THE EFFECT OF MAXIMAL STRENGTH AND PLYOMETRIC TRAINING ON PHYSICAL PERFORMANCE OF YOUNG FOOTBALL PLAYERS AND GAME INTENSITY

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Master's Thesis in Science of Sports Coaching and Fitness Testing
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Fall 2020
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ABSTRACT

Asadi, Mostafa. 2020. The effect of maximal strength and plyometric training on physical performance of young football players and game intensity. University of Jyväskylä, Faculty of Sport and Health Sciences, Master's thesis in Coaching and Fitness Testing, 74 pp.

Football is a sport that is played in every country and it is considered as an intermittent activity involving sudden actions such as tackling, jumping, kicking, change of direction, and short distance sprinting. Aerobic and anaerobic power are important for football players. Nevertheless, strength, power and speed are the most important qualities for athletic performance. Strength training (ST) and plyometric training (PT) are two frequently used methods for improving sport performances. The aim of this study was to examine the effect of maximal strength and plyometric training on physical performance of young football players and game intensity.

In total, thirty one young football players (age: 16.3 ±0.5, weight: 66.2 ±8.7, height:177.3 ±6.6, BMI: 21.1 ± 2.3) from two different football clubs competing in first division of Finland, participated in the 8-week training intervention. One team was recruited fully for the training group (TG, n=16) and the other one as the control group (CON, n=15). Repeated sprint ability (RSA), 30-m sprint, countermovement jump (CMJ), yo-yo intermittent recovery test level 1 (YYIR1), small-sided game, one-repetition maximum in leg press and dumbbell stepping lunge were executed before and after the intervention.

The TG group improved mean time in 30-m sprint and RSA, vertical jump height in CMJ, maximum strength in 1RM leg-press and dumbbell stepping lunge throughout the intervention. The CON group did not improve in any tests. There was no significant differences between the groups after the intervention.

Combination of strength and plyometric training together had a beneficial impact on physical ability of young football players. Young football players can improve their physical performance such as speed, maximal strength, and endurance by training twice a week. The training should consist of regular football training including strength and plyometric training and it must be scheduled in the weekly program of young football players.

Key words: Small-sided game, yo-yo intermittent recover test level 1, 30-m sprint, countermovement jump, repeated sprint ability, one-repetition maximum.

ABBREVIATIONS

BMI	body mass index
CMJ	countermovement jump
CON	control group
JBL	James B. Lansing
PT	plyometric training
RFD	rate of force development
RSA	repeated sprint ability
SSG	small-sided game
SSC	stretch-shortening Cycle
ST	strength training
TD	total distance
TSD	total sprint distance
YYIR1	yo-yo intermittent recovery test level 1
YYIR2	yo-yo intermittent recovery test level 2
1 RM LP	one-repetition maximum in leg press
1 RM DSL	one-repetition maximum in dumbbell stepping lunge

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1 INTRODUCTION

Football is a sport that is played in every country and it is considered as an intermittent activity involving sudden actions such as tackling, jumping, kicking, change of direction, and short distance sprinting (Stolen et al. 2005). Players' fitness must be at the highest level that leads to success in football (Svensson & Drust 2005). Therefore, many studies have shown that aerobic and anaerobic features play a huge role in athletic performance (Bangsbo, Norregaard & Thorso 1991; Cometti et al. 2001; Kotzamanidis et al. 2005; Stolen et al. 2005; Wisloff, Helgerud & Hoff 1998). Nevertheless, strength, power, speed and endurance are the most important qualities for athletic performance (Helgerud et al. 2001; Arnason et al. 2014; Stolen et al. 2005).

There are different training approaches that researchers and practitioners recommend in order to improve these specific neuromuscular abilities (Cormie, McCaulley & McBride 2007; Cormie, McGuigan & Newton 2011; Kobal et al. 2016). However, strength training (ST) and plyometric (PT) training are the most familiar strategies for improving sport performances (Lamas et al. 2012; Markovic & Mikulic 2010). The benefit of strength training has been already proven by increase in maximum strength and muscle hypertrophy (Cormie, McGuigan & Newton 2011); on the other hand, plyometric training is for improvement in muscle power capacity and functionality of the stretch-shortening cycle (SSC) (Folland & Williams 2007; Komi 1984). There are studies that have shown combining ST and PT may have greater positive impact in muscle capacity comparing with ST and PT alone (Kobal et al. 2016; Helgerud et al., 2001). This study will focus on TD (traditional training) and search the effects of neuromuscular training (ST and PT) on sprinting ability, strength, and endurance of young football players. Lloyd et al. (2014) stated that developing "athleticism" is to maintain health, increase physical fitness ability, reduce risk of injury, and enhance the confidence and competence of athletes for long term progression and development of youth athletes.

2 PLYOMETRIC TRAINING

2.1 Plyometric training in football

Plyometric training (PT) exercises are mainly jump drills and count as a resistance training (Asadi et al. 2016). It has been proven that PT is an effective way for sprinting and jump ability improvement; in addition to that it has a positive influence on running economy, joint stability, and prevention of injury (Impellizzeri et al. 2006). It is possible to do PT exercises with or without external loads, which has been shown that both can improve physical performance of the athletes (Ronnestad et al. 2008).

Plyometric exercises will develop sport performance and prepare young athletes for the requirements of training and competition. Even though physical training is beneficial for young athletes, the age must be taken into a consideration because of hormonal changes (Wang & Zhang 2016). According to some studies young athletes should have physical exercises in their training sessions (Behringer et al. 2011; McCambridge & Stricker 2008). Plyometric exercises include lots of loads on joints, tendon, and muscle; therefore, designing PT for young athletes must be carefully done. Duration, technique, and intensity are the most important factors that should be paid attention on. By means of that PT can be safe and effective for young athletes in their performance abilities (Wang & Zhang 2016).

2.2 Stretch-shortening cycle (SSC)

Plyometric training includes stretch-shortening cycle (SSC) muscle action, where lengthening refers to eccentric contraction and shortening points to concentric contraction. These types of exercises can increase dynamic performances by using maximal force at short intervals; whereby during a movement pre-activated muscle is first stretched and followed by a shortening phase of the same muscle and connective tissue (Komi 1984; Miller et al. 2006) (Figure1). Researchers believe that PT has a functional effect on power production, which is strongly connected with performance of football players (Arnason et al. 2014; Ramirez-Campillo et al. 2018). As SSC improves the muscle-tendon unit will generate maximal force, which is an

essential factor for PT (Asadi et al. 2016; Bauer, Thayer & Baras 1990; Komi 1984), therefore football training includes this type of muscular power training.

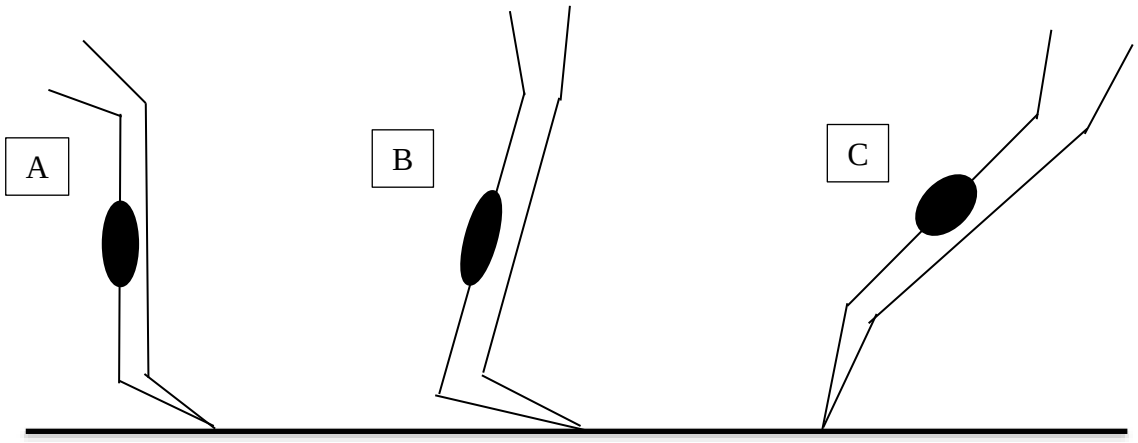


FIGURE 1. Phases of stretch-shortening cycle (Modified from Komi 1992)

Regarding to Komi 1992 “phase (A) eccentric contraction refers to pre-activation of agonist muscle, where elastic energy is stored in the series elastic components. Phase (B) indicates to amortization, where muscle spindles are stimulated and type 1a afferent nerves synapse with α motor neurons transmit a signal to agonist muscle group. Lastly, phase (C) concentric contraction point to shortening of agonist muscle fibers, where elastic energy is released from the series elastic component and α motor neurons stimulate the agonist muscle group, which correspond to Plyometric training” (Komi 1992, Wang & Zhang 2016).

3 STRENGTH TRAINING

3.1 Strength training in football

Power and velocity performance are results of maximal strength (Baker 2001). Therefore, any improvement in maximal strength by planned strength training will affect power and velocity performance. When there is an increase in one repetition maximum, there will be an increase in power, acceleration, movement velocity and jumping (Baker, Nance & Moore 2001). The range of speed and loads can define the meaning of strength, and as load increases there will be an inverse connection between force and velocity. Consequently, when the load is heavier the velocity is slower and when the load is lighter the velocity is higher (Toji & Kaneko 2004; Taber et al. 2016).Researchers have found that there is a limitation in human muscle velocity regarding shortening of muscle (Nyitrai et al. 2006; Sargeant 2007), so the quality of strength must be increased in order to improve force-velocity concept (Taber et al. 2016).

Traditional strength training exercises improve force production, speed and acceleration in young football players even during short-term training (Westcott 2012). There are many benefits concerning strength training, which are improvements in cardiovascular, endocrine, velocity of movement, injury prevention, body composition, an increase in velocity of movement, peak ground reaction force, muscle mass, and bone development (Stowers et al. 1983; Westcott 2012). Muscle strength is a major factor that has an important influence on success in sport (Dowson et al. 1998; Young et al. 1999) and neuromuscular system with the ability of production maximal force is as important as endurance performance. Activities such as kicking, jumping, turning, and sprinting are in relation with neuromuscular system (Cometti et al. 2001; Kalapotharakos et al. 2006).

3.2 Maximal strength

Maximal strength is the ability to generate the upper limit of the force. Production of higher force is improved when there is an increase in maximum strength (Baker 2001). Strength is also in a relation with RFD, impulse, momentum, velocity, and power. Many studies have been

reported that maximal strength has a strong relation with rate of force development (RFD) and power (Baker 2001; Baker, Nance & Moore 2001, McLellan, Lovell & and Gass 2011; Taber et al. 2016). The ability to produce maximal force is dependent on time limitation of sport related task. This statement makes it clear about the importance of RFD with limitation of time demands. Submaximal and maximal are the two different levels of strength; however maximal strength is the one that has more influence on performance than submaximal (Stone et al. 2004; Taber et al. 2016).

Strength training has grown in popularity, and it has been used by athletes, adults, adolescents, elderly and clinical populations in different ways (Kraemer, WJ & Ratamess 2004). Strength, power, balance, coordination, agility, and speed are qualities of physical performance that are often attached with the strength training outcomes (Thompson et al. 2014). Strength training programs can be planned with taking in a count of the exercise intensity, volume, frequency, order and exercise mode and selection (Kraemer, WJ & Ratamess 2004; Stone et al. 2002).

3.3 Strength training and testing strength in athletes

In strength training the neuromuscular system has an important role and loading the neuromuscular system is the essence of everything. There are many ways to design a program with the same load. The training program can be different in training density x sets x frequency x load. In order to that, it is possible to increase frequency of the training and have a decrease in intensity from one repetition maximum or sets x repetitions. Designing a strength training depends on the goal, training background and quality of the athletes (Lloyd et al. 2014).

Jumping is a movement where an athlete needs to connect upper- and lower-body segments in regards of motor coordination arrangement (Markovic et al. 2004). The countermovement jump (CMJ) is mainly used for the measurement of lower-body strength and explosiveness (Markovic et al. 2004), and it has been one of the most used tests for keeping track of neuromuscular status in athletes (Gathercole, Stellingwerff & Sporer 2015). Consequently, when performance in many athletes depends on their ability to generate force quickly (Newton & Kraemer 1994),

therefore valid and reliable tests are beneficial to control the effects of training (Markovic et al. 2004).

The CMJ test can be performed either with or without use of the arm-swing. According to some studies, using arm-swing during the jump will have an increase in performance by 10% or more (Cheng et al. 2008). Also, athletes must remember to keep their knee, ankle and hip extended during the jump for avoiding any additional flight time (Markovic et al. 2004; Nuzzo, Anning & Scharfenberg 2011). Countermovement jump as a measurement is functional, simple and reliable in related to finding strength in athletes' lower-limbs, therefore CMJ is a clear way to measure and monitor performance of the athletes (Markovic et al. 2004).

Researchers stated that 30-m sprint (Markstrom & Olsson 2013), and relative strength in dynamic 1RM squat and power clean (Nuzzo, Anning & Scharfenberg 2011) are linked with CMJ performance. In other words, athletes with higher CMJ result perform better in sprint performances and 1RM tests (Markovic et al. 2004).

4 ENDURANCE

4.1 Endurance performance

Aerobic capacity in is an important component for football players, they need high level of aerobic system for high intensity with intermittent bouts of activity during a game. During a competitive game, an athlete could lose approximately 90% of the total energy (Bangsbo 1994; Moran et al. 2019), which is highly related to performance ability (Chamari et al. 2005; McMillan et al. 2005; Moran et al. 2019). According to Aughey (2011), there is usually 20 seconds of rest between high-intensity efforts.

Saltin and Gollnick 1983 stated that human body has a significant ability to answer to the functional changes requirements. Exercise training is one of the standpoints that use this plasticity, where endurance is enhanced by moderate intensity and long duration exercises (Saltin & Gollnick 1983; Degens et al. 2019).

