

**EFFECT OF PLYOMETRIC TRAINING ON SPEED, STRENGTH AND  
POWER OF MALE FOOTBALL PLAYERS IN CASE OF GOHATSION  
FOOTBALL TEAM PLAYERS, IN NORTH SHOWA ZONE, OROMIA  
REGIONAL STATE, ETHIOPIA**

**MEd. THESIS**

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**Effect of Plyometric Training on Speed, Strength and Power of Male Football  
Players in Case of Gohatsion Football Team Players, in North Showa Zone,  
Oromia Regional State, Ethiopia**

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## **DEDICATION**

This thesis is dedicated to my family and my friend Melese Ebabu for their constant physical, emotional, and financial support throughout my educational career and life.

## STATEMENT OF THE AUTHOR

First, I declare that this thesis is my genuine work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Ed. Degree at Haramaya University and is deposited at the university library to be made available to browsers under rule of library. I solemnly declare that this thesis is not submitted to other institutions anywhere for the award of any academy degree diploma or certificate.

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## **BIOGRAPHICAL SKETCH**

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## **ABBREVIATIONS AND ACRONIUMS**

ACSM	American College of Sport Medicine
CG	Control Group
DTT	During Training Test
EG	Experimental Group
FIFA	Federation International Football Association
MoE	Ministry of Education
NSCA	National Strength and Conditioning Association
PoT	Post Training Test
PT	Pre Training Test
SD	Standard Deviation
SLJT	Standing long jump test
SPSS	Statistical Package for Social Science
SQT	Squat Test
ST1	Speed Test 1 (10 m sprinting test)
ST2	Speed Test 2 (30 m acceleration test)
VJT	Vertical Jump Test
WST	Wall Sit Test

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ETHIOPIA**

**ABSTRACT**

*The purpose of this study is to find out the effect of plyometric training on speed, strength and power of Gohatsion male football team players. To achieve the purpose of the study thirty football players ( $X \pm SD = 21.10 \pm 1.689$  years of age) were volunteered to participate in this study. All of the subjects played on Gohatsion football team and none were being trained by means of a plyometric training program. The subjects were grouped randomly in to EG (N= 15) and CG (N = 15). All of the experimental group members had successfully passed a physical exam and completed a medical history questionnaire in which they were screened for any possible injury or illness. The group received all the necessary information about the study's procedures in oral and written form. Then the plyometric training was given for experimental group for two days per a week in addition to their regular football related activities for 12 weeks. Both groups underwent measurements of their 10m and 30m speed tests, squat and wall - sit strength tests and vertical jump and standing long jump power tests before, during and after the training program and the scores were recorded. The collected data were analyzed by paired sample T- test using SPSS version 21. In EG the results were found for 10m sprint test ( $p = 0.00$ ), 30m acceleration test ( $p = 0.02$ ) whereas in a CG the results were found for 10m and 30m ( $p = 0.05$ ) and ( $p = 0.046$ ) respectively. Both groups showing improvements in VJ and SLJ power tests, but the improvement in EG (VJ)  $P = 0.00$ , (SLJ)  $P = 0.001$ ) greater than CG (VJ)  $P = 0.046$ , (SLJ)  $P = 0.047$ ). On the other hand, the EG improved in their squat test result (SQT)  $P = 0.00$ ) and (WST)  $P = 0.04$ ) significantly more than players in the CG ((SQT)  $P = 0.040$  and (WST)  $P = 0.077$ ). Consequently, it was observed that 12-week plyometric training in addition to football trainings contributed to the speed, strength and power development among footballers; therefore, the present study recommended that plyometric training with a proper intensity, frequency, rest and progression needs to be incorporated with regular football training program to improve the players' speed, strength and power performance.*

**Key words:** Plyometric Training, Football, Speed, Strength, Power, Experimental Group, Control Group.

# 1. INTRODUCTION

## 1.1 Background of the Study

Among a various sports in the world, football happens to be one of the most popular. It enjoys a fan base that seems to go beyond various divisions like race, language, age, and gender. As a result, it can truly be called as the universal sport. As it is explained by Reilly *et al.*, (2003) football is the only sport which attracts the entire world population.

As the part of this big world in our country football is the most popular sport. Although not one of the leading football nations in Africa, Ethiopia has produced some outstanding teams at both club and international level as well as some talented individual players. (Mooda, 2013)

The rapidly increasing popularity of football has also need a demand of excellent performance. (Maylan and Malatesta, 2009) Football practitioners require many attributes to become successful Players. These include cardiovascular fitness, muscle strength, Endurance, flexibility, agility, coordination, skill and tactical knowledge. U.S. Soccer Coaching Manual (2010) acknowledged that; soccer is a physically demanding sport characterized by explosive activities such as tackling, turning and jumping in addition to high intensity running and sprints over relatively short distances. The attributes of football could be developed through systematic methods of preparation and applying the scientific method of training.

To improve explosive movements' coaches can use different types of training methods; among those trainings plyometric training is the one which include different physical exercises that improve fitness components especially speed, strength and power for football players. (Markovic, 2007)

Plyometric training is a type of neuromuscular training leading to increased explosive power to use maximum power in minimum time.(Brophy, *et al.*,2004) Plyometric training causes some changes in neuromuscular system and improves muscle's strength to

response rapidly and strongly during competitions. (Zearei, 2013) Plyometrics, also known as "jump training" or "plyos", are exercises in which muscles exert maximum force in short intervals of time, with the goal of increasing power (speed-strength). This training focuses on learning to move from a muscle extension to a contraction in a rapid or "explosive" manner, such as in specialized repeated jumping. (Chu, 1998) Plyometric training (PT) is a technique used to increase strength and explosiveness. It consists of physical exercises in which muscles exert maximum force at short intervals to increase dynamic performances. (Schulet, *et al*; 2005) Plyometric training has been shown to improve performance in 10-30 meter straight-line speed in young male athletes (Thomas, *et al*; 2009)

Speed is very crucial to the game of football. An effective speed training program would be based on the realistic aspects of the game. A football player needs to practice gaining speed with the ball this is what good soccer performance involves. (Haugen, 2014)

"Strength is a quality that underpins everything," says Jordan Webb, strength and conditioning coach for Major League Soccer's Chicago Fire. "It underpins endurance, agility, speed- it underpins power production, everything you need to be an athlete. The body strength is probably the quality that is most important for any soccer player, no matter the position (www.menfitness.com, 2017)

In the majority of sport movements, like sprinting, jumping or throwing a ball, the time available to produce force is limited. For example, when kicking a football, the foot contacts the ball for a short period of time as ~50ms (Watkins, 2007). The short time available for one to produce force justifies the importance of power training.

## 1.2 Statement of the Problem

Today's sports require athletes to be in condition physically. Especially speed, strength and explosive power are qualifying components of physical fitness and desirable athletic performance and play a key role in most sports especially in football. But most trainers believe that running for distance is the only way to condition an athlete (including goalkeepers).

