, 10 years of applied strength and conditioning experience (private sector).

Daniel Hiscock, BSc. (Exercise & Health) (Honours), PhD, ASCA Professional Coach, Lecturer, Physical Performance Manager.

All supervisors have been providing constant, timely support, advice and guidance for the chief investigator on every aspect of the project to make sure it is well prepared and conducted. During the time at Viettel SC to collect data, the chief investigator Cuong Le will still be in close contact with all supervisors via video discussion and/or email to update the progress and receive advice whenever necessary.

<u>Research Purpose</u>

The purpose of this research is to develop and investigate the effects of a Position-Specific Conditioning Training (PSCT) model for soccer players, as compared to 3v3 Small Sided Games (3v3 SSG). Although several coaching manuals and scientific reports have shown that certain skills are more important to certain playing roles, this study is the first to examine the effects of a conditioning method that involves position-specific technical actions to help soccer players improve both physical qualities and technical skill performances. Comparisons of training effects, physical and physiological responses will be made between PSCT and the 3v3 SSGs, which has been previously established as an effective conditioning method for soccer players. Moreover, whilst there are several studies showing the improvements of Loughborough Soccer Passing Test (LSPT – soccer technical skill assessment) after certain training strategies, there is no evidence on how soccer conditioning interventions can help players improve their LSPT performances during a fatigued condition, which is very specific to real soccer matches, especially during the most intense periods of the game. The results of

this study can add value to the practice of soccer coaches, provide additional effective conditioning tools and determine the efficacy of position-specific conditioning training for soccer players.

Research Methods

The players of this study will participate in three identical testing episodes and two 30minute additional training sessions per week (either position-specific training or small sided games), for 8 weeks on top of the normal team practice and competition. Each testing episode will assess (1) aerobic endurance using the Yo-Yo Intermittent Recovery Test level 2 (YYIRT2), (2) linear sprinting speed over 10 to 30meters and (3) repeated sprinting ability (RSA) using photocell timing gates, as well as (4) technical skills in normal and during fatigued condition using Loughborough Soccer Passing Test. The particpants' height and weight will also be recorded, but only one time before the commencement of any testing activities.
After the first testing episode, players will resume the team training and competition as per normal for 4 weeks. The players will be assessed again on all parameters at the end of week 4. Then an 8-week intervention period will with either (i) PSCT or (ii) 3v3 SSGs interventions (random selection) on top of normal practice and competition as mentioned above. After 8 weeks, players will be tested one last time (third testing episode) to finalise the research procedure. All assessments and training sessions will have appropriate warm up and cool down, delivered by a chief investigator or soccer coaches. During the course of a research, all players will be asked to wear Global Positioning System (GPS) units during team practice, competition, aerobic endurance testing and all additional conditioning sessions for data collection purposes.

Below is the descriptive information of each testing procedure:

YYIRT2 consists of repeated 2 × 20m runs at a progressively increased speed, guided by the audio beep sound. Between each running bout, the players have a 10s active rest period where

they move to the cone located 5m away before returning to the starting line. The test starts at 13 km/h, increases 2 km/h after the first stage and 1 km/h after the second stage. The speed continues to increase by 0.5 km/h every stage until exhaustion. The test is terminated when the players fail to reach the line on time for two consecutive occasions or by voluntary withdrawal. Players will be given verbal warning after one failed occasion. The score will be collected based on the distance covered up to the last successful attempt.

The LSPT consists of 16 passes: eight short passes to the red and white targets located 3.5m away from the passing area; and eight slightly longer passes to the green and blue targets located 4m away from the passing area. There are time pressure and technical constraints associated with the tests, where the performance will rely on both speed and accuracy of execution. In other words, the players must aim to complete the 16 passes as fast as possible, whilst avoiding as many technical errors as possible, including wrong pass, inaccurate pass, or passing from wrong areas, etc.

To assess the LSPT performance under a fatigued condition, players will complete a 5-min high intensity simulation, consisting of 10 consecutive 40m high-intensity shuttle runs (five at 16 km/h and five at 19 km/h) with a 180 degree turn every 20m following the audio signal. Each running bout is separated by a 25 s recovery phase, alternating between standing (0 km/h), walking (5 km/h) and jogging (7 km/h).

For repeated sprinting and linear sprinting assessment, the players will complete a protocol comprised of 10 maximal 30m sprints separated by 30 s recovery. The players will decide when to start from a static position, 30cm behind the photocell gates. Time will be recorded to the nearest 0.01 s when the players intercept the photocell beam.