There are different endurance trainings such as steady-state or extensive interval training, which coaches have been used to improve the aerobic capacity of their players. Even though, that type of training will positively effect on maximal oxygen uptake, blood lactate, and running economy (Iaia, Rampinini & Bangsbo 2009; Moran et al. 2019), but not necessarily help the player with the intermittent activity and to perform football skills under fatigue condition (Harrison et al. 2015; Moran et al. 2019). Consequently, coaches should understand this aspect regarding aerobic system because fatigue has been shown to have a negative influence on performance of the players (Russell & Kingsley 2011; Moran et al. 2019).

4.2 Yo-Yo Intermittent Recovery Test (Yo-Yo IR)

The mainly used test for measuring intermittent physical ability of football players is yo-yo intermittent recovery test (YYIR). YYIR test consists of two different levels with common characteristic methods. Both levels have 20m shuttle runs where velocity will be increased

progressively with 10 seconds of active recovery until exhaustion (Rampinini et al. 2010). The only difference between the two levels is the progressive velocity of the tests. Accordingly, yo-yo intermittent recovery test level 1 (YYIR1) is for young athletes with lower aerobic capacity which starts at 10 kilometers per hour; on the other end yo-yo intermittent recovery test level 2 (YYIR2) starts at 13 kilometers per hour and it is directional for athletes with higher fitness capacity. Submaximal yo-yo intermittent recovery test is another form of YYIR test, where it concentrates during in-season for injury rehabilitation, or athletes who have difficulties to perform maximal tests (Fanchini et al. 2014; Mohr, Krustrup & Bangsbo 2003).

There are physiological differences between the two levels of Yo-Yo IR test, where Yo-Yo IR1 is more correlated with maximal oxygen consumption (Rampinini et al. 2010) examining athlete's ability to perform repeatedly high-intensity aerobic bout (Fancini et al. 2014; Walker 2016). On the other hand, Yo-Yo IR2 is more related with the demands of anaerobic capacity (Rampinini et al. 2010) investigating athlete's ability to perform intense intermittent activities with a remarkable aerobic support (Fanchini et al. 2014; Bangsbo et al. 2008).

4.3 Repeated Sprint Ability (RSA)

Repeated sprint ability is a quality when a person can sprint with high intensity back to back with a short recovery phase (Dawson, Fitzsimons & Ward 1993, Impellizzeri et al. 2006). In football players, fatigue occurs during the match temporarily and it increases toward the end of the match, at the same time notifies the reduction in repeated sprint ability (RSA) (Collins et al. 2018). The ability to repeat activities such as jogging, jumping and sprinting are important in football players (Mohr, Krustrup & Bangsbo 2003; Stolen et al. 2005; Impellizzeri et al. 2006). That is the reason why RSA exercises getting more popular among football players and it is important for their physical performance (Impellizzeri et al. 2006). In addition to ability of performing several repeated sprints, RSA is also an important determinant of performance in football players that can be used as a good sign of high-intensity performance during a match (Rampinini et al. 2007). In a football match, players perform repeatedly maximal sprints for duration of 1-7s with a short period of recovery (Bangsbo, Norregaard & Thorso 1991; Impellizzeri et al. 2006).

Repeated sprint ability tests consist of many sprints with short periods of time, which happens during an actual football games and it is a quality of a high-level athlete (Spencer et al. 2005, Svensson & Drust 2005). The most important feature in RSA tests is that it should reflect the physical demands of a real football match (Impellizzeri, Rampinini & Marcora 2005).

There are many repeated sprint ability tests that have been developed and used in different studies Table 1, which has fifteen to fourty meters (15-40 m) of distance with repetition of 3-15 including 15-30 s of recovery (Da Silva, Guglielmo & Bishop 2010; Rampinini et al. 2009). When choosing RSA protocol, the length of recovery should be carefully recognized by answering the physical demands of match play (Buchheit et al. 2010).

Mostly total- or mean sprint time has been used for evaluating RSA in football players (Aziz et al. 2008, Impellizzeri et al. 2006). According to Rampinini et al. (2007) RSA, the number of high intensity work and total distance during a football match has been an important factor of endurance in team sports and there is a strong statistical relationship between them. Analysis of football matches has given the information about the rest periods between each sprint by less than 30s, which does not have a good influence on the following sprint effort (Spencer et al. 2004; Bishop and Spencer 2004).

Study	Test protocol	TSD	Recovery
Krustrup et al. 2010	3x30m	90 m	25 s
Gabbett, 2010	6x20	120 m	<15 s
Aziz et al. 2007	6x20m	120 m	20 s
Mujika et al. 2009	6x30m	180 m	20 s
Dellal et al. 2012	10x20m	200 m	30 s
Dupont et al. 2010	7x30m	210 m	25 s
Chaouachi et al. 2010	7x30m	210 m	20 s
Meckel et al. 2009	6x40m	240 m	25 s
Impellizzeri et al. 2008	6x20+20m	240 m	20 s
Bangsbo et al. 1994	7x34.2m	240 m	20-25 s
Wong et al. 2010	9x30m	270 m	25 s
Tonnessen et al. 2011	10x40m	400 m	60 s
Little & Williams 2007	15x40m	600 m	20-30 s

TABLE 1. Repeated sprint field test protocols [sets x (repetitions x distance)] used on young elite or professional football players. TSD, total sprinting distance. Modified from (Haugen et al. 2013).

There are variations and differences regarding timing in testing RSA make the situation complicated. However, most of the RSA tests simulate an intensive game period along with short recovery between each sprint. Therefore, it is a possibility of overrating the aerobic demands of the test. Total time in RSA tests are extremely in correlation with single sprints, therefore it is determined that RSA has a relation with short sprint than endurance capacity (Pyne et al. 2008). Balsom et al. (1992) reported that short sprints (15m) are better compared to longer sprints (30-40m) concerning harmful effects. This might be the reason behind the developed RSA tests which include small amount of sprinting.

5 SMALL-SIDED GAMES (SSGS)

5.1 Small-sided games in football

If football players want to reach the optimum performance, they need to control their training load. There are two different ways that coaches and scientists can clarify training loads of an individual. Training loads can be monitored internally by heart rate and blood lactate, rating of perceived exertion or externally by monitoring distance covered, maximum speed, and quantity of different intensity running (Helgerud et al. 2007). High-intensity training is used for improving football player's endurance performance, but football players have an alternative training in the form of small-sided games (SSG) (Impellizzeri et al. 2006; Radziminski et al. 2013).

Coaches use small-sided games (SSG) to improve physical fitness, technical and tactical abilities of football players (Hill-Haas et al. 2009; Impellizzeri et al. 2006; Rebelo et al. 2016). Physical and physiological qualities of athletes are important and it should be well developed (Hoff 2005; Lacome et al. 2017), but there are match contextual factors that prevent poorly trained players to profit their physical potential during games (Paul, Bradley and Nassis 2015; Lacome et al. 2017).

5.2 Influence of mental fatigue in small-sided game

A psychobiological factor such as mental fatigue is recognized when an athlete feels tired with small amount of energy that is the result of slow periods of demanding cognitive activity (Boksem, Meijman, Lorist 2005). There are studies that have shown mental fatigue can influence the effort during an endurance-based physical activity (Brownsberger et al. 2013; Marcora, Staiano, Manning 2009; Pageaux, Marcora, Lepers 2013; Smith et al. 2016). As football is an endurance-based sport, therefore mental fatigue may influence how much distance a player could cover during a match. As physical quality of an athlete decreases, the quality and quantity of technical performance will reduce (Carling & Dupont 2011; Bradley et al. 2011). Lately researchers reported that there has been a decrease in football-specific physical and technical performance when it is related to mental fatigue players (Smith et al. 2016). Therefore,

SSG are general training protocol for football players because it accurately reflects the physical and technical demands of a real game (Hill-Haas et al. 2011; Dellal et al. 2011; Casamichana & Castellano 2010).

Coaches and scientists are interested in how much SSG and football game play replicate each other in regarding of physical demands. They are mostly concerned with optimizing training stimuli. Therefore, it is important to understand differences in physical requirements between SSG and match play (Casamichana, Castellano & Castagna 2012; Rampinini et al. 2007).
It is reported that elite young central midfielders and strikers only reach 85% to 94% of their maximal running speed during a game (Al Haddad et al. 2015).

According to Bordonau and Villanueva (2014) elite players are physically fit enough but they are not necessarily at their best. In the past years, the methodology behind football training related to physical training in se the sense of training with ball has been developed. This type of training is referred as "the tactical periodization model" and gives the players a great lead regarding physical development on both quality and density of athletes' specific actions and intercommunication (Bordonau & Villanueva 2014; Lacome et al. 2017). Football games demand endurance, speed and strength, which are the three important base for fitness and in "tactical periodization model"; its important principle is the overload relative to football games (Impellizzeri et al. 2006; Lacome et al. 2017). Impellizzeri et al. in (2006) noted that training must include exercises involved endurance, speed and strength in a football-specific way during the week not only in a single session. This helps the coach to improve the tactical principles during this type of session and as match-overload could be reached, therefore there would be an improvement in physical fitness of athletes using SSG. (Impellizzeri et al. 2006; Lacome et al. 2017).

5.3 Small-sided games as a drill

There are five different parameters related to planning training loads of high intensity endurance exercises that should be paid attention on. These parameters are duration period, intensity, recovery time between period, intensity during recovery period and total training duration (period number x period duration) (Seiler & Sjursen 2004). Coaches use SSG as a training drill to improve the physical fitness, technical and tactical qualities of football players (Rebelo et al. 2016; Hill-Haas et al. 2009; Impellizzeri et al. 2006). There are components that are important in maintaining physical demands of SSG (Casamichana, Castellano & Castagna 2012; Rampinini et al. 2007). When planning a SSG drill, the field size (Table 3) (Casamichana & Castellano 2010; Rampinini et al. 2007), number of players Table 2 (Brandes, Heitmann & Muller 2012), rules (Hill-Haas et al. 2010), feedback of the coach (Brandes & Elvers 2017, Rampinini et al. 2007), duration (Ferraz et al. 2018), using goalkeepers and training regimen (Castellano, Casamichana & Dellal 2013) must be recognized to make a perfect SSG drill that can develop the physical and tactical abilities of an athlete. Therefore, those factors have a great benefit on physical qualities of SSG training (Hill-Haas et al. 2011).

5.4 Number of players in SSGs

Number of players on the field has a great impact on intensity, technical, tactical and physiological effect of the game (Rampinini et al. 2007). Rampinini et al. in 2007 mentioned that in order to understand the intensity of the SSG influenced by the number of players, the field size must be kept the same. Table 2 shows the differences between different set ups during SSG in some studies.

In the study of Hill-Haas et al. (2009), 2 v 2 sub-phased lead to greater amount of time spent at 490% heart rate (HR) max than the 4 v 4 and 6 v 6 sub-phases. These results give the information that fewer number of players caused higher HR responses with players spent more time in the higher heart zones (Hill-Haas, Dawson, Coutts & Rowsell, 2009). Also in study of Athanasios & Eleftherios in (2009), 3 v 3 appeared to be harder in intensity compared to 6 v 6

situations. Adding players to SSG drills can decrease heart rate, which means when there is an increase in number of players during SSGs drills it will decrease heart rate and physical demands of the athletes (Owen, Twist & Ford 2004).

TABLE 2. Set up of SSG in different studies.

Study	Numver of players	Field size	Duration
Little & Williams 2007	5v5	45x30 m	4x6 min
Rampinini et al. 2007	5v5	30x40 m	4 min
Jones & Drust, 2007	4v4	30x25 m	10 min
Dellal et al. 2008	5v5	30x25 m	2x4 min
Hill-Haas et al. 2009	4v4	40x30 m	24 min

Modified from Clemente et al. 2012.

Also, Rampinini et al. (2007) study showed that, when there were less players in the field during SSG drill there was an increase in intensity of the game. At the same time when there were less players on the field the frequency of ball touches by each athlete increased (Rampinini et al. 2007).

5.5 The field size in SSGs

The space that players must move is depended on the field size and according to that passing and receiving ball and complete the task during SSG may be influenced because of the field size. That is why coaches have the responsibility to plan an accurate SSG drill to achieve the main goals of the training (Clemente et al. 2012). Even though there is not much literature information regarding the physical aspect influenced by the field size, but Rampinini et al. (2007) stated that HR of the players were higher in larger fields than small ones. Also, Casamichana and Castellano (2010) found similar results in their study that players had higher physical and physiological values when they played in a bigger field Table 3.

TABLE 3. The results in total and high intensity distance in Casamichana & Castellano 2010 study. Modified form Clemente et al. 2012.

Study	Number of players	Field size (m)	Duration	TD	HID
Casamichana & Castellano	5v5	32x23	8	695.8m	50.3m
	5v5	50x35	8	908.9m	155.4m
	5v5	63x44	8	999.6m	180.9m

HID, high intensity distance; TD, total distance

The size of the field can effect in different ways; for example smaller field may bring more braking, change of direction or acceleration, on the other hand larger field gives players more time to react and move (Clemente et al. 2012). There can be an increase or a decrease in the distance between players and it can affect the match-play technically, which means that players had more actions in larger fields than smaller ones (Casamichana & Castellano 2010, Clemente et al. 2012).

5.6 Rules in SSGs

Rules are important factors in SSGs that can be used as a tool to achieve the goal of the training. It helps players to focus on the specific information in terms of perception. Hence, rules limit the movement of the players during a match-play and it is depended on instructions (Clemente et al. 2012). An example of rules can be, “keep the ball in possession”, which Mallo and Navarro (2008), did in their study. They founded by that rule, players touched the ball more and short distance passes increased in SSGs. This type of rules or instructions can have an impact on technical side of the game (Mallo & Navarro 2008). Also, there were differences in physical and tactical part of the game when goalkeepers were included in the SSG. According to Mallo and Navarro (2008) the presence of goalkeeper put players in the situation that they tried to play more carefully and defensively, at the same time the intensity and distance covered by players decreased.