Our country coaching style also shows the same thing, the training program and the preparation of different teams are quite inappropriate and incomplete. (Teshome, 2012) Coaches concentrate on ball work, team drills and distance running during practices and their trainings do not give emphasis for plyometric training which is important for the development of explosive moments in football especially on speed, strength, and power.

Plyometric drills are recommended in soccer training because of the fast force production and explosive actions with change of directions, Although plyometric training has been shown to increase performance variables in sports, and little scientific information is available to determine if plyometric training actually enhances skill performance in soccer.

Because of the above point of views and due to lack of enough investigation related to plyometric training, and its effect on explosive fitness components, the researcher implemented a plyometric training programs on football training and assessed its effect on speed, strength and power of football players, specifically on Gohatsion football team players.

To examine the effect of plyometric training on speed, strength and power of football players the researcher tried to testified the following hypotheses:

H<sub>A1</sub>: Plyometric training has an effect on speed of football players.

H<sub>O</sub>: There is no effect on speed of football players after plyometric training.

H<sub>A2</sub>: Plyometric training improves the strength of football players.

H<sub>0</sub>: There is no improvement on strength of football players after plyometric training.

H<sub>A3</sub>: There is a significance increase on power of football players after plyometric training program applied.

H<sub>0</sub>: Plyometric training has no significant effect on power of football players.

### **1.3 Scope of the Study**

Investigating a research on all soccer and fitness related components are challenging and unmanageable because of this the researcher tried to analyzed the effect of plyometric training on speed, strength and power of football players. This research investigated on Gohatsion male football team players, who represent the town in different competitions and the town is the researcher's working place.

Because of the above reasons the research focused and delimited on the effect of plyometric training on speed, strength and power of Gohatsion town football team players only.

### **1.4 Significance of the Study**

The researcher investigated this study because the researcher understood that there were a few studies on effect of plyometric training on speed, strength and power of football players especially in our country; therefore, the study may contribute a lot as review for other investigators in this area. Further the contribution of this study would be for players, coaches and clubs who are interested to implement plyometric training on their soccer fitness and to enhance their players' performance and it may create awareness for coaches about plyometric training.

### **1.5 Objectives of the Study**

#### **1.5.1 General objective**

To assess the effect of plyometric training on speed, strength and power of football players.

### **1.5.2 Specific objectives**

- To analyze the effect of plyometric training on strength of football players.
- To examine the effect of plyometric training on power of football players.
- To evaluate the effect of plyometric training on speed of football players.

## **2. REVIEW OF RELATED LITRATURE**

This section discussed about plyometric training and its characteristics, the effect of plyometric training on speed, strength and power. Introduction to football, fitness in football and fitness training in football, effect of plyometric training in soccer and lastly guide lines for plyometric training included in section.

### **2.1 Introduction to Plyometric Training**

When we try to discuss about plyometrics and its development we should give a great credit for one person called Yuri Verkhoshansky. According to Natalia (2012) Yuri Verkhoshansky was the coach of Russian track and field team and later a scientist of different training types.

At the end of the 1950s, Yuri Verkhoshanski who was Russian coach in track and field have realized the importance of maximizing power in jumping, throwing, and running by linking the strength and speed of movement. Yuri Verkhoshanski contributed the idea of plyometric training and experimented with "depth jumping" and the "shock" method. (Natalia, 2012)

Plyometric training has emerged in two forms that have evolved since 1980s. An original version defined as the 'shock method' was created by the Russian scientist Yuri Verkhoshansky, the second version is widely used in the United States. (Ying and Zhang, 2016)

According to Ying and Zhang (2016) in 'depth' and 'shock' experiments the athlete is required to drop down from a height and experience a 'shock' upon landing. This in turn led to a forced eccentric contraction, which was then immediately switched to a concentric contraction as the athlete jumped upward. The landing and take-off were executed in an extremely short period of time (0.1-0.2 sec). The shock method is the most effective method used by athletes to improve their speed, quickness, and power after development of a strong strength base.

The second version of plyometrics widely used in the United States, relates to doing any form of jump regardless of execution time. This involves jumps that are lower in intensity and execution, while the time required for transitioning from eccentric to the concentric contraction is much greater. The relationship produces the "explosive-reactive power" known as "plyometrics." (Natalia, 2012)

According to [www.bodybuilding.com](http://www.bodybuilding.com), (2013) Plyometric (from the Greek plio = more, and metric = to measure) is a combination of an involuntary reflex (myotatic "stretch-reflex"), which is then followed by a fast voluntary muscular contraction. This is the basic idea behind plyos (Cited in Mesfin, 2014). Related to this idea Chu(1992) explained plyometrics as follows "plyometrics also known as 'jump training' or 'plyos', are exercises in which muscles exert maximum force in short intervals of time with the goal of increasing power (speed and strength). This training focuses on learning to move from a muscle extension to a contraction in a rapid or 'explosive' manner, such as in specialized repeated jumping."

Plyometric exercises are defined as the exercises and drills that employ the combination of speed and strength to increase relative explosive movements (Yakup, 2014)

Plyometric training (PT) is popular among individuals involved in dynamic sports, and plyometric exercises such as jumping, hopping, skipping and bounding are executed with a goal to increase dynamic muscular performance (Impellizzeri *et al.*, 2008)

Plyometric training (PT) consists of dynamic and rapid stretching of muscles (eccentric action) immediately followed by a concentric or shortening action of the same muscles and connective tissues. This training focuses on learning to move from a muscle extension to a contraction in a rapid or 'explosive' manner, such as in specialized repeated jumping. PT involves hops and jumps used to capitalize on the stretch-shortening cycle of the muscle. (Hakkinen, *et al.*, 1985)

### 2.1.1 Characteristics of plyometric training

Plyometrics is considered a high-intensity conditioning program. It consists of explosive exercises that require muscles to adapt rapidly from eccentric to concentric contractions (Kevin,*et al*,2009)

Plyometrics training is almost exclusively applied to extensor Muscle of the legs, and consists of a vigorous lengthening of the active extensor muscles (eccentric contraction) immediately followed by a maximal concentric contraction. It consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue (Baechle and Earle, 2000).