Potential Risks

This study has a low risk as the total level of physical exertion during each additional training session is not any higher than that of playing a soccer match. There is a potential risk for muscle soreness or muscle strain due to the repeated powerful actions associated with the interventions, such as sprinting, kicking, long passing or jumping. However, this will be minimised by using a proper warm up and cool down during each testing or training session. Moreover, a workload monitoring process will be applied throughout the study, and apart from serving for the research purpose, it can also help detect players at high risk of injury (overload), so the players' training activities can be adjusted in accordance. The additional conditioning training session could be delayed to allow further recovery for players if they are having signs of overload. The chief investigator also holds a first aid certificate and has been involved in strength & conditioning settings of both private and professional club environment and can therefore adequately monitor the athletes training or testing activities. Besides, the club's doctor is staying at the training facility at all times and always available if any injury incident happens.

Potential Benefits

The players may have these potential benefits:

A detailed report of physical, physiological and technical measurements, as a reference point, to make comparisons with norms and over time.

The players can potentially improve either or both physical and technical abilities after the intervention period, which can enhance their performance on the field

The players will be provided with effective training tools/methods, for later use that can help enhance the performance as a professional soccer player.

Privacy and Confidentiality

Testing and performance data will be forwarded to the club's director and coaching staff for their high-performance reporting requirements and training plans. A copy of results can also be sent to the players, if requested via either hard copy or email pathways at the end of the data collection period. The electronic copy of data will be stored in the chief investigator's personal computer and portable hard drives with password protected. A hard copy version of data will be stored in a locked cabinet at Edith Cowan University. Copies of data stored by the chief investigator will be destroyed after 10 years.

Apart from these, all information collected in this research will be de-identified if used or reported in any type of public presentation, such as conference or journal articles. Players will not be referred to by names or any sort of identity during these types of reports or discussions. At some points during the research, players might be recorded/filmed by the chief investigator. Whenever there is a need for video recording, players will be asked to give permission. The video recordings are purely for research/analysis purposes and will not be published in any form.

Voluntary Participation

The choice to participate in this research project is voluntary. No explanation is needed if the players/parents/gurdians choose not to participate and there is no disadvantage to the decision. If the players decide to take part in the study, the parents/guardians need to read and sign in the consent form and return it to the chief investigator. During the research process, players are free to withdraw the consent and discontinue the involvement at any time with no pressure or need for explanations. If a player of the project decides to withdraw at any time, the data will be destroyed permanently.

Approval by the Human Research Ethics Committee

This research project is conducted by Cuong Le, as part of the Master's degree of Sports Science. The ECU Human Research Ethics Committee has approved for this research.

Contacting Us

If you have any questions or require any further information about the research project, please contact:

Chief Investigator: Cuong Le | Mobile: (+61) [redacted] or (+84) [redacted] | Email: [redacted]

The Viettel Football Club Director: Mr Dung Do | Mobile: (+84) 972 055 555| Email: [redacted]

Principal supervisor: Dr Fadi Ma'ayah | Email: f.maayah@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 the Research Ethics Officer by telephone (+61) 8 6304 2170 or by email research.ethics@ecu.edu.au.

Appendix C. Consent Form

Effects of High-Intensity Position-Specific Drills on Physical & Technical-Skill Performances in Young Soccer Players

I have read and clearly understood the information sheet and consent form. I agree to participate in this study and provide my consent freely. I understand that all study procedures will be carried out as described in the information sheet, which I have retained for my own record. I am aware that my decision to participate in this study or withdraw at any time is fully at my disposal. There is no disadvantage if I decide not to participate or withdraw from the research at any time, and I do not need to give any justification for my decision. I have had all my questions/concerns clearly answered. I understand the collected data will primarily be used for research purposes and will possibly be used for future research. I agree that the data will be sent to the coaching staff and director at the club for high performance understanding and training plans. Other than that, all my information will be kept confidential to the public. I can ask for a copy of results to keep for myself. I also agree that all the data collected from this research may be published, but my names and any sort of identity will not be disclosed. I am aware that at some points, I will be asked to give permission for the chief investigator to video record myself for research or analysis purposes, and these footage will not be published in any form.

I understand that if I have any further question or information about the project, I can contact the chief investigator at any time by telephone (+61) 4 6858 6855 or (+84) 908 31 22 64 and/or by email caol@our.ecu.edu.au. I can also contact the club's director and the principal supervisor of the project at any time with the contact details as outlined in the information

sheet. If I have any concern or complaint about the research project and wish to talk to an independent person, I may contact the ECU Research Ethics Officers by telephone (+61) 8 6304 2170 or by email research.ethics@ecu.edu.au.