In study of Hill-Haas et al. (2009) there were significant differences between intermittent and continuous exercises. Intermittent exercises increased the amount of moderate to high speed running compared to continuous in SSG. Therefore, physical level of the players is depended on recovery time, and the effects of continuous and intermittent exercises are physically in different levels during SSG (Hill-Haas et al. 2009, Clemente et al. 2012). Hill-Haas et al (2009) added that the reason behind the number of sprints might be the additional passive rest between the games, which allowed players to have more recovery time.

These results show (in 3 previous sub-chapters) that coaches can effect on the intensity of the drill depending on what is the goal of the training. SSG drill can be either beneficial or ineffectual, therefore coaches should be aware of what they want to achieve by training SSG. Physical, tactical and technical level of each team must be carefully considered. This means that the same exercise for two different teams may not be as beneficial for both of them. Consequently, coaches need to understand how to use several factors in order to adjust the SSG to training objectives (Clemente et al. 2012).

6 AIMS OF THE STUDY

There are many different approaches to improve physical performance of the athletes. Many studies have shown that strength training and plyometric training together lead to a greater improvement in physical demands of football players. (Adams et al. 1992; Harris et al. 2000; Chaouachi et al. 2012). Therefore, the aim of this study was to design a training program including strength and plyometric exercises that could improve the physical ability of young football players and to increase the game intensity after the training intervention.

Research Question 1: Does the combination of strength and plyometric training influence physical performance of young football players?

Hypothesis: Yes, the combination of strength (ST) and plyometric (PT) training has beneficial impacts on physical performance of young football players. Many studies proved that young football players can improve their physical ability including speed, endurance, and strength by having ST and PT combined in their training program (Ronaldo et al. 2016; Smilios et al. 2005; Ronnestad et al., 2008). Combination of ST and PT training induced important gains in countermovement jump and sprint ability of young football players (Marquez et al. 2015).

Research Question 2: Is there a relationship between game intensity (small-sided game) and physical ability of young football players?

Hypothesis: Yes, there is a relationship between small sided game and physical ability of young football players. Chaouachi et al. (2014) and Los Arcos et al. (2015) found a positive relationship between small-sided game, 30-m sprint and countermovement jump. In the study of Dello Iacono. (2016), Radziminsky et al. (2012) and Hill-Haas et al. (2009) the physical factors of football players including sprint, jump, yo-yo intermittent recovery and repeated sprint ability were in a significant relationship with small-sided game.

7 METHODS

7.1 Subjects

There were 32 youth football players (age: 16.3 ±0.5, weight: 66.2 ±8.7, height:177.3 ±6.6, BMI: 21.1 ± 2.3) from two different football club competing in first division of Finland, participated in this study. One team was recruited fully for the training group (TG: additional strength training twice per week during 8 weeks of training intervention) and the other one as control group (CON: normal football training during the intervention of 8 weeks). The training group had no experience in strength training. On the other hand, the control group was just started to have a session of strength training per week. The training group had only some experience of muscle condition training using their own bodyweight. Therefore, all the important information was given carefully to the subjects and all the coaches. All the information including risks and benefits involved in this study was told accurately to the subjects and coaches. In addition to the strength training program for training group, the subjects had also football training sessions including technical and tactical training twice a week and some friendly matches were also involved during the training intervention. When the pre-test was done; the control group had normal football training four times in a week including one session of strength training and friendly matches were also involved during the intervention.

Before starting of the research each player was asked to bring an informed consent form signed by their parents. The research was revealed by the University of Jyväskylä Ethical Committee.

Table 6. Age, height, weight, number of participants and body mass index in both groups before and after the intervention.

Group	Age	Height (cm)	Weight (kg)	BMI (kg/m²)
TG pre-test (n=16)	16.3±0.5	176.3±7.9	65.9±11.2	21.1±2.6
CON pre-test (n=16)	16.2±0.4	178.3±4.8	65.5±5.3	20.9±1.9
TG post-test (n=15)	16.3±0.5	177.2±7.3	67.3±11.5	21.3±2.8
CON post-test (n=4-6)	16.2±0.4	178.6±4.6	65.9±4.8	20.3±1.6

TG, training group; CON, control group; BMI, body mass index.

The subjects in TG group were divided into two different groups (8 players per group) according to their pre-test results (the closest 1RM results were placed in the same group), because of saving time during training sessions. The subjects had no injuries before pre-test measurements.

7.2 Study design

The experiment was completed during in- and off-season of Finnish first division competition. Due to various barriers that came across to this research's study design; there were various changes that came along with the new team and different tests, also the time of the intervention was set totally at different times. Due to different challenges in control group; there were only four to eight (4 to 8) players in different tests, who completed the research Table 6. Number of player's and every other change regarding groups are considered in statistical analysis.

The control group's (CON) intervention took place at the end of the season and training group's (TG) intervention took place in off-season after their vacation was over. The intervention lasted for ten (10) weeks including two (2) weeks of pre- and post-test measurements.

7.3 Training programme

In this study, the TG group had their own football training twice a week and two sessions of combination of ST and PT training. CON group was instructed not to have any ST or PT exercises in their program. Only football training was allowed for CON group. ST training was consisted of leg press and dumbbell stepping lunge. Between each set both in PT and ST training, there was at least three minutes of rest. The load for each week was counted from the 1RM results Table 7. TG group was divided into two groups regarding their 1RM results. The players whose load was near to each other was placed into the same group. Due to small number of adjustable dumbbells the training order was also different. Therefore, ST training LP (leg press) and DSL (dumbbell stepping lunge) was performed alternately between the groups Table 4. There was always warm up included in each exercise with less weights.

ST TRAINING						
Weeks	Load %	Sets	REPS	Rest	Group 1	Group 2
Week 1-2	60%	4	5	3+	LP	DSL
Week 3-4	70%	4	4	3+	DSL	LP
Week 5-6	80%	4	3	3+	LP	DSL
Week 7-8	90%	4	2	3+	DSL	LP

TABEL 4 ST training programme of the TG group ST, Strength training; REPS, repetitions; LP, leg press; DSL, dumbbell stepping lunge.

PT training was consisted of squat jump, skater jump, scissor jump, forward box jumps and drops. Forward box jumps and drops performed on three different height. The height of the boxes was set at 20cm, 40cm and 60cm during the whole intervention. All the PT exercises was performed at the same time with using only body weight Table 5.

TABLE 5. PT training programme of the TG group

PT TRAINING				
Weeks	Load	Sets	REPS	REST
Week 1-2	BW	3	6	3+
Week 3-4	BW	3	6	3+
Week 5-6	BW	3	6	3+
Week 7-8	BW	3	6	3+

PT, plyometric training; REPS, repetitions; BW, body weight

7.4 Testing procedures

All the tests were completed inside a football facility including running tracks. Pre- and post-test measurements were taken place in three different days separated by twenty-four hours for training group. Due to distance and schedule problems, two days of testing sessions separated by twenty-four hours was completed for the control group. All the tests were measured during the same time of the day. Players had their own warming up routine that was instructed by their captains before starting the testing sessions both in training- and control group. Before pre- and post-test measurements height and weight of each player were clarified.

7.4.1 Countermovement jump (CMJ)

The captains lead the warm-up for about 15 minutes before the countermovement jump test. Each player had 3 submaximal countermovement jumps to learn the movement and technique of the concerned jump. The CMJ was performed in basic infrared jump and speed analyzer Figure 2. Each player performed 3 maximal jumps with hands on the hip following 2-3 minutes of rest period between each attempt. The result of each jump was counted automatically by the device. The highest jump achieved out of three attempts was counted as their CMJ height and used for data analysis. The test was fully supervised and instructed.

FIGURE 2 The device that was used for countermovement jump test (infrared jump and speed analyzer).

Each player was instructed to start the jump in standing position with hands on hip and then fast drop into the squat position and immediately jump as high as possible as demonstrated in Figure 3.

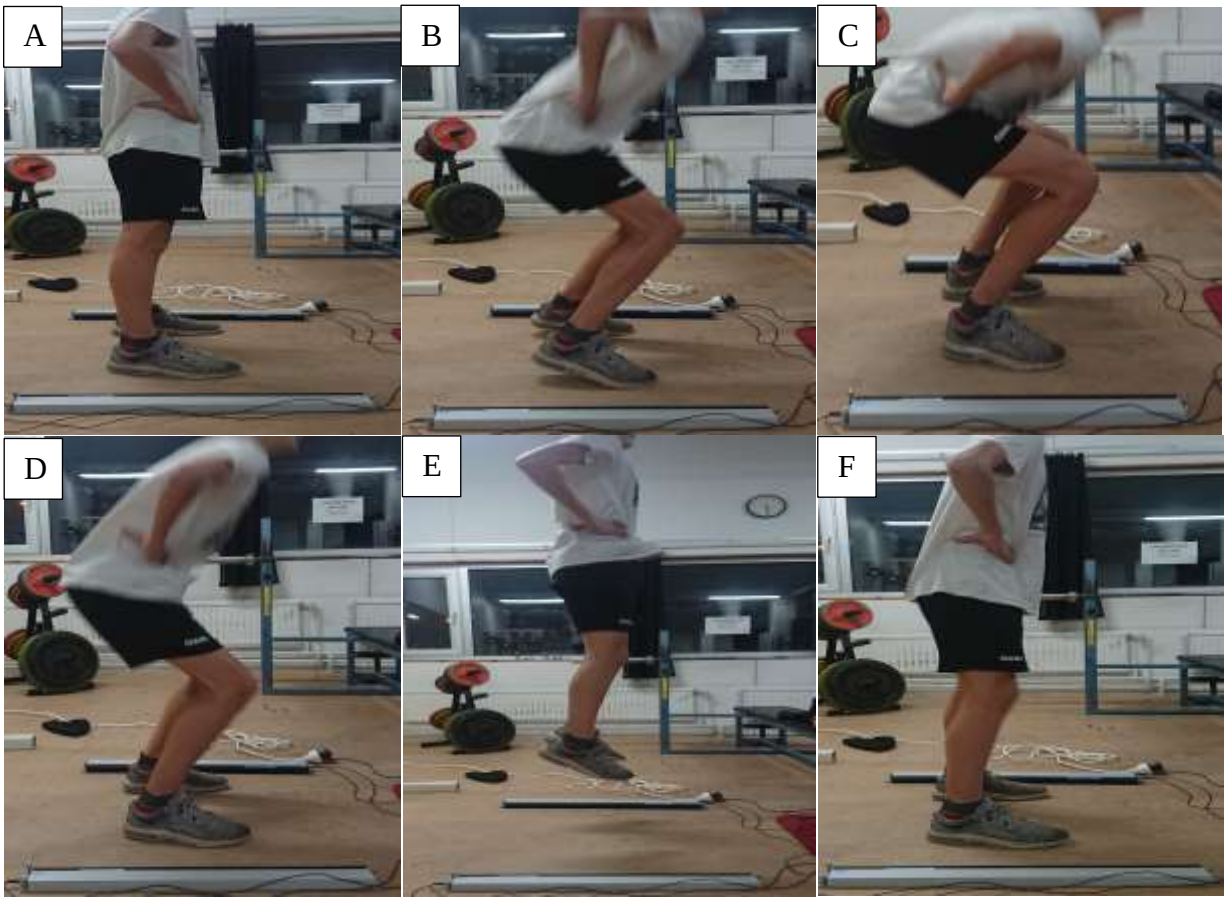
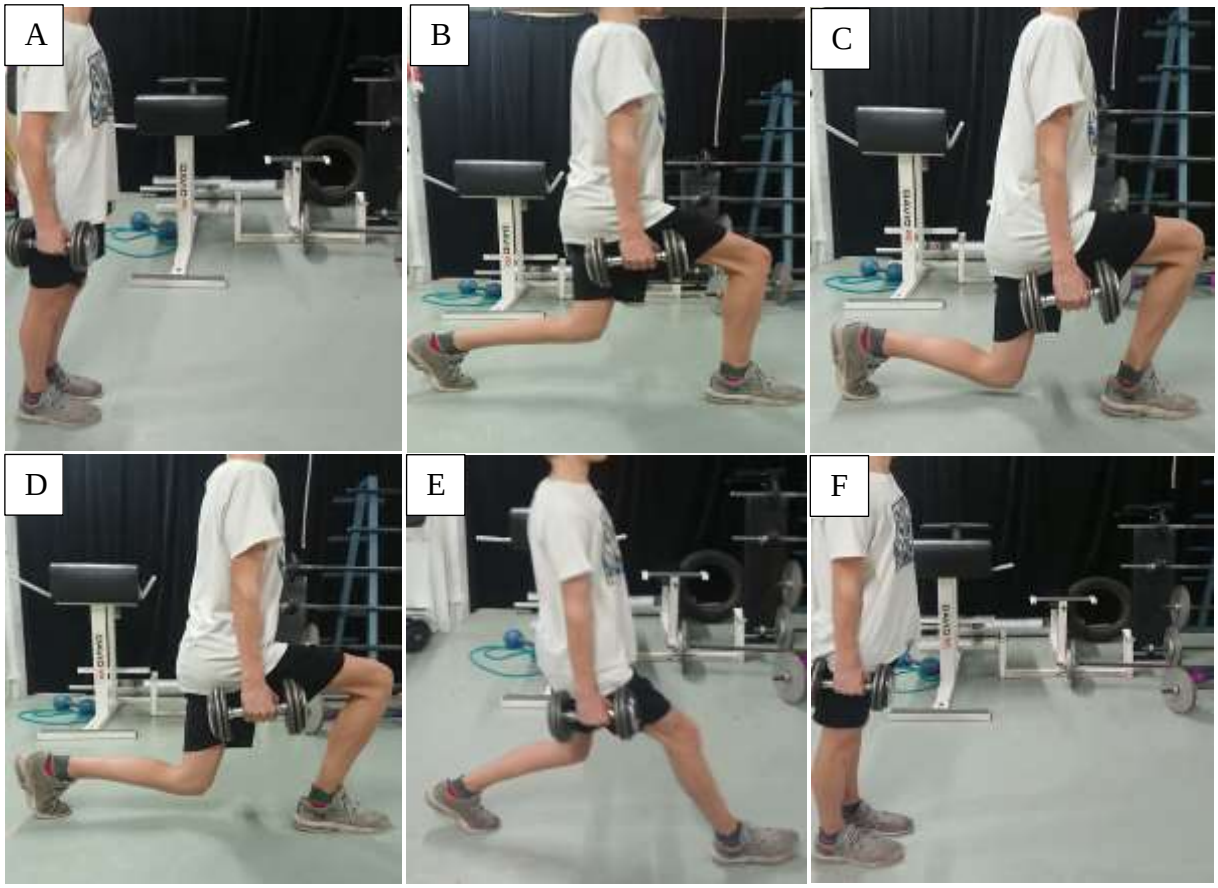


FIGURE 3 Countermovement jump test (A: starting point → F: ending point).