Plyometric training involves practicing plyometric movements to toughen tissues and train nerve cells to stimulate a specific pattern of muscle contraction so the muscle generates as strong a contraction as possible in the shortest amount of time. (Marcovic, 2007) A plyometric contraction involves first a rapid eccentric movement followed by a short amortization phase then an explosive concentric movement, which enables the synergistic muscles to engage the myotatic stretch reflex during the stretch shortening cycle. ([www.soccercoachinginternational.com](http://www.soccercoachinginternational.com), 2013)

All types of plyometric movement occur during three consecutive phases: the first phase consists primarily of stretching or eccentric muscle activity, which is marked by a high concentration of elastic muscle energy, the second phase is known as the amortization phase and begins with the end of the first phase and ends with the beginning of the concentric muscle action, and finally the third phase, the final phase of muscle contraction, which is primarily manifested as the jump, hit or throw.(Fukunaga,*et al*.,2002) These phases in plyometric movement are known by one name: the stretch-shorten cycle of muscle work. This cycle is characterized by two patterns. The first is the mechanical pattern of movement which includes muscles, joints, and tendons which are elongated in the stretch cycle only to decrease in length during the shorten phase, in order to revert back to their original state after the action. (Rassier and Herzog, 2005)

The jump, hit or throw in this case are the components of the muscle-joint-tendon elastic component. (Rassier and Herzog, 2005)

The second pattern of plyometric movement is characterized by a neuro-muscular pattern and the role and function of the stretch reflex, the so-called “myotatic reflex” (Pašić, 1993, as cited in Nikola,*et al.*,2012), which primarily has a protective function to help prevent injury. This action of deceleration to acceleration is known as the stretch-shortening cycle (Leubbers, *et al.*, 2003)

### **2.1.1.1 The eccentric phase**

The first stage of a plyometric movement can be classified as the eccentric phase, but it has also been called the deceleration, loading, yielding, countermovement, or cocking phase. This phase increases muscle spindle activity by pre-stretching the muscle prior to activation. Potential energy is stored in the elastic components of the muscle during this loading phase. A slower eccentric phase prevents taking optimum advantage of the myotatic stretch reflex (Kubo *et al.*, 2007).

### **2.1.1.2 The amortization phase**

This phase involves dynamic stabilization and the time between the end of the eccentric-contraction (the loading or deceleration phase) and the initiation of the concentric contraction (the unloading or force production phase) (Wilk *et al.*, 1993 cited in Mesfin 2014).The amortization phase, sometimes referred to as the transition phase, is also referred to as the electromechanical delay between the eccentric and concentric contraction during which the muscle must switch from overcoming force to imparting force in the intended direction. A prolonged amortization phase results in less-than-optimum neuromuscular efficiency from a loss of elastic potential energy (Chimera *et al.*, 2004). A rapid switch from an eccentric contraction to a concentric contraction leads to a more powerful response (Wilk *et al.*, 1993 cited in Mesfin , 2014).

### **2.1.1.3 The concentric phase**

The concentric phase (or unloading phase) occurs immediately after the amortization phase and involves a concentric contraction (Ishikawa *et al.*, 2005), resulting in enhanced muscular performance following the eccentric phase of muscle contraction.

This occurs secondary to enhance summation and reutilization of elastic potential energy, muscle potentiating, and contribution of the myotatic stretch reflex (Fukunaga *et al.*, 2002).

This active muscle switching from a rapid eccentric muscle action to a rapid concentric muscle action or from a rapid deceleration to a rapid acceleration helps the players or the athletes to do different movements. (Rassier and Herzog, 2005). According to Leubbers, *et al* (2003) This stretch- shortening movements, in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervations of muscle and surrounding tissues to jump higher, run faster, throw farther, or hit harder, depending on the desired training goal.

## **2.2 Effect of Plyometric Training**

All types of plyometric movement occur during three consecutive phases: the first phase consists primarily of stretching or eccentric muscle activity, which is marked by a high concentration of elastic muscle energy, the second phase is known as the amortization phase and begins with the end of the first phase, and ends with the beginning of the concentric muscle action, and finally the third phase, the final phase of muscle contraction, which is primarily manifested as the jump, hit or throw. (Chu and Myer, 2013). These phases in plyometric movement are known by one name: the stretch-shorten cycle of muscle work. This cycle is characterized by two patterns. The first is the mechanical pattern of movement which includes muscles, joints, and tendons which are elongated in the stretch cycle only to decrease in length during the shorten phase, in order to revert back to their original state after the action. (Chu and Myer, 2013)

The jump, hit or throw in this case are the components of the muscle-joint-tendon elastic component. The second pattern of plyometric movement is characterized by a neuromuscular pattern and the role and function of the stretch reflex, the so-called “myotatic reflex” (Pasic, 1993, 179), which primarily has a protective function to help prevent injury. The mechanical component enables the elastic characteristics of movement and the neuro-physical component (the stretch reflex) to increase the level of generated strength during the plyometric exercise. (Cory, *et al.*, 2006)

The stretch- shortening cycle of plyometric training has an effect on the body mechanics of the athletes. Corey, *et al.*, (2006) stated that The muscles react to the sudden stretch by sending a signal to the central nervous system to resist the sudden stretch. In other words, the muscle is going to rebound rapidly from the sudden stretch. Considering this information plyometric training has the potential to develop quicker reaction times that lead to an increase in an athlete’s speed and power (Marcovic, *et al.*, 2007). This type of training can improve performance in explosive sports that rely on moving speed and power such as hockey, basketball, track and field, football, and volleyball (Bullard, 2002).

Plyometric training is an effective mode of training as it enhances motor learning and neuromuscular efficiency promoting the excitability, sensitivity, and reactivity of the neuromuscular system to increase the rate of force production (power), motor-unit recruitment, firing frequency (rate coding), and synchronization. Muscles produce the necessary force to change the direction of an object’s center of mass. (Voight and Brady, 1992) All movement patterns that occur during functional activities involve a series of repetitive stretch-shortening cycles. The neuromuscular system must react quickly and efficiently following an eccentric muscle action to produce a concentric contraction and impart the necessary force (or acceleration) in the appropriate direction. Therefore, specific functional exercises that emphasize a rapid change in direction must be utilized to prepare each athlete for the functional demands of a specific activity. (Witzke and Snow, 2000)

Plyometric training may promote better neuromuscular control of the contracting agonists and synergists, thus enabling the central nervous system to become more reflexive. These neural adaptations lead to enhanced neuromuscular efficiency even in the absence of morphological adaptations, such as muscle hypertrophy. Exploiting the stretch reflex and enhancing the ability of the nervous system to react with maximum speed to the lengthening muscle optimizes the force produced by the concentric contraction. (Hewett, *et al.*, 2005)

Plyometric training also provides the opportunity to train specific movement patterns in a bio-mechanically correct manner at a more functionally appropriate speed. This provides functional strengthening of the muscle, tendon, and ligaments specific to the demands of everyday activities and sports. The ultimate goal of plyometric training is to improve the reaction time of the muscle action spectrum (eccentric-deceleration, isometric stabilization, and concentric acceleration). (Eskandar, *et al.*, 2014)

Bullard, *et al.*,(2002) described plyometric exercises as explosive callisthenic-like exercises which involve the conditioning of the neuromuscular system to permit faster and more powerful changes of direction such as moving from up and down in jumping or switching leg positions as in running. The stored elastic energy within the muscle is used to produce more force than can be provided by a concentric action alone.

The fundamental reason to train with plyometrics is to reduce the ground contact time that an athlete spends when running or jumping. This time is reduced as the athlete matures, gets stronger, and practices the skills of their game. To further enhance resistance training the athlete spends considerable time practicing the specific movement skills they wish to improve; namely, running and jumping. These two movement patterns are often thought of as genetic endowments and affected little by outside influences such as training programs. (Cometti,*et al.*, 2005)

Plyometric exercises have been used successfully over the years to elicit training responses from athletes. According to Chu (1998) plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness. In addition to this idea Chu (2004) described that research has shown virtually all athletes can positively influence their performance outcomes by using plyometric training on a regular basis.