Name & Signature

Name & Signature of Parent/guardian: Date:

Name & Signature of Participant: Date:

Appendix D. Vietnamese Translated Information Letter to Players

THƯ THÔNG TIN GỬI CHO NGƯỜI THAM GIA

Hiệu quả của các mô hình đào tạo điều hòa cụ thể theo vị trí với khả năng thể chất và kỹ thuật của người chơi bóng đá chuyên nghiệp

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Đây là lá thư thông tin gửi đến tất cả những người tham gia được lựa chọn nghiên cứu khoa học bóng đá sắp tới được thực hiện tại Viettel SC. Tất cả những người tham gia được lựa chọn vì những lý do sau:

Cầu thủ bóng đá chuyên nghiệp tại Viettel SC

Dưới 18 tuổi.

Hiện tại khỏe mạnh, năng động và phù hợp để đào tạo và cạnh tranh ở cấp độ chuyên nghiệp.

<u>Nhóm nghiên cứu</u>

Nghiên cứu này được thực hiện bởi Cường Lê, là điều tra viên chính, có bằng Thạc sĩ tại Đại học Edith Cowan, Perth, Tây Úc. Các thành viên khác của nhóm nghiên cứu là giám sát chính, Tiến sĩ Fadi Maya'ah và đồng giám sát, Tiến sĩ Christopher Latella và Tiến sĩ Daniel Hiscock. Dưới đây là chi tiết về từng thành viên của nhóm nghiên cứu và kinh nghiệm liên quan đến dự án nghiên cứu này:

Cường Lê - Cử nhân Khoa học Thể dục Thể thao, Sơ cứu, CPR, Nhà khoa học Thể thao tại Đội ngũ Perth Glory NPL, thực tập huấn luyện thể chất tại Athletic Institute, kinh nghiệm kiểm tra thể chất, kinh nghiệm trong việc sử dụng Hệ thống Định vị Toàn cầu (GPS) và phân tích.

Fadi Ma'ayah - BHMS (Hons), MHMS, Tiến sĩ, WACOT, Giảng viên cao cấp và Điều phối viên khóa học môn Thể thao và Bóng đá tại ECU, Huấn luyện viên cấp cao hạng B của Liên đoàn Bóng đá Úc/ Bóng đá miền Tây, Giản viên giáo dục Huấn luyện viên của Liên đoàn Bóng đá Úc / Bóng đá miền Tây, được công nhận cấp 3 Sportstec Hiệu suất phân tích.

Christopher Latella, nghiên cứu sinh tiến sĩ (Khoa Dược và Khoa học sức khỏe). Cử nhân Khoa học Thể thao và Phong trào Con người (Hons), Tiến sĩ. Huấn luyện viên được công nhận ASCA cấp 1. Chương trình công nhận huấn luyện quốc gia (NCAS) đủ điều kiện, 10 năm kinh nghiệm áp dụng và điều kiện kinh nghiệm (khu vực tư nhân).

Daniel Hiscock , Cử nhân. (Thể thao & Sức khỏe) (Honours), Tiến sĩ, Huấn luyện viên chuyên nghiệp ASCA, Giảng viên, Kiểm soát thể lực.

Tất cả các giám sát viên đã cung cấp sự hỗ trợ, tư vấn và hướng dẫn liên tục, kịp thời cho điều tra viên trưởng về mọi khía cạnh của dự án để đảm bảo chuẩn bị và tiến hành tốt. Trong thời gian tại Viettel SC thu thập dữ liệu, điều tra viên chính Cường Lê sẽ tiếp xúc với tất cả các giám sát viên thông qua thảo luận video và/ hoặc email để cập nhật tiến độ và nhận lời khuyên bất cứ khi nào cần thiết.