7.4.2 One-repetition maximum (1RM in leg press and dumbble stepping lunge)

One-repetition maximum was used to measure the maximal strength of the players. Players did not have any experience of one repetition maximum testing. The test quality was set at the best to get subject's maximum strength accurately both in dumbbell stepping Figure 4 lunge and leg press Figure 5. A set of warm-ups for 15 minutes was leaded by the captain. The load was added progressively, and repetition was reduced to one until to the failure to get an accurate 1RM for each player in both 1RM tests. The two tests were separated by twenty-four (24) hours. There were three to four (3-4) minutes of rest periods between each attempt. Concentric and eccentric phase were involved in both 1RM tests.

FIGURE 4. 1 repetition maximum test in dumbbell stepping lunge (A: starting point → F: ending point).



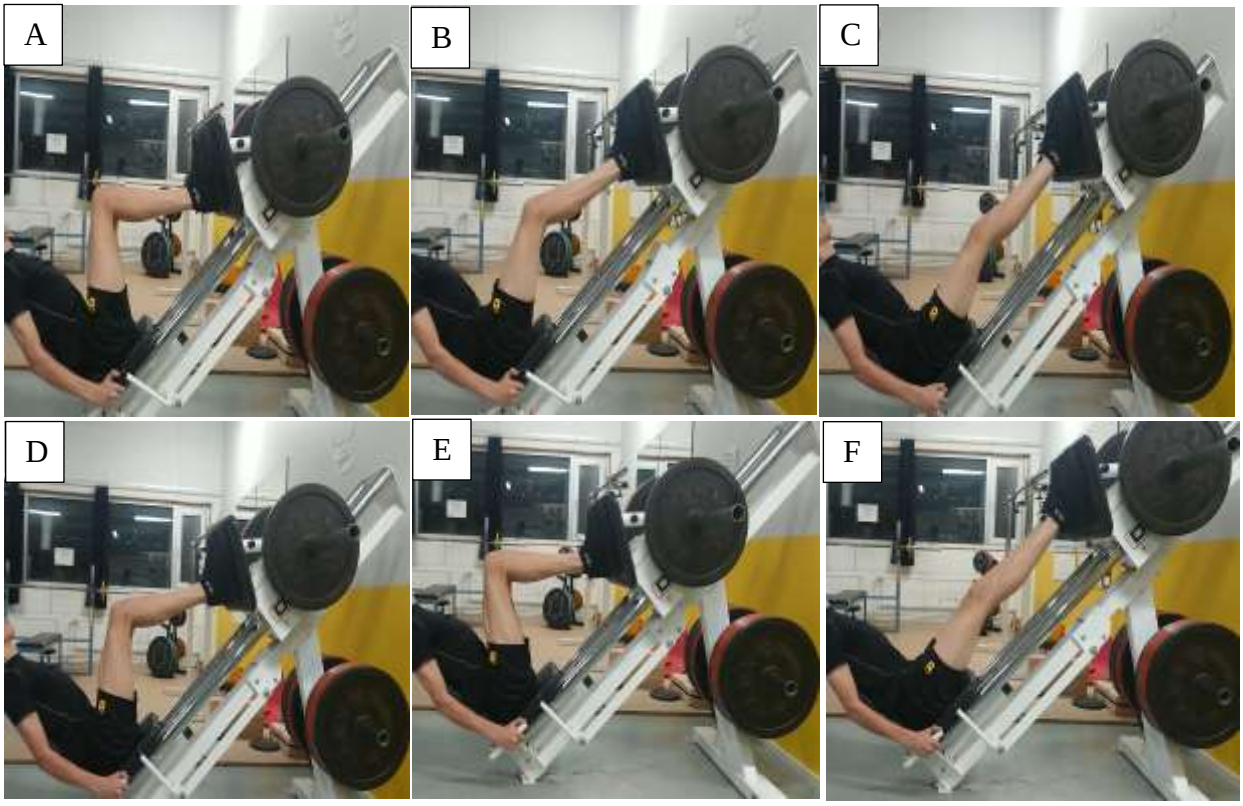


FIGURE 5. 1 repetition maximum test in leg press (A: starting point → F: ending point).

7.4.3 30 m-sprint

The sprint test was measured to see the speed of each player and acceleration ability of the subjects on an indoor running track. Subjects had a quick warm-up with different types of run because they already had a session of warming-up before earlier test. Each subject did only one submaximal run before the actual test. Basic infrared speed analyser FIGURE 6 including timing gates were used to measure the speed of each player by taking time and it were located thirty (30) meters apart each other. The rime resolution was set at 0.01s. There was a line marked one meter behind the first timing gates, where each player had to start the run and accelerate towards the end to get the best result. Each player had three maximal runs with two to three (2-3) minutes rest between each attempt, and the best run was counted for data analysis.

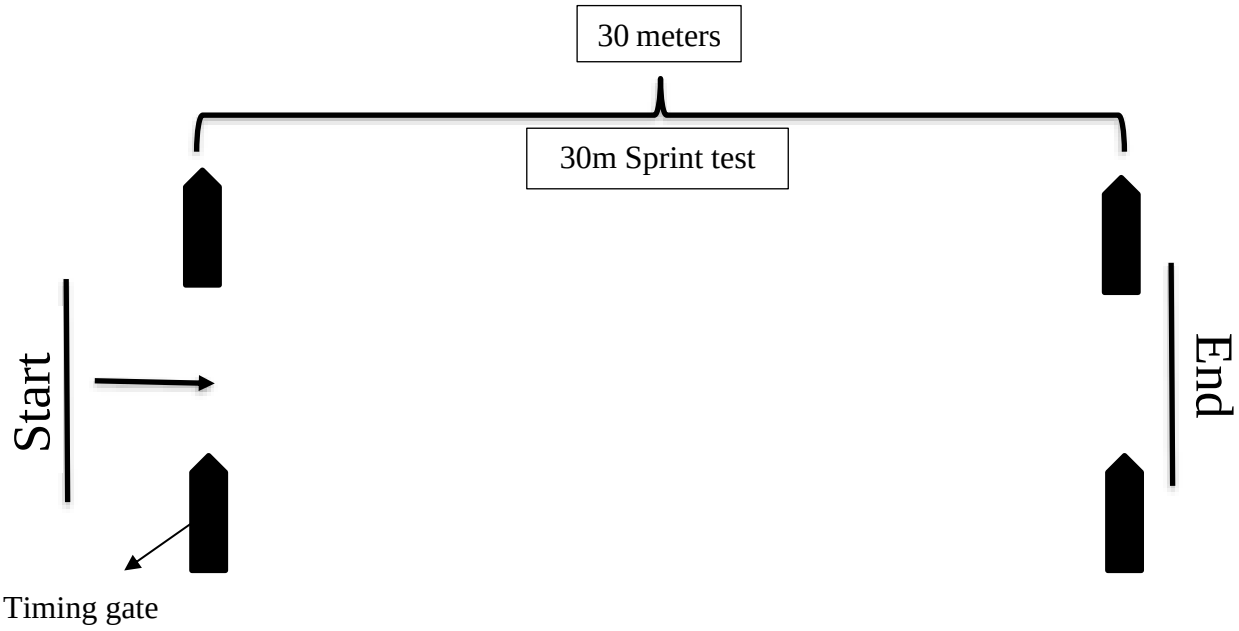


FIGURE 6. The set up in 30-m sprint test.

7.4.4 Repeated sprint ability (RSA)

Plyers were already warmed-up and ready to proceed the test protocols. Repeated sprint ability is a test that is mostly used in team sports to evaluate the aerobic ability of athletes. The test equipment was setup in an indoor running track. Timing gates were used in this test and located 30 meters apart each other. The starting point was marked one meter behind the first timing gates. As the name of the test says, each player had to run back to back with a 30 seconds (s) of active rest Figure 7. The passive rest was to jog back to starting point and getting ready for the next sprint. Each player had to sprint 5 times and the average of 5 runs was counted for data analysis.

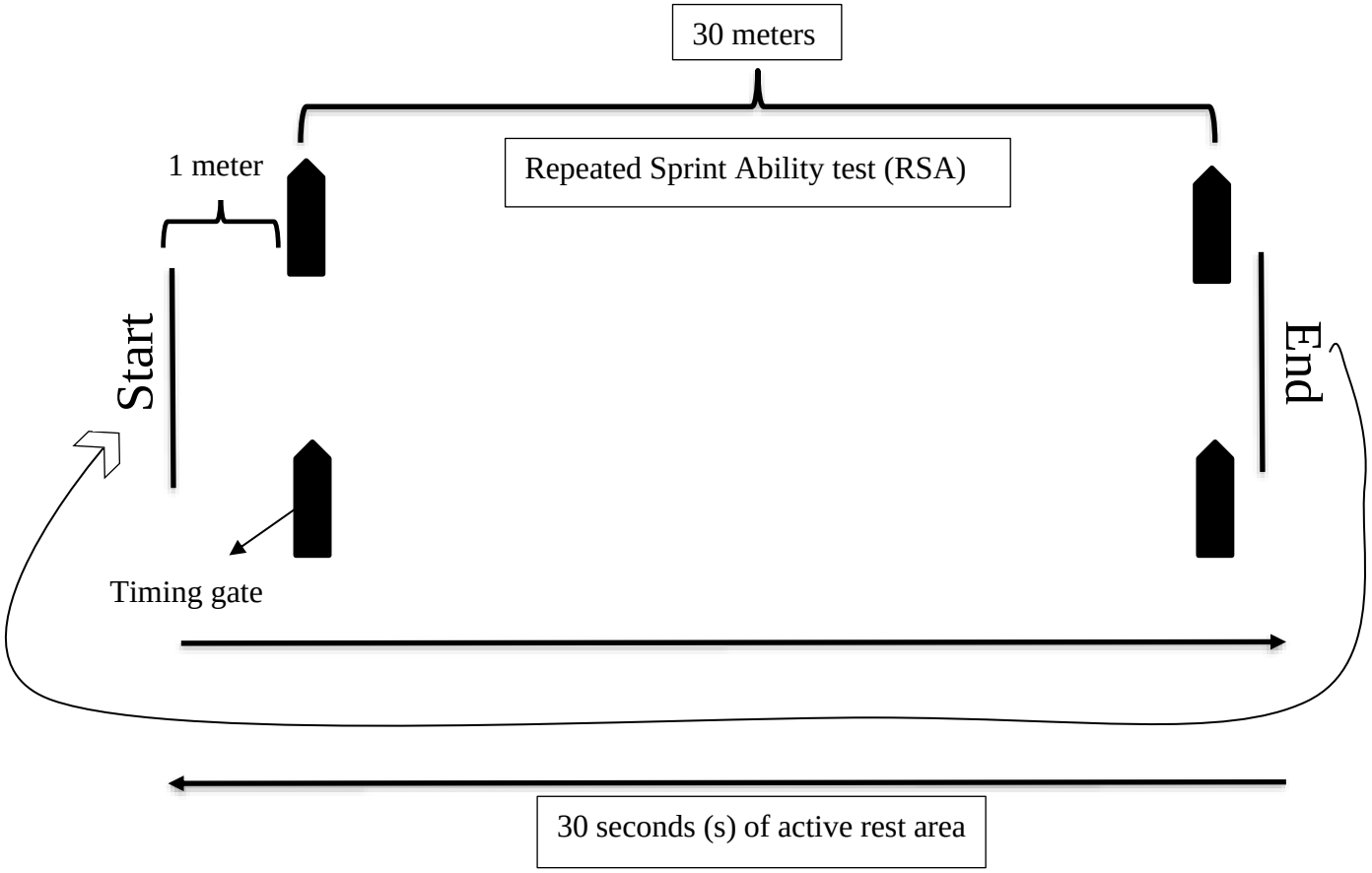


FIGURE 7. The set up in Repeated sprint ability (RSA) test.

7.4.5 Yo-Yo intermittent recovery test level 1 (YYIR1)

The Yo-Yo tests are used to evaluate the endurance ability of athletes. The Yo-Yo intermittent test level one was used in this research in an indoor football facility on turf with cleats on. There were clear instructions provided to the athletes and they jog two shuttles just to get the idea of the test protocol. The 15 minutes session of warm-up including stretching before the test was leaded by the captains of the teams. The setup of the yo-yo test is shown below in Figure 8. The test was finished, if the player did not complete the run in time before the audio cue. Each shuttle run was twenty (20) meters and there was five (5) meters of recovery area. The audio cue came from James B. Lansing (JBL) speaker that was connected to a mobile.