### **2.2.1 Effect of plyometric training on speed**

Short sprints are very common in many team sports including soccer, rugby, basketball, hockey, etc. High intensity activities are defined as those that are carried out from 5.3 to 6.3  $\text{m}\cdot\text{s}^{-1}$  and, specifically, sprinting activities are those performed at over 7  $\text{m}\cdot\text{s}^{-1}$  (Amelia, *et al.*, 2014)

Plyometric drills are recommended in soccer training because of the fast force production and explosive actions with change of directions, and their needs for the ability to start and stop quickly (Little and Williams, 2005). Plyometric training has been shown to improve performance in 10-30 meter straight line speed in young male athletes. (Impellizzeri, 2008)

Plyometric exercises evoke the elastic properties of the muscle fibers and connective tissue in a way that allows the muscle to store energy during the deceleration phase and release that energy during the acceleration period. (Mathisen, 2014)

Plyometrics are used to increase the speed or force of muscular contractions, often with goals of increasing the height of a jump or speed of a punch or throw. (www.soccercoachinginternational.com, 2013)

The energy stored, followed quickly by a concentric contraction, produces greater force than a concentric contraction alone. Therefore training muscles to adapt from an eccentric to a concentric contraction should enable them to increase the speed and force with which they perform. (Reilly, 2007)

### **2.2.2 Effect of plyometric training on strength**

Researchers have shown that plyometric training, when used with a periodized strength-training program, can contribute to improvements in vertical jump performance, acceleration, leg strength, muscular power, increased joint awareness and overall proprioception (Bullard, *et al.*, 2002).

The plyometric method is used as an effective method for the development of explosive strength. It is dominated by the plyometric movement of the athlete during exercise. Marullo (1999) stated that “Plyometrics is speed-strength training, a combination of strength and speed” Plyometrics refers to exercise characterized by powerful muscular contraction in response to the eccentric-concentric activity which loads (stretches) the elastic and contractile components of muscles.

The combination of both eccentric and concentric training is thought to enhance muscular strength and power to a greater degree than concentric alone (Kevin, *et al.*, 2009)

Plyometric training (PT) consists of dynamic and rapid stretching of muscles (eccentric action) immediately followed by a concentric of shortening action of the same muscles and connective tissues. This training focuses on learning to move from a muscle extension to a contraction in a rapid or ‘explosive’ manner, such as in specialized repeated jumping. Exercises are of high-intensity, explosive muscular contractions combining strength and speed for acquisitions of benefits in power. PT involves hops and jumps used to capitalize on the stretch-shortening cycle of the muscle (Chu and Myer, 2013).

Effects of Plyometric training on lower extremity strength have been characterized in various populations, and in a recent Meta analysis a conclusion was made that PT Improved one repetition maximum measured in isometric or slow velocity contractions in leg muscles (Vaczi, *et al.*, 2013)

### 2.2.3 The effect of plyometric training on power

Today the soccer is becoming more dynamic and the power has become an important aspect of condition for soccer players of all ages. Exercises are of high-intensity, explosive muscular contractions combining strength and speed for acquisitions of benefits in power. (Manolopoulos, *et al.*, 2004)

Plyometrics is necessary for the development of the neuromuscular reflexes, stretch reflexes, explosive power, and ballistic movements (Chu, 1998). In additions to this idea Leubbers *et al.*, (2003) stated that plyometrics is a type of training methodology that can increase power output and explosiveness.

Reilly (2007) discussed about the contribution of Plyometric exercises on power of the players as follows “plyometric exercises can be used during the late preseason period or within the season n order to maintain or develop further muscular power”. Many researchers agreed about the effect of plyometric training on the power of athletes they stated that plyometrics is considered a high-intensity conditioning program. It consists of explosive exercises that require muscles to adapt rapidly from eccentric to concentric contractions. Muscles, when stretched during an eccentric contraction, store elastic energy for a very brief period of time. (Chu, 1998; Ronnsted ,*et al.*,2008)

Plyometric exercises use explosive movements to develop muscular power, the ability to generate a large amount of force quickly. Plyometric training acts on both the muscular tendnous and neurological levels to increase an athlete's power output without necessarily increasing their maximum strength. (Thomas, 2009)

Plyometrics exercises are suitable for improving various measures and components of muscle power such as vertical jumping ability, speed and acceleration). Plyometric training can improve the jumping power of the athletes (Mathise, 2014).

## **2.3 Introduction to Football**

Soccer is the world's most popular sport. According to the International Federation of Association Football approximately 265 million players and 5 million referees and officials are actively involved. This is equivalent to 4% of the world's population. The game is intermittent in nature and involves multiple motor skills such as running, dribbling, kicking, jumping and tackling. (Haugen, 2014).

### **1. Laws of football**

There are 17 Laws of the Game; coaches must have at least a basic understanding of these laws by studying the latest Laws Book and passing an online Laws exam (or undergoing Referee training). (Kelly, 2013)

### **2. The purpose of football**

As the Laws state: 'A goal is scored when the whole of the ball passes over the goal line, between the goalposts and under the crossbar, provided that no infringement of the Laws of the Game has been committed previously by the team scoring the goal'. (Kelly, 2013)

The team scoring the greater number of goals during a match is the winner. If both teams score an equal number of goals, or if no goals are scored, the match is drawn clearly, the purpose of the game is to score goals, and it is obviously just as important to avoid conceding goals. (Kelly, 2013)

### **3. The structure of football**

There are two teams in a game of football and this of course, keeps things interesting. However, the fact that there is only one ball makes it fascinating! This one ball can naturally only be in the possession of one team at a time; there will be times when Team A has it, and times when Team B has it. (Kelly, 2013)

Soccer is a high-intensity, intermittent activity during which players are required to repeatedly perform striding, turning, sprinting and jumping, which place considerable demands on the neuromuscular system. (Stolen, *et al.*, 2005)

Performance depends upon a variety of individual skills and their interaction and integration among different players within the team. Technical and tactical skills are considered to be predominant factors, but physical capabilities must also be well developed in order to become a successful player. (Haugen, 2014)

## **2.4 Fitness in Football**

Performance in soccer depends upon a variety of individual skills and the interaction among different players within the team. Technical and tactical skills are considered to be predominant factors, but physical capabilities must also be well developed in order to become a successful player (Haugen, *et al.*, 2013).

Today, soccer is a highly physical demanding game in which the participants are subjected to numerous actions that require overall strength and power production, speed, agility, balance, stability, flexibility, and the adequate level of endurance (Jovanovic,*et al.*, 2011). Maintaining a high level of these components throughout the season is necessary for achieving consistent high-quality performance, while the basis for these individual components of players is built during youth. (Michal,*et al.*, 2017).