<u>Mục đích nghiên cứu</u>

Mục đích của nghiên cứu này là phát triển và điều tra các ảnh hưởng của mô hình đào tạo điều kiện theo vị trí cụ thể (PSCT) cho người chơi bóng đá, so với Trò chơi nhỏ 3v3 (3v3 SSG). Mặc dù một số hướng dẫn huấn luyện và báo cáo khoa học đã chỉ ra rằng một số kỹ năng quan trọng hơn đối với vai trò chơi nhất định, nghiên cứu này là nghiên cứu đầu tiên để xem xét tác động của phương pháp điều hòa liên quan đến hành động kỹ thuật cụ thể theo vị trí để giúp người chơi bóng đá cải thiện cả phẩm chất và kỹ thuật biểu diễn kỹ năng. So sánh các hiệu ứng đào tạo, phản ứng vật lý và sinh lý sẽ được thực hiện giữa PSCT và các SSG 3v3, trước đây đã được thiết lập như một phương pháp điều hòa hiệu quả cho các cầu thủ bóng đá.

Hơn nữa, trong khi có một số nghiên cứu cho thấy sự cải thiện của Loughborough Soccer Passing Test (LSPT - đánh giá kỹ năng bóng đá) sau một số chiến lược đào tạo nhất định, không có bằng chứng nào về can thiệp điều trị bóng đá có thể giúp người chơi cải thiện màn trình diễn LSPT của họ trong điều kiện mệt mỏi rất cụ thể cho các trận đấu bóng đá thực sự, đặc biệt là trong các giai đoạn căng thẳng nhất của trò chơi. Kết quả của nghiên cứu này có thể làm tăng thêm giá trị cho việc thực hành huấn luyện viên bóng đá, cung cấp thêm các công cụ điều hòa hiệu quả và xác định hiệu quả của việc huấn luyện điều hòa theo vị trí cụ thể cho cầu thủ bóng đá.

Phương pháp nghiên cứu

Với tư cách là người tham gia nghiên cứu này, bạn sẽ tham gia ba đợt thử nghiệm giống hệt nhau và hai buổi huấn luyện bổ sung 30 phút mỗi tuần (đào tạo theo vị trí cụ thể hoặc trò chơi nhỏ), trong 8 tuần trên thực tế và cạnh tranh bình thường. Mỗi giai đoạn thử nghiệm sẽ đánh giá độ bền hiếu khí (1) của bạn bằng cách sử dụng Yo-Yo Intermittent Recovery Test level 2 (YYIRT2), (2) tốc độ chạy nước rút trên 10 đến 30 mét và (3) khả năng chạy nước rút lặp lại (RSA) , cũng như (4) kỹ năng kỹ thuật trong bình thường và trong tình trạng mệt mỏi bằng cách sử dụng Loughborough Soccer Passing Test. Chiều cao và cân nặng của bạn cũng sẽ được ghi lại, nhưng chỉ một lần trước khi bắt đầu bất kỳ hoạt động kiểm tra nào.

Sau đợt thử nghiệm đầu tiên, bạn sẽ tham gia đào tạo và thi đấu theo nhóm như bình thường trong 4 tuần. Bạn sẽ được đánh giá lại trên tất cả các thông số vào cuối tuần 4. Sau đó, thời gian can thiệp 8 tuần sẽ bắt đầu khi bạn bắt đầu thực hiện (i) PSCT hoặc (ii) 3v3 biện pháp can thiệp SSG (lựa chọn ngẫu nhiên) trên thực hành bình thường và cạnh tranh như đã đề cập ở trên. Sau 8 tuần, bạn sẽ được kiểm tra lần cuối (tập kiểm tra thứ ba) để hoàn tất quy trình nghiên cứu. Tất cả các buổi đánh giá và buổi huấn luyện sẽ có sự ấm lên và làm mát thích

hợp, do một điều tra viên trưởng hoặc huấn luyện viên bóng đá cung cấp. Trong quá trình nghiên cứu, bạn sẽ được yêu cầu mặc các hệ thống Định vị Toàn cầu (GPS) trong khi thực hành nhóm, cạnh tranh, kiểm tra độ bền hiếu khí và tất cả các phiên điều hòa bổ sung cho mục đích thu thập dữ liệu.