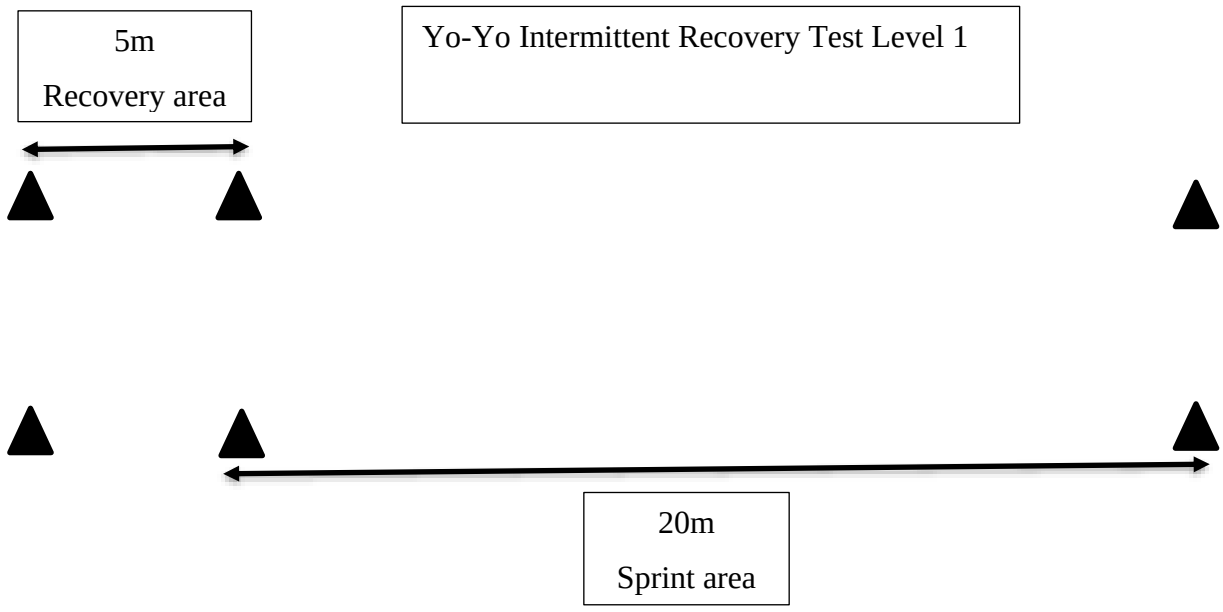


FIGURE 8. The set up in yo-yo intermittent recovery test level 1 (YYIR1).

7.4.6 Small sided-game (SSG)

Small sided game was done on turf inside a football facility to reflect an actual football game to monitor the maximal speed, total distance and distance in different zones covered by the athletes. All the information was recorded by Polar Team Pro Figure 9.

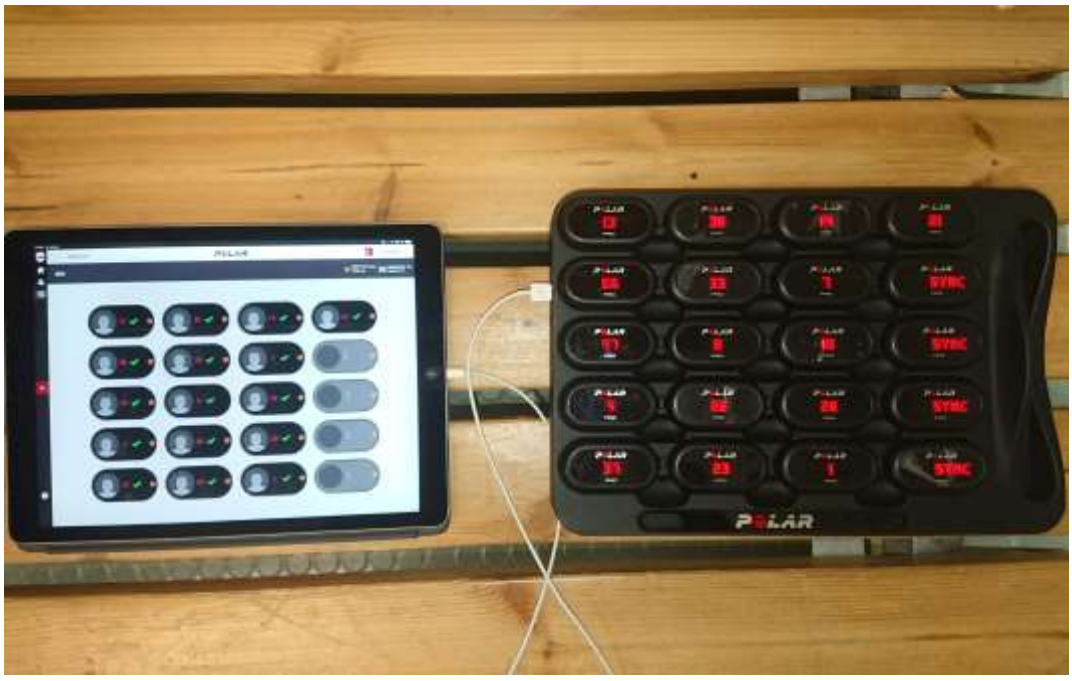


FIGURE 9. Polar Team Pro device that was used in small-sided games to monitor total distance covered, maximal speed and distance in different zones.

The size of field was set at 30x40m (width x length) shown in Figure 10. Each session was 4 minutes long with a high intensity and 2 minutes of rest between each session. There were lots of footballs around the area to make sure that the game continues immediately after the ball goes out. Goalkeepers were instructed to get a new ball and open the game as soon as the ball is in the goal or out of the field. Players were instructed to play with a high intensity and as close as a real football game. The polar team sport system was used to measure all the information needed for this test including heartrate, distance covered, sprints and speed of the players.

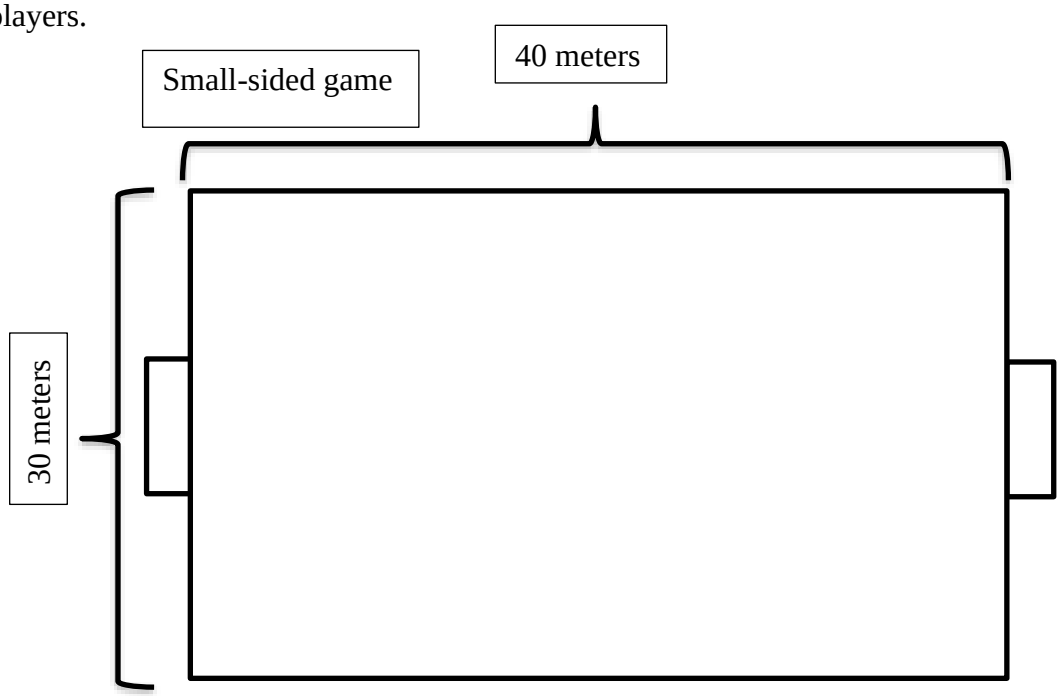


FIGURE 10. The set up in small-sided game. The width of field was set at 30 meters and the length was set at 40 meters.

7.5 Statistical analysis

Statistical analyses were executed with IBM SPSS statistics 26. In this study all data is reported as mean ± standard deviation (SD) and mean rank. The normality of all data was examined by Kolmogorov-Smirnov normality test. Homogeneity of the variances was revealed by Levene Test. P-value in every test was set at 0.05. In case if, $p<0.01$ and $p<0.001$ are reported seperately.

The differences within the groups after the training intervention were analysed by Paired Samples T-Test. The Independent Samples T-Test (Levene's test for equality of variances) was used for analyzing the results of pre-tests between the two gropus. There were a big difference in the number of subjects after the training intervention. Therefore, the Two-Independent-Samples test (Nonparametric Test; Mann-Whitney Test) was used to analyse the differences between training group (TG) and control group (CON).

Due to lack of players in the control group, the results were only analysed for the training group in small-sided game before and after the intervention.

8 RESULTS

8.1 Results of pre- and post-tests in training group (TG)

The next table presents anthropometrical data and the results of physical performance tests of the training groups before and after the intervention. The normality of the results in pre- and post-tests were tested by Kolmogorov-Smirnov test.

In training group (n=16) players participated in pre-test measurements. After the training period, there were less players in some post-test measurements and (Table 7) presents, how many palyer particiapted in each measurements.

TABLE 7. Anthropometrical results of the physical performance before and after the intervention in training group (TG). The table shows mean, standard deviation, minimum and maximum for each test including individual's information.

	n	Mean	SD	Min	Max
Pre-test					
Age (years)	16	16.3	0.5	16	17
Height (m)	16	176.3	7.95	160	190
Weight (kg)	16	65.9	11.25	50	94
BMI kg/m²	16	21.1	2.68	16.90	26.88
30m-sprint (s)	16	4.28	0.21	3.90	4.55
RSA (s)	16	4.55	0.21	4.17	4.94
CMJ (cm)	16	33.14	3.72	27.80	38.70
1RM-LP (kg)	16	178.33	55.79	110	260
1RM-DSL (kg)	16	39.17	10.83	40	60
YYIR1	12	1603.33	529.99	1040	3440
Post-test					
Age (years)	15	16.3	0.48	16	17
Height (m)	15	177.2	7.36	160	190
Weight (kg)	15	67.3	11.51	53	96
BMI kg/m²	15	21.3	2.87	17.59	27.45
30m-sprint (s)	15	4.20	0.28	3.77	4.59
RSA (s)	15	4.43	0.23	4.10	4.87
CMJ (cm)	15	34.66	3.89	28.60	40.20
1RM-LP (kg)	15	239.16	42.12	175	330
1RM-DSL (kg)	12	48.46	7.56	40	60
YYIR1	7	1565.71	633.16	1120	2960

Min, minimun; Max, maximum; SD, standard deviation; BMI, body mass index; RSA, repeated sprint ability; CMJ, countermovement jump; 1RM-LP, leg press 1 repetition maximum; 1RM-DSL, dumbbell stepping lunge; YYIR1, yo-yo intermittent recovery test level 1

The results are presented within the TG group as means and standard deviation. Precise analysis has done seperately for each test and is shown in figures in the next chapters.

8.1.1 Changes in 30m-sprint in training group (TG)

The training group (TG) decreased their mean time by 3.3 % after the intervention Figure 11. There was a significant differnce between ($p<0.001$) pre- and post-test measurements. Most of the players had an imporvement in their sprint ability.

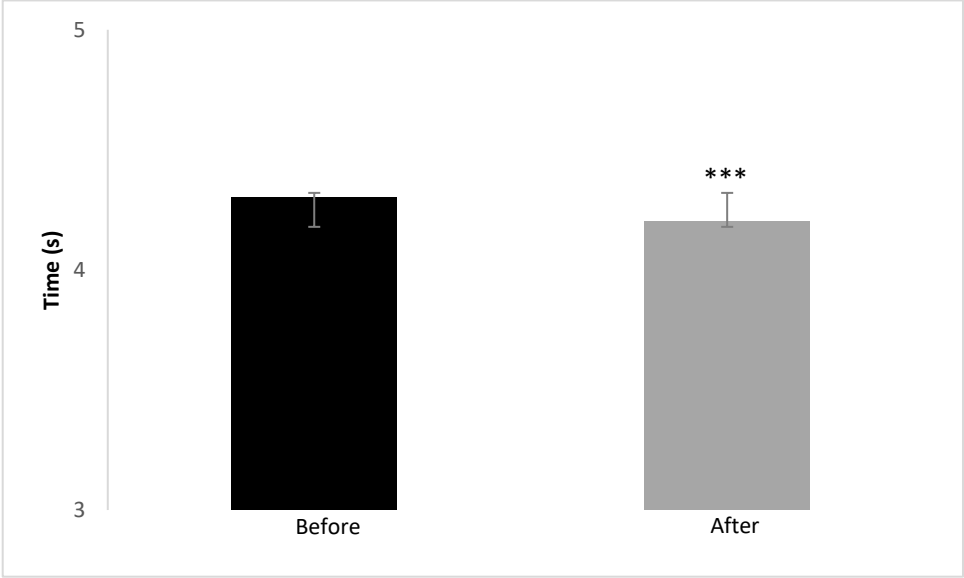


FIGURE 11. The results of 30-m sprint before and after the training intervention in TG group; SD, standard deviation. Mean time within the training group. *** significant difference within the group after the intervention.

8.1.2 Repeated sprint ability changes in training group (TG)

The training group decreased their mean time by 2.5 % in RSA after the intervention Figure 12. Even though the change is small after the training period, but the paired samples test confirmed that; there was an extremely significant change in repeated sprint ability by p-value (p=0.004) being smaller than 0.01, therefore p<0.01 and, there was a significant difference within the group after training period.