Aerobic capacity is an important factor which, in addition to the quality of the game itself, ultimately affects the final position of the teams in the league (Impellizzeri, *et al.*, 2005). Moreover, aerobic capacity has beneficial effects on parameters such as total time spent on high intensity activities during the game, number of sprints and the number of contacts with the ball during the match. High aerobic capacity also enhances recovery from high-intensity interval loads. (Michal *et al.*, 2017).

Components of anaerobic capacity have the biggest impact on the final outcome of the match and are characterized by repeated short high-intensity activity. (Markovic,*et al.*, 2007)

Soccer is a high-intensity, intermittent activity during which players are required to repeatedly perform striding, turning, sprinting and jumping, which place considerable demands on the neuromuscular system. (Stolen, *et al.*, 2005) Therefore, the ability of the lower limb muscles to produce power is an important fitness component for soccer players. During a 90-minute soccer match, professional soccer players makes numerous explosive bursts, like kicking, tackling, jumping, turning, sprinting, and changing pace (Little and Williams, 2005).

Speed strength, also known as power, is crucial for the performance in sports where changes of direction, accelerations, and jumps are of importance. Hence, strength and power in leg muscles are important for professional soccer players.(Rønnestad,et al,2008)

Physical training is a key part of preparing to play soccer (football) at any level, but organizing a genuinely effective training program requires both an understanding of the physiological principles involved and a practical knowledge of the demands of the game.(Reilly, *et al.*,2003)

Anaerobic training has multiple effects, the most important of which are enhancement of neural activation of muscles, increased activity of creatine kinase and the enzymes in the glycolytic pathway. Anaerobic training can also increase the amount of glycogen stored within the active muscles and enhance their capacity to neutralize the effects of hydrogen ions, thereby delaying or offsetting fatigue. The aims of anaerobic training can be expressed as:

- ❖ To improve the rate of force development and the peak force achieved during brief, fast movements;
- ❖ To improve speed over short distances;
- ❖ To enhance the provision of anaerobic energy so that an all-out sprint can be sustained for longer without training;
- ❖ To improve the capability of performing repeated sprints by enabling the player to recover quickly from strenuous efforts. (Reilly, 2007)

These aims refer to power and acceleration, speed and speed endurance (production and repetition) respectively. These components of physical conditioning for soccer must be complemented by other attributes that form unique requirements of the game. These include agility, reactions, timing of movements and implementation of games skills accurately and often at speed. (Sheppard and Young, 2006). There is a wealth of practices for training these characteristics, adapted from training theory rather than based on experimental evidence. Generally football is the combination of both aerobic and an aerobic exercises which have a significant effect on the overall performance of a player. (Reilly, 2007)

#### **2.4.1 Speed in football**

The components of the multi-dimensionality of speed are one of its important components. (Rimmer and Sleiver, 2000)

Speed is a multi-dimensional motor skill which primarily takes four different shapes: 1. the latency time of a motor reaction, 2. the speed of an individual movement, 3. the speed of frequent movements and 4. Sprinting speed. (Stojiljkovic, 2003)

Movement speed or the shifting of a body in space is a function determined by numerous factors (motor coordination, external conditions, strength, muscle endurance, the stretch-shorten cycle, relaxation skills, reaction skills and speed which includes reaction time and movement time). “Nevertheless, just speed, like an action without any additions has nothing in common with the speed necessary to perform complex movements in sport.” (Siff, 2000,) In many definitions and studies on speed abilities, the connection between speed and the occurrence of force, strength, flexibility, precision, or balance is emphasized. “First and foremost, it is well-known that speed is basically the result of force acting on mass. Second, speed usually represents movement with a constant speed frequency. Body movement (be it a human body or any other kind) with constant speed frequency requires enough motor force to equal out the forces which oppose movement.” (Disalvo, *et al.*, 2007)

The speed of a muscular contraction is regulated by the neuromuscular system. The human movement system will only move within a set speed range regardless of how strong a muscle is. The faster the eccentric loading, the greater the concentric force production (Vigne,*et al.*,2010).In different research literature, straight line sprinting is commonly categorized as acceleration, maximal running velocity and deceleration. Since game analyses have shown that more than 90 % of all sprints in matches are shorter than 20 m, acceleration capabilities are obviously important for soccer players in the game context. (Haugen,*et al.*,2013)

Players are often required to repeatedly produce maximal or near maximal sprints of short duration (1–7 s) with brief recovery periods .Thus, the ability to repeat sprint are seemed relevant fitness prerequisites in competitive soccer players and for soccer physical performance (Impellizzeri *et al.*, 2008).

Kicking, control and speeding dribbling, controlling and shooting: all movements in soccer depending on speed which affect agility, power, strength and reaction time of the players. (Vigne,*et al.*,2010)

#### **2.4.1 Strength in football**

Physical strength is achieved through muscle development. Muscular strength is defined as the force or tension of a muscle group which can be exerted against a resistance in one maximal effort. Muscle strength and increase in muscle size are acquired by muscles working against a resistant force which is gradually increased as the muscles become stronger. (Váczí,*et al.*,2013)

Muscle strength can be increased by a more effective recruitment of muscle fibers contributing to the generation of force and a reduction of neural inhibitory influences. Neural adaptations resulting in increased voluntary activation of muscle may account for improvements in strength over the initial weeks of a resistance-training program (Reilly, 2007)

In soccer there are around 1000-1400 strength and power actions per match (Stolen, *et al*, 2005). Actions like sprinting, jumping or kicking are known to be critical on a soccer match, therefore, is not surprising that maximum strength and vertical jumps can distinguish competitive level between soccer athletes (Tavares,2015)

Soccer strength is all about being able to handle everything that is thrown at you on the soccer field. Not only do you have to have strength to hold off your opponents when trapping the ball, you also have to have strength to have the stamina to stay on the field for an entire game. (Mark. 2012)

It's important to note that strength training isn't the same in soccer as it is in a lot of other major sports. While it is good to lift weights to bulk up a bit, soccer players should mostly focus on toning their bodies while adding lean muscle. (Reilly, 2007)

Soccer players have to focus on building strength in every muscle, so the ideal workout regimen will have very specific exercises that will hit all of those muscles. (Mark. 2016)

Training for muscle strength entails use of the overload principle and progressive resistance exercise offers a means by which the training stimulus can be upgraded on a regular basis. The intensity can be regulated by use of the RM principle, which can be determined from a single maximum effort (1-RM) or a number of repeated efforts (e.g. 10-RM). The training program may be designed on the basis of the number of repetitions of each specific exercise, the number of sets of these repetitions and the rest periods in between. (Reilly, 2007)

### **2.4.3 Power in football**

Power is defined as the ability to produce maximum force in the shortest time. The two components of power are speed and force (strength). An effective combination of these two components allows a person to produce explosive movements such as in jumping, putting the shot, and spiking/throwing/hitting a ball. (Miller, *et al.*, 2006)

Power is necessary to perform many activities of daily living that require strength and speed, such as climbing stairs, lifting objects, preventing falls, or hurrying to catch a bus. Power is also beneficial in sports such as soccer, tennis, softball, golf, and volleyball. Power is defined as an ability to do work per unit of time. In physical education, it refers to the maximal force that a muscle generates in the shortest possible time in order to confront the resistance, it is equal to muscular force or explosive power. Increased power enables muscles to do the same work in small time period, or high work volume within the same time. (Mesfin, 2014)

Peak muscle power is determined by the ability to generate maximum strength and speed, and represented as the highest power output during a specific movement. The variable can be improved through several exercises. Among them, plyometric exercises have been applied by athletes, especially runners and jumpers, over the past three decades (Bullard, *et al.*, 2002).