Rủi ro tiềm ẩn

Nghiên cứu này có rủi ro thấp vì tổng mức gắng sức trong mỗi buổi tập bổ sung không cao hơn so với chơi bóng đá. Có một nguy cơ tiềm ẩn cho đau nhức cơ bắp hoặc căng cơ do các hành động mạnh mẽ lặp đi lặp lại liên quan đến các can thiệp, chẳng hạn như chạy nước rút, đá, đi qua hoặc nhảy. Tuy nhiên, điều này sẽ được giảm thiểu bằng cách sử dụng thích hợp ấm lên và làm mát trong mỗi buổi thử nghiệm hoặc đào tạo. Hơn nữa, quy trình giám sát khối lượng công việc sẽ được áp dụng trong suốt quá trình nghiên cứu, ngoài việc phục vụ cho mục đích nghiên cứu, nó còn giúp phát hiện người chơi có nguy cơ bị thương nặng (quá tải). Buổi huấn luyện điều hòa bổ sung có thể bị trì hoãn để phục hồi thêm cho người chơi nếu họ có dấu hiệu quá tải. Điều tra viên trưởng cũng nắm giữ một giấy chứng nhận viện trợ đầu tiên và đã được tham gia vào các thiết lập sức mạnh và điều hòa của cả hai môi trường câu lạc bộ tư nhân và chuyên nghiệp và do đó có thể theo dõi đầy đủ các hoạt động đào tạo vận động viên hoặc kiểm tra. Bên cạnh đó, bác sĩ của câu lạc bộ luôn ở tại cơ sở đào tạo và luôn sẵn sàng nếu có bất kỳ sự cố chấn thương nào xảy ra.

Lợi ích tiềm năng

Là người tham gia, bạn có thể có những lợi ích tiềm năng sau:

Bạn sẽ được cung cấp một báo cáo chi tiết về các phép đo vật lý, sinh lý và kỹ thuật của bạn, như một điểm tham chiếu, để xác định xếp hạng của bạn (so với các chỉ tiêu) và so sánh theo thời gian.

Bạn có thể cải thiện khả năng về thể chất và kỹ thuật sau giai đoạn can thiệp, điều này có thể nâng cao hiệu suất của bạn trên thực địa

Bạn sẽ được cung cấp các công cụ / phương pháp đào tạo hiệu quả, để sử dụng sau này có thể giúp nâng cao hiệu suất của bạn như một cầu thủ bóng đá chuyên nghiệp.

<u>Quyền riêng tư và bảo mật</u>

Dữ liệu kiểm tra và hiệu suất sẽ được chuyển tiếp đến giám đốc câu lạc bộ và nhân viên huấn luyện của bạn để có các yêu cầu báo cáo hiệu suất cao và kế hoạch đào tạo của họ. Một bản sao của các kết quả cũng có thể được gửi cho bạn, những người tham gia nếu được yêu cầu thông qua một trong hai bản sao hoặc đường dẫn email ở cuối giai đoạn thu thập dữ liệu. Bản sao dữ liệu sẽ được điều tra viên lưu trữ tối thiểu 10 năm, chỉ trong trường hợp sử dụng sau này. Bản sao dữ liệu điện tử sẽ được lưu trữ trong máy tính cá nhân của nhà điều tra chính và ổ cứng di động có mật khẩu bảo vệ. Một phiên bản dữ liệu bản cứng sẽ được lưu trữ trong một tủ bị khóa tại câu lạc bộ và / hoặc Đại học Edith Cowan. Những bản sao được giữ bởi nghiên cứu sinh sẽ được hủy sau 10 năm.

Ngoài những thông tin này, tất cả các thông tin thu thập được trong nghiên cứu này sẽ không được xác định nếu được sử dụng hoặc báo cáo trong bất kỳ loại hình trình bày nào, chẳng hạn như các bài báo về hội nghị hoặc tạp chí. Những người tham gia sẽ không được gọi bằng tên hoặc bất kỳ loại nhận dạng nào trong các loại báo cáo hoặc thảo luận này. Ở một số thời điểm, bạn sẽ được thu hình bởi nghiên cứu sinh vì mục đích phân tích, nghiên cứu đơn thuần và

những thước phim sẽ không được công bố ra bên ngoài. Bất cứ khi nào cần thu hình, bạn sẽ được thông báo trước để quyết định cho phép hay không.

Tham gia tự nguyện

Lựa chọn tham gia vào dự án nghiên cứu này là tự nguyện. Không cần giải thích nếu bạn chọn không tham gia và không có bất lợi cho quyết định của bạn. Nếu bạn quyết định tham gia, bạn cần hoàn thành một sự đồng ý có hiểu biết và gửi lại cho điều tra viên chính. Trong quá trình nghiên cứu, bạn được tự do rút lại sự đồng ý của bạn và chấm dứt sự tham gia của bạn bất cứ lúc nào mà không có áp lực hoặc cần giải thích. Nếu một người tham gia dự án quyết định rút bất kỳ lúc nào, dữ liệu của bạn sẽ được xóa vĩnh viễn.