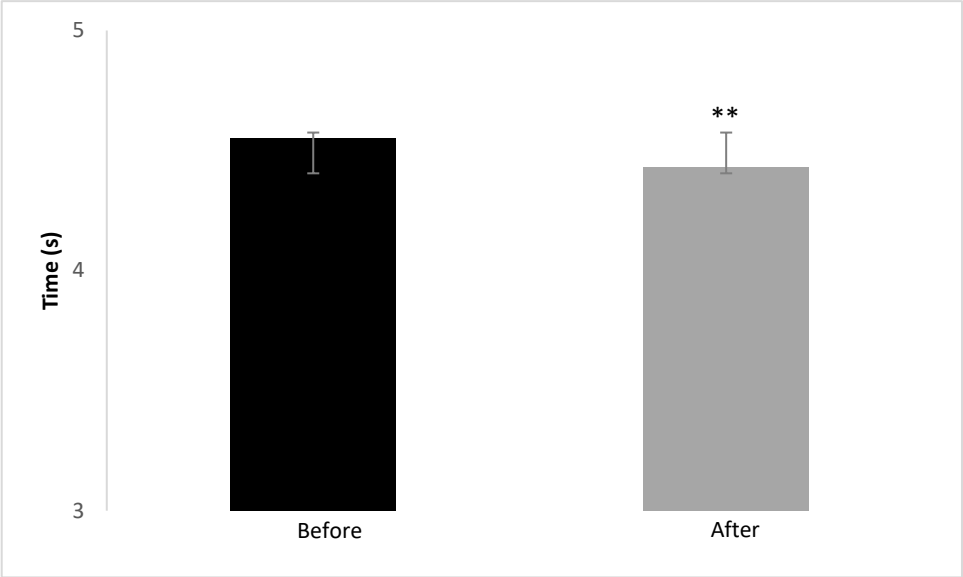


FIGURE 12. The results of repeated sprint ability before and after the training intervention in TG group; SD, standard deviation. Mean time in training group. ** significant difference within training group in repeated sprint ability after the training intervention.

8.1.3 Changes in countermovement jump in training group (TG)

The training group improved their mean height by 1.65 % in CMJ after the intervention Figure 13. There was a significant change ($p<0.001$) in countermovement jump. As the results show; each player's mean height in CMJ was improved after training period.

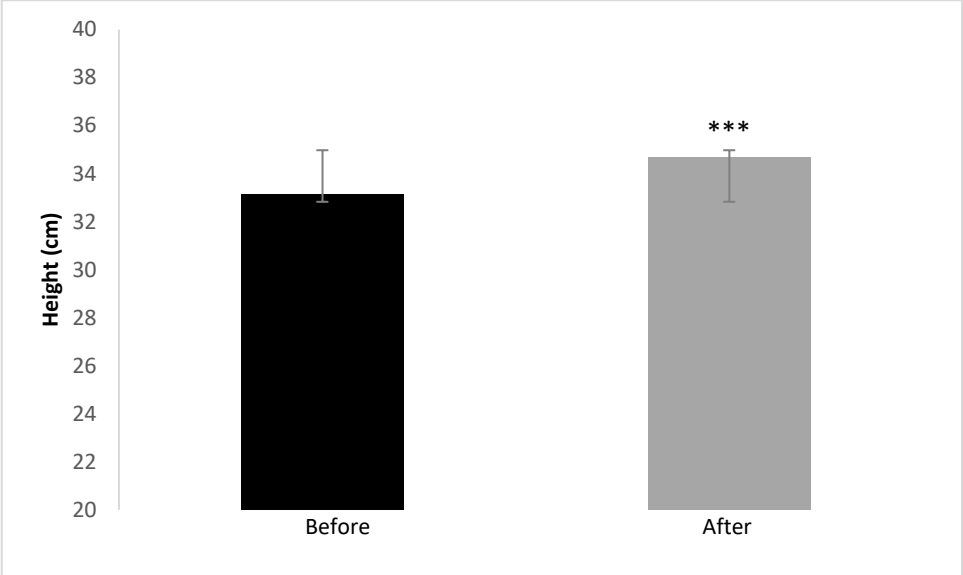


FIGURE 13. The results of countermovement jump (CMJ) before and after the training intervention in TG group; SD, standard deviation. Mean height in training group. *** significant difference within the group in countermovement jump after the training intervention.

8.1.4 Changes in 1RM leg press in training group (TG)

The training group improved their maximal strength mean by 25% in leg press after the intervention Figure 14. The results are highly significant ($p<0.001$) in 1RM leg press in training group. The results show that each subject did improve their 1RM after the training period.

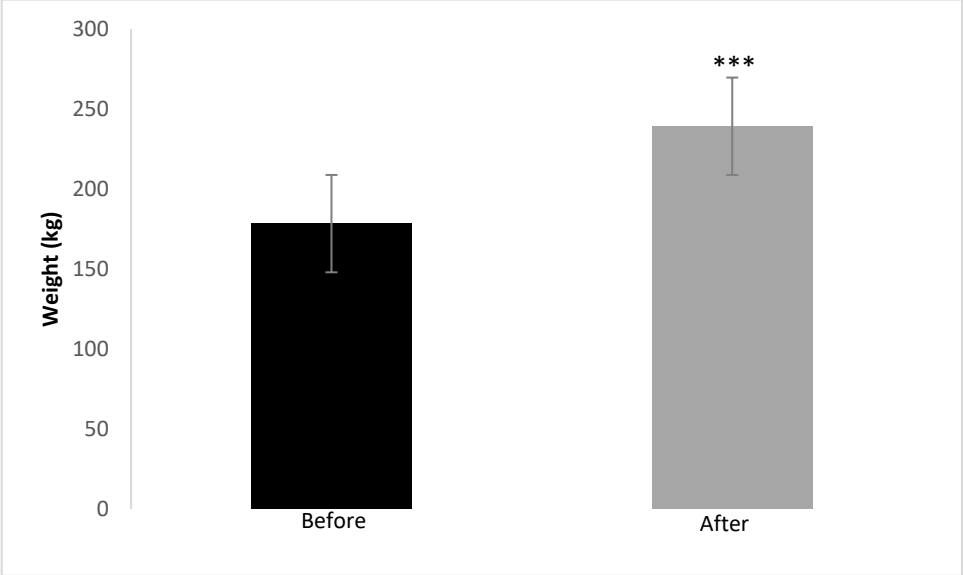


FIGURE 14. The results of 1 repetition maximum in leg press before and after the training intervention in TG; SD, standard deviation. Mean weight within the training group. *** significant difference within the group after the training intervention.

8.1.5 Changes in 1RM Dumbbell stepping lunge (DSL) in training group (TG)

The training group improved their 1RM dumbbell stepping lunge (DSL) by 19% after the intervention Figure 15. There was differences between pre- and post-tests with $p<0.05$. Therefore, the training period of 8 weeks was beneficial for young football players.

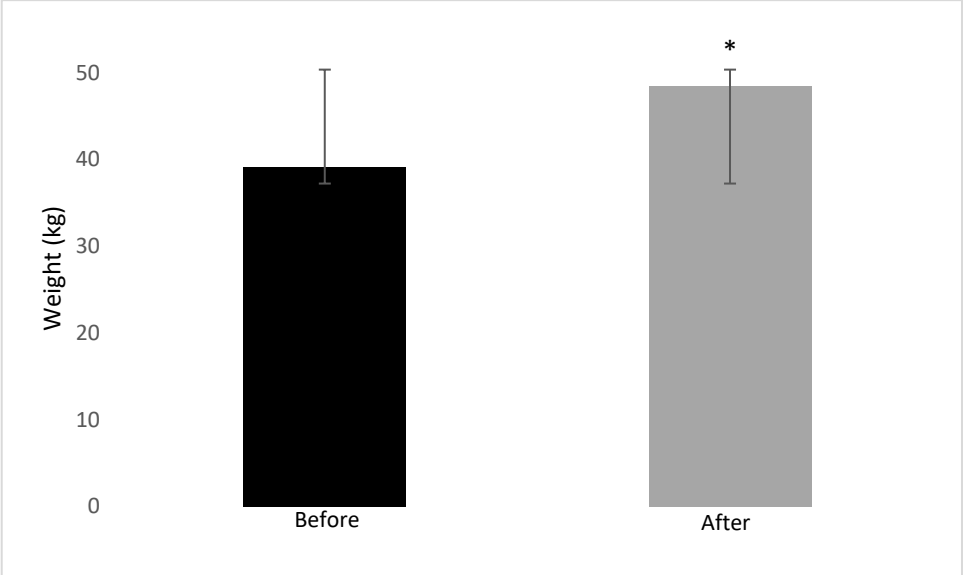


FIGURE 15. The results of 1 repetition maximum in dumbbell stepping lunge before and after the training intervention in TG group; SD, standard deviation. Mean weight in training group. * significant difference between before and after the intervention.

8.1.6 Yo-Yo intermittent recovery test level 1 changes in training group (TG)

Before the intervention (n=15) players participated in Yo-Yo intermittent recovery test level 1. During the test (n=3) players droped out due to nausea. After the training intervention due to injuries and sickness; there were only (n=8) players, who compeleted the YYIR1 (yo-yo intermittent recovery test level 1) and (n=7) of them were qualified for data analyzing. Therefore, (n=12) players compeleted the test before the intervention and (n=7) players after the intervention.

There was an increase in mean distance by 3.83% in YYIR1 after the intervention Figure 16. There was no significant changes ($p>0.05$) in YYIR1. Even though there was no significant changes after the intervention, but the results show that each player had an improvement in distance after training period. Out of seven players, who did compelete the test; only one player (ID3) had a decrese in distance of YYIR1 test.

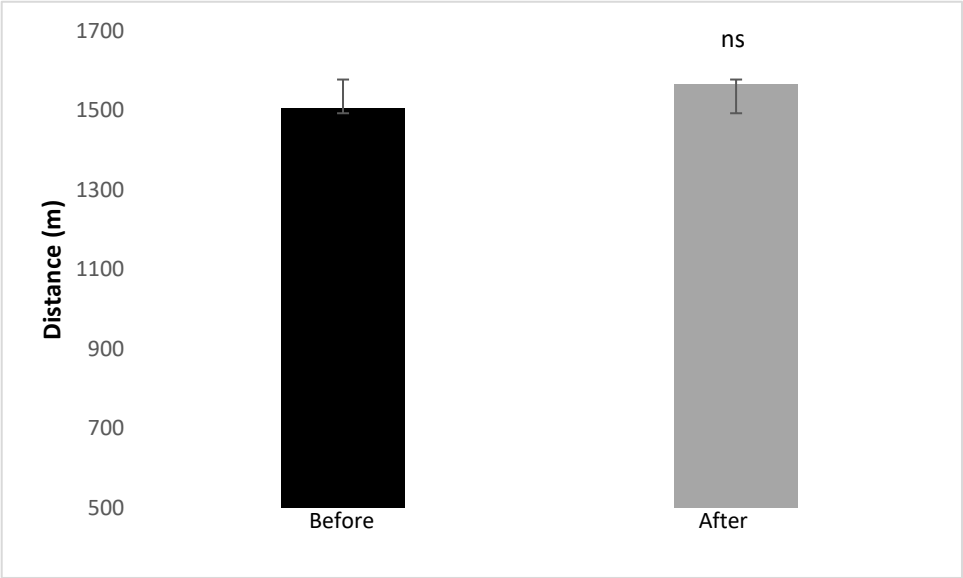


FIGURE 16. The results of yo-yo intermittent recovery test level 1 before and after the training intervention in TG group; SD, standard deviation. Mean distance within training group. ns, not significant; there were no significant differences between before and after the intervention in training group.

8.2 Small-sided game (SSG) in training group (TG)

In training group there were (n=14) players, who completed 4 session of SSG before and after the intervention. During small-sided game total distance, maximal speed and distance in different speed zones were measured by Polar Team Pro. There were only a decrease in mean distance in zone 2; at the same time, there were an increase in maximal speed, total distance and distnace in zone 1, zone 3, zone 4 and zone 5 Table 8.

TABLE 8. presents anthropometrical data and the results of the physical performance tests before and after the intervention including standard deviation and mean for small-sided game. The table also shows the distance (m) in different speed zones, maximal speed and total distance covered during all the small-sided sessions.

	Pre-test			Post-test		
	n	Mean	SD	n	Mean	SD
Age (years)	14	16.3	0.47	14	16.2	0.46
Height (m)	14	178.3	4.89	14	178.6	4.60
Weight (kg)	14	65.5	5.34	14	65.9	4.85
BMI kg/m²	14	20.9	1.92	14	20.3	1.65
Total distance (m)	14	451.20	51.06	14	485.95**	71.44
Maximal speed (km/h)	14	19.13	1.89	14	23.20***	3.12
Zone 1 (3.00-6.99 km/h)	14	153.50	21.37	14	169.71**	25.21
Zone 2 (7.00-10.99 km/h)	14	160.52	30.56	14	141.12	37.97
Zone 3 (11.00-14.99 km/h)	14	91.68	31.55	14	93.27	35.12
Zone 4 (15.00-18.99 km/h)	14	29.91	18.32	14	42.96**	23.18
Zone 5 (19.00- km/h)	14	3.46	6.06	14	29.55***	34.60

SD, standard deviation; BMI, body mass index. There were significant changes found $p<0.01$ in total distance with 7.1%, zone 1 with 9.5%, and zone 4 with 33.4% increase in distance. There were also statistically significant changes in maximal speed with 7.5% differences in sprinting speed and 88.3% increase in distance in zone 5 with $p<0.001$. Due to significant change in zone 2 with a speed of 7.00-10.99 km/h, there was a decrease in distance, which is not beneficial in this case. And there were no significant changes found in zone 3 with $p>0.05$. ** significant changes within training group after the intervention. *** significant changes withing training group before and after training period.

8.3 Results of pre- and post-tests for control group (CON)

In control group there were (n=16) players, who took part in pre-testing protocol. After the intervention period, there were 4 to 6 players out of total (n=16) players in different measurements; who participated into post-testing. Therefore, there was a big difference between the number of the players in pre- and post-testing measurements. The next table shows, how many players took part in each measurement during pre- and post-testing.

After all the data was gathered only 30-m sprint, RSA, CMJ and YYIR1 results were statistically analysed.