Explosive power is also an important factor in leg muscles of professional football players. It is very important to obtain a level of explosive power in football. (Faigenbaum and Yap, 2000). Explosive power is one of the essential factors for skillful athletes, which enables them to achieve their peak jump height. However many explosive movements require little time. Therefore, obtaining maximum muscle strength from the major muscle groups of the lower limb for explosive power needs particular training exercises (Markovic, 2007)

Training for power must exploit the force–velocity characteristic of muscle. This requirement reflects the trade-off due to the velocity-specific effects of training. Concentric exercise performed at slow velocities improves force production only at the training velocity whereas exercise at high velocities is not so specific to the exact velocity used. The football player requires both great force production for muscle development and fast actions for game-related movements. (Reilly, 2007)

#### 2.4.4 The relationship of speed, strength and power

Speed, power and strength are the three un separate components of fitness, we cannot improve one of the three without the remaining components improvement related to this idea Reilly (2007) described as follows: It is possible to separate the ‘top speed’ component of running from the initial acceleration that is dependent on muscle strength and power. Pure speed is independent of the capability to sustain a sprint or repeat short all-out efforts, a faculty that is loosely referred to as speed- endurance.

In many definitions and studies on speed abilities, the connection between speed and the occurrence of force, strength, flexibility, precision, or balance is emphasized. “First and foremost, it is well-known that speed is basically the result of force acting on mass. Second, speed usually represents movement with a constant speed frequency. Body movement (be it a human body or any other kind) with constant speed frequency requires enough motor force to equal out the forces which oppose movement.” (Disalvo, *et al.*, 2007)

In regards to movement speed training in sport, it is important to know that explosive strength is at the same time a function of strength and muscle contraction speed. The athlete will be much faster if he uses a greater strength for the surface take-off. This strength must be a part of the technique for surface contact. For the purpose of developing movement speed, explosive strength training is of special importance to an athlete. (Marulo, 1999) Speed, strength and power are explosive or anaerobic exercise, which contributes a lot in football.

Maximal strength is an important quality for power performance, because power is the product of force (strength) and velocity (speed). Thus, an increase in 1RM is usually related to improved power abilities.( Mendes,2016) In professional soccer players, heavy strength training twice per week on leg extensor muscles has been shown to improve 1RM, vertical jump height, 10m, and 20m sprint time. In general, heavy strength training on leg extensor muscles is reported to improve power, jumping height and sprint performance (Rønnestad, *et al.*, 2008)

To improve these three components together players can participate in plyometric training because plyometric training has the potential to develop quicker reaction times that lead to an increase in an athlete's speed and power. (Corey, *et al.*, 2006)

## **2.5 Fitness Training in Soccer**

Everybody concerned with the game of association soccer (football) realizes that training is a necessary part of preparing for competition. Playing soccer itself is only one part of that preparation. There is a requirement to be fit to play, to work on correcting physical deficiencies and enhance individual strengths. (Reilly,*et al.*, 2003)

The basic purpose of training is to improve human capabilities in all their manifestations. These capabilities are characterized in physical, physiological, psychomotor and psychological attributes (Reilly,*et al.*, 2003) Today's sports require athletes to be in optimum condition physically. This is a process which requires more weight. (Jovanovic ,*et al.*, 2011)

The ideal level of fitness is arguably never achieved. Athletes always strive to improve, to push their limits as far upwards as possible. As soccer makes demands on the majority of the body's physiological systems, fitness for the game includes many factors besides competence in game skills and tactical awareness. A key aim in fitness for soccer is to enhance or maintain fitness in areas of strength while correcting weaknesses. In this way the goal of securing an optimal combination of fitness measures can be realized. (Reilly, 2007)

## **2.6 The Effect of Plyometric on Soccer**

Today soccer is becoming more dynamic and the power has become an important aspect of condition for soccer players of all ages. If we take a look at typical movement sequences in soccer (abrupt stops and changes of direction, quick sprints, ball kicking and explosive shots) makes it clear that depend on the stretch-shortening cycle (SSC) characteristics of the involved muscles. (Manolopoulos, *et al.*, 2004).

During a 90-minute soccer match, professional soccer players makes numerous explosive bursts, like kicking, tackling, jumping, turning, sprinting, and changing pace (Bangsbo,*et al.*,2006).

Speed strength, also known as power, is crucial for the performance in sports where changes of direction, accelerations, and jumps are of importance. Hence, strength and power in leg muscles are important for professional soccer players. Therefore this game requires a certain and special training that improve the speed, strength, power, reaction time and agility. (Ronnsted,*et al.*,2008).

Even though coaches used a numbers of training method combinations to improve the above explosive movements using plyometric training independently is the effect way of improving of explosive movements, related to this idea there are several models of plyometric training for the development of explosive leg strength, such as the Chu Model 1992. (Natalia, 2012)

The application of the plyometric model indicated the need to study the possibilities of its application in cadet training on the one hand, and the efficiency of a certain set of plyometric exercises for the development of jumping skills, if it is used after a technical-tactical training, on the other. These models stated about Plyometric techniques for increasing neuromuscular development, explosive-reactive power, and dynamic strength. Using plyometrics for soccer is one the most effective ways to increase explosive speed and power. (Behrens. *et al.*, 2016)

Research has shown that a muscle stretched before contraction will contract more forcefully and rapidly. And that is basically what plyometric exercises do. They stretch muscles rapidly and then immediately demand a powerful concentric contraction. (Thomas,*et al.*, 2009)

It's not just jumping that requires this "pre-stretching" type of movement. Any explosive movement - rapid changes in direction, sprinting (as each leg is planted on the ground) and of course, kicking, will all benefit from plyometrics for soccer. (www.sportsfitnessadvisor.co.uk, 2017)

A successful player must not only be able to jump high but must also be able to reach that height quickly. This requires an ability to generate power in a very short. The use of strength during the play is determined by the fact that the usage of maximum strength lasts from 0.5 to 0.7 seconds (www.iosrjournals.org, 2013)

Based on the finding of Vaczi,*et al.*, (2013) plyometric mode should be included in all trainings that involve the development of explosive power and strength of the leg muscles either for recreation, competition, or rehabilitation purposes.