Phê duyệt của Ủy ban Đạo đức Nghiên cứu Con người

Dự án nghiên cứu này được thực hiện bởi Cường Lê, là một phần của bằng Thạc sĩ Khoa học Thể thao. Ủy ban Đạo đức Nghiên cứu Con người ECU đã phê duyệt cho nghiên cứu này.

Liên hệ với chúng tôi

Nếu bạn có bất kỳ câu hỏi nào hoặc cần thêm bất kỳ thông tin nào về dự án nghiên cứu, vui lòng liên hệ:

Điều tra viên trưởng : Cuong Le | Di động: (+61) 4 6858 6855 hoặc (+84) 908 31 22 64 | E-mail: caol@our.ecu.edu.au

Giám đốc câu lạc bộ bóng đá Viettel : Mr Dung Do | Di động: (+84) [redacted] | E- mail: [redacted]

Giám sát viên chính : Tiến sĩ Fadi Ma'ayah | E-mail: f.maayah@ecu.edu.au

Nếu bạn có bất kỳ lo lắng hoặc khiếu nại nào về dự án nghiên cứu và muốn nói chuyện với một người độc lập, bạn có thể liên hệ với Cán bộ nghiên cứu Đạo đức nghiên cứu qua điện thoại (+61) 8 6304 2170 hoặc email research.ethics@ecu.edu.au .

Appendix E. Vietnamese Translated Consent Form

GIẤY CHẤP THUẬN

Hiệu quả của các mô hình đào tạo điều hòa cụ thể theo vị trí với khả năng thể chất và kỹ thuật của người chơi bóng đá chuyên nghiệp

Tôi đã đọc và hiểu rõ tờ thông tin và mẫu chấp thuận. Tôi đồng ý tham gia vào nghiên cứu này và tự do đồng ý. Tôi hiểu rằng tất cả các thủ tục nghiên cứu sẽ được thực hiện như được mô tả trong tờ thông tin mà tôi đã giữ lại để lưu giữ hồ sơ của riêng tôi. Tôi biết rằng quyết định của tôi để tham gia vào nghiên cứu này hoặc rút tiền bất cứ lúc nào là hoàn toàn theo ý của tôi. Không có bất lợi nếu tôi quyết định không tham gia hoặc rút khỏi nghiên cứu bất cứ lúc nào, và tôi không cần đưa ra bất kỳ biện minh nào cho quyết định của mình. Tôi đã có tất cả các câu hỏi / thắc mắc của tôi được trả lời rõ ràng. Tôi hiểu dữ liệu được thu thập chủ yếu sẽ được sử dụng cho mục đích nghiên cứu và có thể sẽ được sử dụng cho nghiên cứu trong tương lai. Tôi đồng ý rằng dữ liệu kiểm tra và hiệu suất sẽ được gửi đến các nhân viên huấn luyện và giám đốc tại câu lạc bộ để biết các kế hoạch đào tạo và hiểu biết hiệu quả cao. Nếu muốn, tôi có thể yêu cầu nghiên cứu sinh gửi bản sao của kết nghiên cứu cho mình bất kì lúc nào. Tôi cũng đồng ý rằng tất cả các dữ liệu thu thập từ nghiên cứu này có thể được xuất bản, nhưng tên của tôi và bất kỳ loại danh tính nào sẽ không được tiết lộ. Tôi hiểu rằng ở một vài thời điểmn, nghiên cứu sinh cần phải thu hình tôi vì mục đích phân tích, nghiên cứu đơn thuần, và những thước phim đó sẽ không được công bố

Tôi hiểu rằng nếu tôi có bất kỳ câu hỏi hoặc thông tin nào khác về dự án, tôi có thể liên hệ với điều tra viên bất kỳ lúc nào qua điện thoại (+61) 4 6858 6855 hoặc (+84) 908 31 22 64 và / hoặc qua email caol @ .ecu.edu.au . Tôi cũng có thể liên lạc với giám đốc của câu lạc bộ và

người giám sát chính của dự án bất cứ lúc nào với các chi tiết liên lạc như được nêu trong bảng thông tin. Nếu tôi có bất kỳ mối quan tâm hoặc khiếu nại nào về dự án nghiên cứu và muốn nói chuyện với một người độc lập, tôi có thể liên lạc với ECU Research Officer theo số điện thoại (+61) 8 6304 2170 hoặc email research.ethics@ecu.edu.au .

Tên và chữ ký

Tên và chữ ký của người tham gia: ______________________________ Ngày: ___________________

Tên và chữ ký của người giám hộ: ______________________________ Ngày: ___________________