TABLE 9 presents anthropometrical data and the results of the control group's physical performance tests before and after the intervention including standard deviation and mean for each test. The normality of the results in pre- and post-tests were tested by Kolmogorov-Smirnov test.

	Pre-test			Post-tes		
	n	Mean	SD	n	Mean	SD
Age (years)	16	16.2	0.47	8	16.2	0.46
Height (m)	16	178.3	4.89	8	178.6	4.60
Weight (kg)	16	65.5	5.34	8	65.9	4.85
BMI kg/m²	16	20.9	1.92	8	20.3	1.65
30m-sprint (s)	16	4.10	0.14	6	4.17	0.13
RSA (s)	16	4.30	0.17	5	4.44	0.19
CMJ (cm)	12	38.60	6.34	4	37.10	4.28
YYIR1 (m)	12	2430	193.08	5	1696	260.15

SD, standard deviation; BMI, body mass index; RSA, repeated sprint ability; CMJ, countermovement jump; YYIR1, yo-yo intermittent recovery test level 1. The results of pre- and post measurements are presented within the CON group as means and standard deviation. Precise analysis has done seperately for each test and are shown in figures in the next chapters.

8.3.1 Changes in 30m-sprint in control group (CON)

The control group lengthen their mean time by 1.6% after the intervention Figure 18. Therefore, there was a significant change ($p<0.05$) between pre- and post-test. Therefore, control group did not improve their mean time in 30-m sprint. It was taken into account that (n=6) players participated in sprinting post-test measurements.

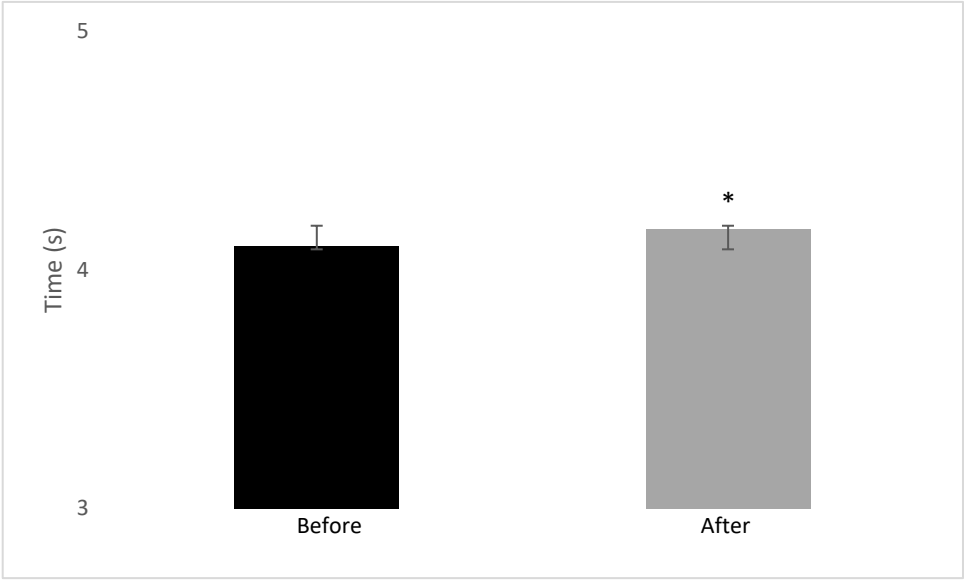


FIGURE 18. The results of 30-m sprint before and after the training intervention in CON group; SD, standard deviation. Mean time within control group. * Significant differences were fround in control group after the intervention.

8.3.2 Repeated sprint ability changes in control group (CON)

The control group lengthen their mean time by 3% in repeated sprint ability (RSA) after the intervention Figure 19. There was no significant changes $p>0.05$ in pre- and post-test in control group. There was a small change after training period, but players did not improve their mean time and their mean time was increased.

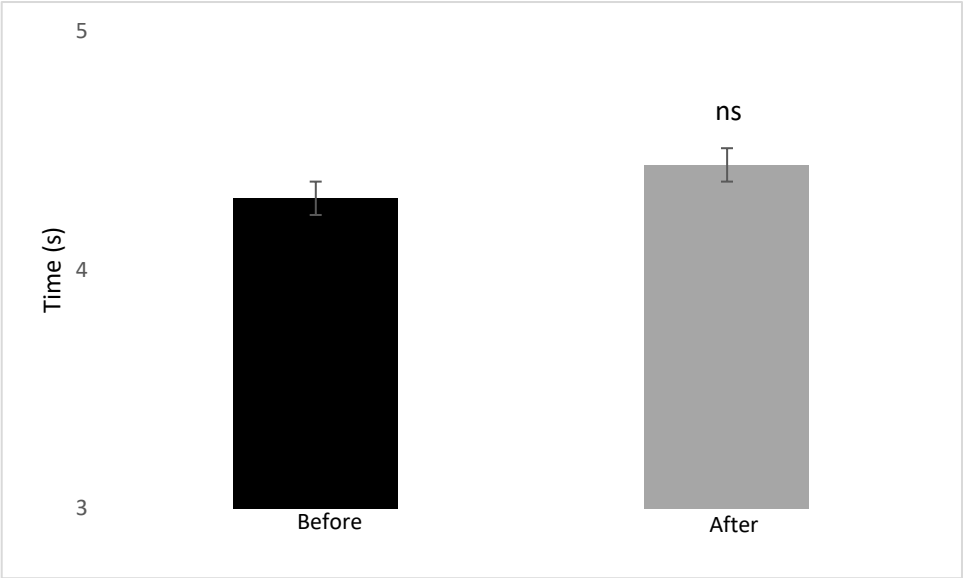


FIGURE 19. The results of repeated sprint ability (RSA) before and after the training intervention in CON group. Mean time within control group. ns, no significant differences between before and after the intervention in control group.

8.3.3 Changes in countermovement jump in control group (CON)

There was a small increase in control group's mean vertical jumping height by 0.5% after the intervention Figure 20. Therefore, there were no significant changes ($p>0.05$) in countermovement jump.

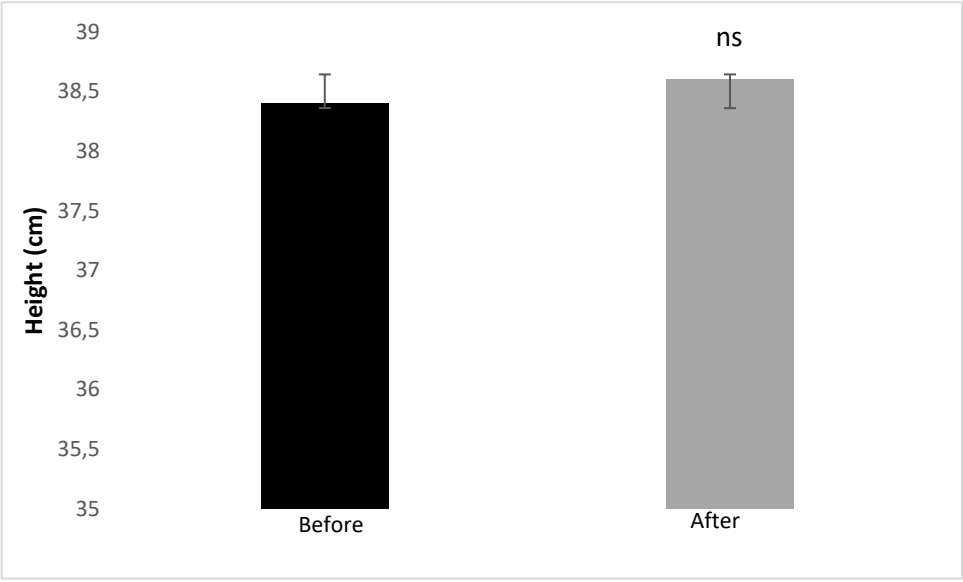


FIGURE 20. The results of countermovement jump (CMJ) before and after training intervention in CON group; SD, standard deviation. Jumping height within control group. ns, no significant changes were found within control group after intervention.

8.3.4 Yo-Yo intermittent recovery test level 1 changes in control group (CON)

There were changes in number of players in pre- and post-testing measurements. There were (n=12) players participating in pre-test measurements and after 8 weeks of intervention; (n=8) players took part in post-testing measurements; and (n=5) of the players were qualified for results analyzing.

There was a decrease in mean distance by 20% in YYIR1 after intervention Figure 21. Therefore, there was significant difference ($p<0.01$) in YYIR1. All 5 players decreased their distance in YYIR1.

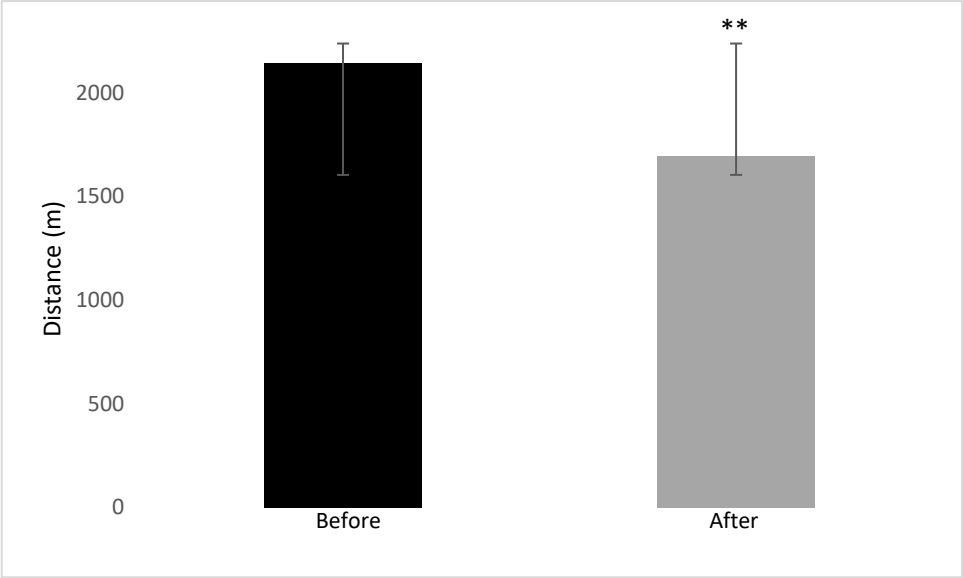


FIGURE 21. The results of yo-yo intermittent recovery test level 1 (YYIR1) before and after training intervention in CON group; SD, standard deviation. Mean distance within control group. * significant changes were found in control group after intervention.

8.4 Comparison between the groups before the intervention

The normality of the test between groups was revealed by Kolmogrov-Smpirnov normality test. Analysis for yo-yo intermittent recovery was exectued with Mann-Whitney test due to differnces in number of players. Therefore, to find the differences in pre-test Independent Samples Test was executed. As the Table 10 shows the mean for each test; control group (CON) performed better in pre-test measurements than training group (TG). Therefore, the physical ability of the players were different on the baseline.

TABLE 10. Pre-test results both in training and control group as means and standard deviations.

	Pre-test CON			Pre-test TG		
	n	Mean	SD	n	Mean	SD
30m-sprint (s)	16	4.10*	0.12	16	4.28	0.21
RSA (s)	16	4.30**	0.14	16	4.54	0.21
CMJ (cm)	12	38.60**	4.15	16	33.21	3.66
YYIR1 (m)	12	2430	324.12	12	1603.33	731.56

RSA, repeated sprint ability; CMJ, countermovement jump; YYIR1, yo-yo intermittent recovery test level 1; CON, control group; TG, training group; SD, standard deviaiton. N, number of participants.

From the start point of the intervention, there was statistically signifcant differences in repeated sprint ability (RSA) by approximately 5% of difference in mean time with $p<0.01$. The difference between groups in countermovement jump (CMJ) was approximately 14% in mean height with $p<0.01$. Also, there was a signficant change $p<0.05$ in 30-m sprint between groups by approximately 4% in mean time.

8.5 Comparison between groups after the intervention

As it was mentioned earlier in subject session about the decrease of subjects in control groups post-test measurements; the Nonparametric test was executed in comparison between the

groups after the intervention. Homogeneity of the varinces was examined by Levene Test. Therefore, to find the differences in post-test Mann-Whitney U test was executed. No significant differences were found $p>0.05$ in all four post-test measurements. The results has shown that the null hypothesis should be retained. Even though, there was no significant changes were found; but training group (TG) had an improvement in repeated sprint ability in comparison between the groups.

In 30-m sprint, countermovement jump (CMJ) and yo-yo intermittent recovery test level 1 (YYIR1) CON group still performed better after the training intervention than TG group. On the other hand after the intervention; CON group had a weaker performance in each post-test measurement. Table 11. shows the mean rank and differnces between the groups in each post-test measurement. At the end of the intervention; regarding to this results both groups were physically closely at the same level. Therefore, there were no significant differences between the groups after the intervention. Figure 22. presents the differences in the level of physical performance of each participant after the training period.

TABLE 11. The comparison between the groups after training period as mean rank.

	Pre-test		Post-test		
	n	Mean rank	n	Mean rank	Sig.
30m-sprint (s)	15	11.20	6	10.50	0.81
RSA (s)	15	10.27	5	11.20	0.76
CMJ (cm)	15	9.83	5	12.50	0.38
YYIR1 (m)	7	5.36	5	8.10	0.19

RSA, repeated sprint ability, CMJ, countermovement jump; YYIR1, yo-yo intermittent recovery test level 1; Sig., significance. ns, no significant changes were found between groups after the training intervention.