Plyometric training has been shown to be an effective method for the improvement of both sprinting and jumping ability (Saez, *et al.*, 2015 ) and it has also been reported to improve running economy, joint stability and reduce the severity of knee injuries. For these reasons, soccer training commonly includes this form of muscular power training. (Impellizzeri *et al.*, 2008)

## **2.7 Important Guidelines for Plyometric Training**

Plyometric exercises carry increased risk of injury due to the powerful forces generated during training and performance, and should only be performed by well-conditioned individuals who are under supervision. Good levels of physical strength, flexibility and proprioception should be achieved before commencement of this training.(Faigenbaum and Yap, 2000)

Here are some very important guidelines to bear in mind before commencing plyometrics for soccer...

- ❖ Warm up with 5-10 minutes of light aerobic activity followed by 5-10 minutes of stretching to all major muscle groups.
- ❖ Perform plyometrics for soccer at the start of a training session before endurance training or lots of ball work. Muscles should be fresh.
- ❖ Plyometric training will not leave you out of breath or even feeling tired. Athletes often feel the urge to do more. Don't. Stick to your program to avoid injury and severe muscle soreness 34 hours later! ... (www.sportsfitnessadvisor.co.ku,2017)

- ❖ Actions should be performed at high speed and with maximum intensity while maintaining high quality. For example, in jumping exercises, as your feet touch the ground you should explode upwards rapidly. Don't sink into a deep squat - minimize ground contact time.
- ❖ Two minutes rest between sets is normal. Remember, the idea is not become fatigued. Keep good form.
- ❖ Plyometrics for soccer should not contain more than 120 ground contacts for each muscle group in each session.
- ❖ Two sessions per week with 24-48 hours rest between during the late pre-season are ample. One session a week is enough during the in-season.
- ❖ It goes without saying - if any muscle feels sore during a session, end it immediately.
- ❖ There is one more very important pre-condition before performing plyometrics for soccer... ([www.sportsfitnessadvisor.co.ku,2017](http://www.sportsfitnessadvisor.co.ku,2017))

### **2.7.1 Reducing the risk of injury**

Plyometrics is not dangerous, but the potential for high intensity and stress on joints and musculo-tendonous units makes safety a strong prerequisite to this particular method of exercise. Low-intensity variations of plyometrics are frequently performed in various stages of injury rehabilitation, indicating that correct performance is valuable and safe for increasing muscular power in all populations. The following list of rules should help prevent serious injury to soccer athletes who perform plyometrics:

1. Athletes must not ignore any aches or pains in the lower back, knees, ankles, or feet. A certified health professional should evaluate the pain before the athlete continues.
2. To help absorb landing forces, players should wear a sturdy training shoe with a solid mid-sole and forefoot construction.
3. Athletes should perform a thorough flexibility routine and warm-up before training

4. Make sure the landing surface is resilient. Portable mats or grassy areas are acceptable surfaces. Gymnasium floors are not. ([www.soccercoachinginternational.com](http://www.soccercoachinginternational.com), 2013)

### 3. MATERIALS AND METHODS

In this section description of the study area, experimental materials, source of data, treatment and study design, description of population and sampling methods, methods and procedures of data collection, experimental measurement, methods of data analysis, data quality control and protocols and ethical consideration were discussed.

#### 3.1 Description of the Study Area

The study conducted for three months at Gohatsion town, Wore Jarso woreda, North Shoa zone, Oromia region Central Ethiopia. Gohatsion is located at elevation of 2,495 meters above sea level, and with latitude of 10<sup>0</sup> 01' 00'' North and longitude of 38<sup>0</sup> 15' 00'' East DMS (degree, minute and second).

The town is located 186 km far from the capital city of Ethiopia, Addis Ababa. It is bordered by Blue Nile River which separate Oromia and Amhara regional states at North, Jemma River which is found between Wore Jarso and Dera Woredas at East, Gebre Guracha at South and Muger River at West which is between North and West Shoa Zones.

Based on figures published by the Central Statistical Agency in 2005, this town has an estimated total population of 159,653, of whom 80,075 are men and 79,578 are women. The languages that dominantly spoke in the town are Afaan Oromo and Amharic languages. The cash crops produced in the area is *Sorgume*, *Sesame*, *Teff* and other important cash crops.

Gohatsion Saint Marry church which is one of the historical and ancient church in Ethiopia estimated that built around 4<sup>th</sup> century which is the notable land mark for the town. The map of the study area is indicated on page 88.

### **3.2 Experimental Materials**

Medical check list, marking Cones, different sized boxes, measuring meters, chalk for marking the floor, stop watch, whistle, paper, pen and other important materials were used for this study.

### **3.3 Source of Data**

The investigator used primary data collecting technique only which were collected through pre, during and post treatment tests for Experimental Group (EG), and Control Group (CG) of this research.

### **3.4 Treatment and Study Design**

This study was focused on assessing the effect of 12 weeks plyometric training on speed, strength and power of football players by applied experimental method. The subjects of this study were 30 male football players who aged 18-25years old. The subjects were randomly divided into experimental (n=15) and control (n=15) groups. To investigate the study research topic, purpose, as well as the method of execution was explained to the subjects. Then the subjects voluntarily consented to participate in the study and signed a medical health questionnaire. The criteria for participating in the study included general health and being the player of Gohatsion football team.

The treatment was implemented for three months (November, December and January) two days in a week on experimental group, during the treatment all participants continued their regular training routine, that was identical for experimental and control groups which is three days per a week.

The treatment consisted of three test sessions (pre, during, and post treatment tests.) Pretreatment tests were takes placed for both groups two days prior to the beginning of the treatment to evaluate the lower extremity of speed, strength, and power of football players. A six week long plyometric training program was applied on experimental group followed by during treatment tests on selected fitness components of experimental and control groups to understand their progression. Post treatment tests were taken two days after the other six week training program was terminated.

### **3.5 Description of Population and Sampling Methods**

All 30 players of the team were taken for this study which means total population purposive sampling technique was used. These 30 players were classified in to two groups randomly; Experimental Group (EG) (n= 15) which had a special treatment of plyometric training in addition to their regular training program and Control Group (CG) (n= 15) which followed a regular training program only; therefore, the researcher used mixed type of sampling method.

### **3.6 Methods and Procedure of Data Collection**

The data were collected through a pre, during and post treatment fitness tests of speed, strength and power; therefore, quantitative data collection method was used for this study. 10m sprint run and 30 m acceleration test for speed, wall sit test and Squat test for strength and Standing long jump test and vertical long jump test for power were used to examine the effect of plyometric training on the above physical fitness components. The data were collected and recorded by the investigator with two assistances in Gohatsion Secondary School and Gohatsion town fields.

### **3.7 Measurement Tools and Applications**

#### **3.7.1 Medical examination**

The researcher prepared a questionnaire to determine their current health status and additional consensus format to get their confirmation to involve actively in this study. The following fitness tests were used to testify the hypotheses:

#### **3.7.2 Speed tests**

The effect of plyometric training on speed of football players was examined by 10m sprint test and 30m acceleration test.