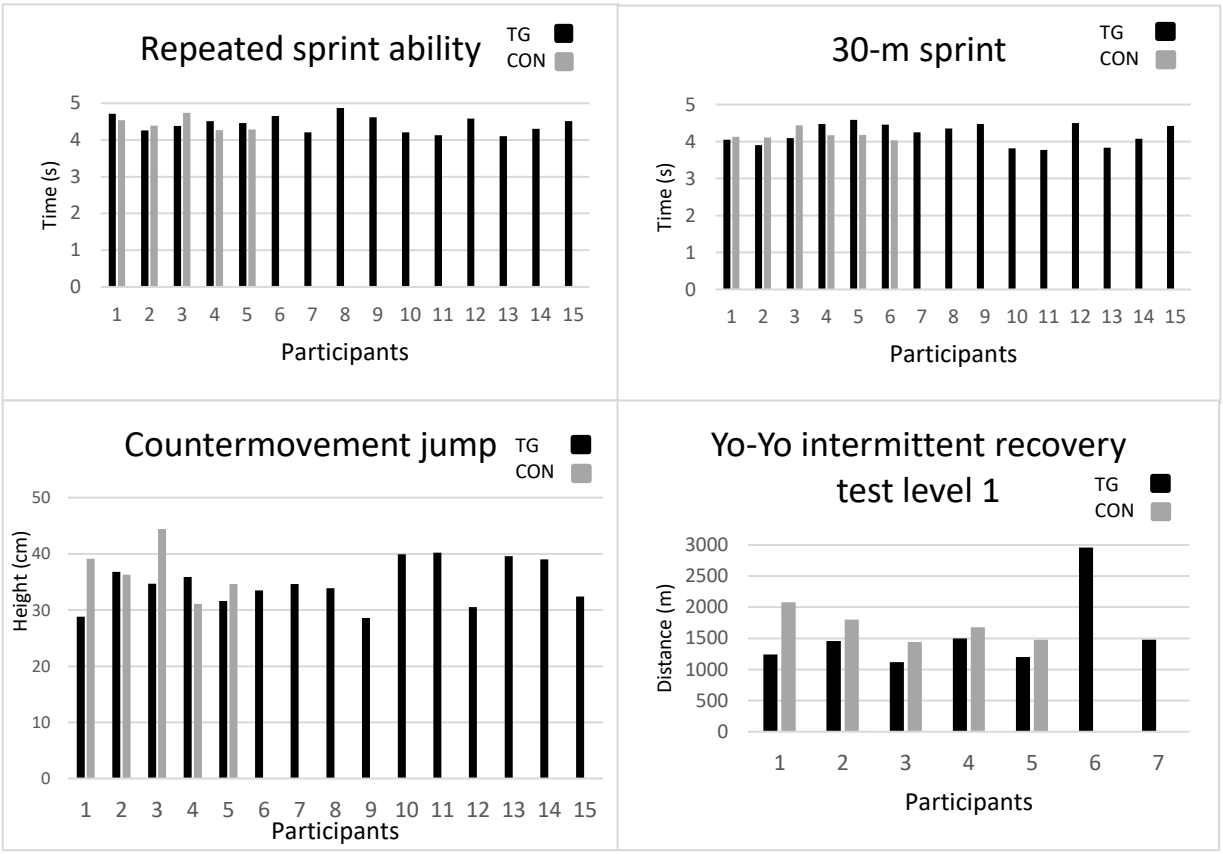


FIGURE 22. Post-test results for all the participants in 30-m sprint, repeated sprint ability (RSA), countermovement jump (CMJ), yo-yo intermittent recovery test level 1 (YYIR1) both in CON and TG group.

9 DISCUSSION

The study was consisted of the combination between plyometric and strength training to find any physical fitness improvement in young football players and game intensity. Football training including strength and plyometric training led to considerable improvements in physical performance of young football athletes. (Helgerud et al., 2001). It was also hypothesized the combination of PT and ST will be beneficial for young football players. TG group improved their mean time in 30-m sprint and RSA, vertical jump height in CMJ, maximum strength in 1RM leg-press and dumbbell stepping lunge throughout the intervention (Table 7). The only test that was not improved in TG group was YYIR1. Even though there were no significant changes after the intervention, (n=6) players out of (n=7) players improved in YYIR1 distance after the training period. Due to these results strength training should be included in the training program for reaching greater maximum strength (Cormie, McGuigan & Newton 2011). To find any changes in the game intensity SSG was performed before and after the intervention. In this research the main findings were mostly linked seperately within the groups.

Due to lack of players after the training period in CON group only 4-6 players did complete 4 tests including 30-m sprint, CMJ, RSA and YYIR1. Those, who completed the tests did not have any improvemetns after the training period. Therefore, there was a decrease in time (s), height (cm) and distance (m) in all four tests that were analysed in this study within the CON group (Table 9). This explains that strength and plyometric training will induce beneficial effects in physical performance of young football players. This supports that combining ST and PT may have a greater positive impact in muscle capacity and physical performance of young football players (Ronaldo et al. 2016).

Due to smaller number of participants after the intervention in CON group, the comparison between the groups is not reliable enough. The baseline of physical performance of CON group before the training period was better than TG group (Figure 10), which took this research to another level and all the aspects regarding training history of both teams had to take account.

Both groups did not have any regular strength and plyometric training. CON group was just started to train strength once a week and TG group had only some physical training using their own body weights. Both teams compete in the first division of Finland, therefore the level of both teams should be the same. Still, CON group was physically in a better shape before starting the intervention.

In this study, there was a big difference in the intervention time. CON group started their intervention at the end of the season with some games left. On the other hand, TG group started their intervention during off-season, just right away after their vacation was over. It is clear, that CON group had a better performance in pre-tests, because they had been active, and all the tests were done almost at the end of the season. TG group had summer vacation and performed the pre-tests at off-season, which can be one of the reasons for the poor pre-test results.

When teams do not have any intensive training and they only compete in some friendly matches, the condition of the players will undergo the normal requirements. The post measurements were during the different phase of the season as well. TG group's post measurements took place before starting pre-season and CON group's post-measurements were done just before off-season. The pre-test measurements in TG group and post-test measurements in CON group both took on off-season proved that young football players are physically fit during off-season of football timeline. After the training intervention CON group did not have improvement in any of the tests. After the training period TG group reached almost the physical level of CON group in post measurements. TG group performed even better in 30-m sprint after the intervention.

The results in this study are in line with hypothesis and regarding to previous studies the combination of strength and plyometric trainings had a positive effect on physical performance of young football players. Marquez et al., 2015 also noted that the combination of strength training and plyometric training had sepecific effects on physical ability of young football players. In the study of Smilios et al., 2005 is noted that most of the imrovements in young football players are mostly correlated with strength training. In a recent study Ramirez-campillo et al., 2018 found that, if athletes train only plyometric, they will only improve plyometric aspects of physical performance requirments; and, if strength training is included in physical

training of young football players then only strength aspects of physical fitness will be improved. Therefore, we can hypothesize that the combination of ST and PT might have a beneficial increase in physical fitness comparing with ST and PT alone (Ronaldo et al. 2016).

Actions such as jumping and sprinting with high endurance ability are the most important factors that lead to success in a football game (Arnason et al., 2014). To get a great endurance ability and reach the optimum performance in football players requires controlling of their training load. As it was mentioned earlier, an effective way to monitor physiological aspects of the players is to take blood lactate during training or just following heart rate. What is important in this case, is to get important data from the physical fitness level of the players. Many coaches and scientists have used different small-sided games to monitor the improvement of their athletes (Helgerud et al. 2007).

High-intensity training induced player's endurance performance and, in many studies coaches used different ways to get the most beneficial information out of their players physical performance (Impellizzeri et al. 2006, Radziminski et al. 2013). However, in this research in the small-sided game, distance covered by each player, maximum speed and distance in different speed zones have taken account as an important data that was analyzed.

In this present research only TG group completed four sessions of SSG in pre- and post-test measurements. The results showed that TG group had a significant improvement in most of the speed zones and maximal speed and total distance covered during all sessions. The improvement in total distance was by 7.1%, zone 1 speed (3.00-6.99 km/h) increased in distance by 9.5%, and zone 4 speed (15.99-18.99) increased in distance by 33.4%. Also, a 7.5% improvement in maximal speed and 88.3% increase in zone 5 speed (19.00- km/h) distance was found after the training period. There was not any improvement in distance in zone 2 speed (7.00-10.99 km/h) and zone 3 speed (11.00-14.99 km/h). Even though SSG was a success in this study with TG group mental fatigue, which is a physiological factor that should be taken in account deeply when dealing with SSG (Boksem, Meijman, Lorist 2005; Lorist, Boksem , Ridderinkhof 2005).

When analysing distance in SSG, it is important to remember that mental fatigue may influence how much an athlete could cover during a match and at the same time physical quality of a player may decrease (Carling & Dupont 2011, Bradley et al. 2011).

In this study SSG was used to express the physical aspects of a real game to see if combination of strength and plyometric training could affect the intensity of the match play. Therefore, SSG is a good protocol for football players to test the physical and technical level of their ability because it accurately reflects a real game (Hill-Haas et al. 2011; Dellal et al. 2011; Casamichana & Castellano 2010).

This research showed that strength and plyometric together may have an influence on physical performance of young football players. The training group was not physically fit at the start of the intervention and they performed very poorly in pre-test measurements, even though they play in the second-high division in Finland youth championship. There was an important finding that TG group had a significant improvement in physical performance aspects of SSG. But what is important these days in a football match? In the study of Bordonau and Villanueva (2014) is noted that elite players may be enough physically fit, but they are not necessarily at their best. In the recent years, there has been a lot of discussion about football is going to be developed to be more tactical and training with ball is getting more attention in a football society (Bordonau & Villanueva 2014, Lacome et al. 2018). We must remember that there are many studies that have already proved that football players need strength, endurance and speed to be a complete athlete that can be successful in a football game (Impellizzeri & Marcora 2006; Lacome et al. 2017).

To plan a great SSG drill, there are factors such as field size, number of players and rules should be carefully designed to get the best out of the drill; it depends on what kinds of goals each coach has. Many researchers have used different types of SSG (Table 2) in their studies and after a lot of searching and findings it was decided to go with 5 vs. 5, recovery of 2 minutes passive rest and a field size of 30x40 (width x length) with no rule in SSG in this research. There was no rule added, because each session lasted 4 minutes and to reflects SSG into the real game it was needed that intensity of the SSG is high all the time. Therefore, it was the aim to make sure that each player could reach the maximum intensity during SSG and get a reliable result in SSG measurements, thus monitoring and analyzing data gives valuable information.

Football training must include strength, speed, and endurance to induce the improvements in physical performance of young football players.

9.1 Limitations and strengths of the study

This study started with lots of challenges that usually comes along with team sports. TG group was changed during this intervention three times, therefore the intervention time was set at different times of the season. This limitation set a different layout in the results, because the pre-test measurements were totally apart from each other between CON and TG group. In this study, it was clear finding that during off-season young football players are not physically in a great shape, which was found both in CON and TG group. The more season is getting closer to the end, young football players decreases the level of their physical ability.

One of the major limitations in this study was the number of the players after training period in CON group, which did not allow to analyze all the results by parametric test. Also, there were differences in players during pre- and post-measurements. Most of the players, who completed pre-tests did not participate in post-testing measurements. Therefore, most of the results regarding CON group were uncompleted. In association with the results all the comparison between group is not unique and the reliability of this study suffers.

One limitation regarding one repetition maximum was to get the accurate results. Players did not have any experience in strength training especially in one repetition maximum testing. Nevertheless, players were carefully supervised, and all the instructions were clearly given to get the best accurate results as possible.

The strength of this study was that TG group's players and the staff of the team was fully involved and their determination was appreciative. All the players participated almost in every training session and only in three sessions the team was no assembled. When a player was absent and could not participate in training session, it was instructed to perform the exercise on his own. Other than that, the facility and all the equipment were used in this study were high level equipment. All the sessions were supervised carefully, and players were completely active in every session. The set-ups in pre- and post-test measurements were set the same.

9.2 Conclusion

It has been proven that players must train to reach a high level of fitness that can lead to success in football (Svensson & Drust 2005). To be a successful athlete in football society aerobic and anaerobic power are main factors to maintain a good level fitness during a football match (Bangsbo, Norregaard & Thorso 1991; Cometti et al. 2001; Korzamanidis et al. 2005; Stolen et al. 2005; Wisloff, Helgerud & Hoff 1998). There are many different training methods that can reach the required level of fitness that a football player must own. One of the most used protocol is strength and plyometric training (Lamas et al. 2012; Markovic & Mikulic 2010).

Combination of strength and plyometric training together will have a beneficial impact on physical ability of young football players. Young football players can improve their physical performance such as speed, maximal strength, and endurance by training twice a week. The training should consist of regular football training including strength and plyometric training together and it must be scheduled weekly in the program of young football players. This is a sufficient way to strengthen the qualities that requires for success in a football athlete. Without ST and PT training the improvement in football players is not at the best and players could not be physically fit, and improvement will not be progressive enough.

The finding of the present study shows that the season time plays an important role in development of physical ability of young players. Young football players have a poor physical fitness during off-season phase of their timetable. During pre-season players train hard to gain their lost physical abilities, which do not take a long period of time. In TG group 8 weeks of training program including PT and ST training twice a week improved their sprint, endurance, and maximal strength. There was also a correlation between game intensity and combination of PT and ST training. When ST and PT training was combined and was included in young football players regular weekly program, they also increased their physical ability during SSG, which was made to reflect the actual football game. The training intervention was successful in TG group and there was a positive effect on the intensity of the game. Furthermore, combination of ST and PT training twice a week has beneficial adaptations on physical performance of young football players.

9.3 Practical recommendations

There is a saying that says ”Well planned is half done”. Therefore, it is really important to plan the study carefully and think about any possible limiation and challenges that researcher might face during the study. When training with team sports; finding a team that can commit on the research and are motivated to participate in the study is really important. In researches, where sports teams are needed, it is important to remeber; if it is allowed, make the training program for off-season. During the season most of the team sports are not willing to participate in any study, because the season is on and they want to concentrate more on the season rather taking part in a study especially for CON group. The results of this study can be used in young football players for the future researches and it can be beneficial in desgining training programs. Furtheremore, more studies with different combinatios between training types can use this study to get the information for this type of training that was desgined for this study.

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