### 3.7.2.1 10m Sprint Test

The objective of this test was to monitor the athlete's ability to effectively and efficiently sprinting from a standing start.

#### Procedures and analysis

The test comprises of 3 x 10m sprints from a standing start and with a full recovery between each run. The assistant should record the: time to complete 10m – start the watch on the first foot strike, the distance covered by the first 10m.

Analysis of the result was by comparing it with the results of previous tests. It was showed that, with appropriate training between each test, the analysis indicated an improvement.(Brian,2005)

Figure 1: Speed Test



### 3.7.2.2 30 Meter Acceleration Test

The objective of this test was to monitor the development of the athlete's ability to effectively and efficiently accelerate from a standing start to maximum speed.

#### Procedure and analysis

The test comprised of 3 x 30m runs from a standing start with a full recovery between each run. The assistant recorded the time for the athlete to complete the 30m distance.

Analysis of the result was by comparing it with the results of previous tests; the best time is recorded and considered as a personal best. (Brian, 2005)

### **3.7.3 Strength tests**

To analyze the effect of plyometric training on the strength of football players, the researcher administered Squat and wall sit tests and analyzed the results.

#### **3.7.3.1 Squats test**

The objective of this test was to monitor the development of the athlete's leg strength.

Figure 2 : Squat Test



#### **Procedure and analysis**

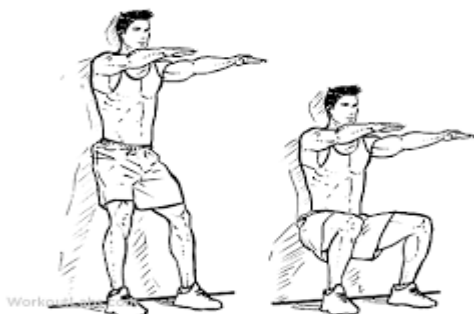
The test was conducted as follows: Stand in front of a chair, facing away from it, with your feet shoulders width apart. Squat down and lightly touch the chair with your backside before standing back up. Keep doing this until you are fatigued, the number of squats completed were recorded. (Brian, 2005)

Analysis of the result was by comparing it with the results of previous tests, with appropriate plyometric training between each test, the analysis indicated an improvement on strength of football players.

### 3.7.3.2 Wall Sit Test

The objective of this test was to monitor the development of the athlete's quadriceps strength endurance.

Figure 3 : Wall Sit Test



#### Procedure and analysis

Stand comfortable on both feet with your back against a smooth wall. Slide your back down the wall to assume the position shown in the diagram. There is to be a 90° angle at the hip and knee. Lift one foot 5cm off the ground. Assistant starts the stop watch. Balance for as long as possible. The watch is stopped when you put your foot back on the ground. Take a rest and then repeat the test with the other leg. (Brian, 2005)

Analysis of the result was by comparing it with the results of previous tests. It was observed that, with appropriate training between each test, the analysis indicated an improvement. (Brian, 2005)

### 3.7.4. Power tests

The researcher used vertical and standing long jump test to measure the effect of plyometric training on power of football players.

#### 3.7.4.2 Vertical jump test

The purpose of this test was to measure the leg muscle power of subjects.

**Figure 4: Vertical Jump Test**



### **Procedures and analysis**

The athlete stands side on to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach height. The athlete then stands away from the wall, and leaps vertically as high as possible using both arms and legs to assist in projecting the body upwards. And jump height was usually recorded as distance score. (Brian, 2005)

The analysis of this test showed an improvement after 12 weeks plyometric training was implemented.

### **3.7.4.2 Standing Long Jump Test**

The objective of this test was to monitor the development of the athlete's leg strength power.

**.Figure 5: standing long jump**



### **Procedure and analysis**

The athlete places their feet over the edge of the sandpit. The athlete crouches, leans forward, swings their arms backwards, the jumps horizontally as far as possible, jumping with both feet into the sandpit.

The coach should measure from the edge of the sandpit to the nearest point of contact. The start of the jump must be from a static position. (Brain, 2005)

Analysis of the result was by comparing it with the results of previous tests, with appropriate plyometric training between each test the analysis indicated an improvement on power of football players.

### **3.8 Methods of Data Analysis**

The data collected through a series of physical fitness tests were presented as a group mean value and standard deviations. The effect of plyometric training on variables was analyzed in separate two pre coded groups experimental (EG) and control group (CG) three times pre, during and posttests.

And the difference between each test result was analyzed statistically with “paired sample T test” at  $p < 0.05$  through the use of computerized statistical package software (SPSS) version 21.

Based on the data analyzed the significance differences were less than 0.05 ( $p < 0.05$ ); consequently, the investigator accepted all alternative hypotheses and rejected the entire null hypotheses.

### **3.9 Data Quality Control**

To ensure the data quality all the test procedures, collection of data and handling information were carried out in accordance with standard protocols and measurements. The researcher used two assistances to collect data, in order to avoid errors; training was given for them on how to use data collecting instruments and measurements during data collection.

The investigator tried to create awareness for the subjects about the objectives of the study, the tests and recommended pre conditions while the tests administered. To ensure the reliability and validity of the result the pretest was administered 2 days before the treatment is begun and the during treatment test was administered two days later on their last training program, then the posttest takes placed two days after their treatment was terminated. The researcher tried to prevent the Control Group (CG) from participated any special treatment or training that was prescribed for the Experimental Group (EG) in addition to their regular training. In addition to the above points the data were recorded and inserted in to the software twice with different individuals.

### **3.10 Protocol and Ethical Consideration**

The study was deal with the ethical issue related to the investigation. It protected the privacy of research participants and made guarantee for any risk harm due to participation, and gave confidentiality of the information that had given to the study. Subjects of this study were participated purely in voluntarily based activities. Therefore the study was conducted based on the university rules, codes of conduct and policies concerning research ethics.

## 4. RESULT AND ANALYSIS

### 4.1 Over view

This section discussed about analysis of the data collected from the subjects of the study through different fitness test batteries. The purpose of this study is to find out the effect of plyometric training on speed, strength and power of Gohatsion football team players. To achieve the purpose of the study thirty football players ( $X \pm SD = 21.10 \pm 1.689$  years of age) were volunteered to participate in this study (the subjects' characteristics are given in Table 1). All of the subjects played on Gohatsion football team and none were being trained by means of a plyometric training program. The subjects were grouped randomly in to EG (N= 15) and CG (N = 15). All of the experimental group members had successfully passed a physical exam and completed a medical history questionnaire in which they were screened for any possible injury or illness. The group received all the necessary information about the study's procedures in oral and written form. Each member of the experimental group completed a medical history form a training background questionnaire and a written informed consent form. Then the plyometric training was given for experimental group for two days per a week in addition to their regular soccer related activities for 12 weeks. Both groups underwent measurements of their 10m and 30m speed tests, squat and wall - sit strength tests and vertical jump and standing long jump power tests before, during and after the training program and the scores were recorded. The collected data were analyzed by paired sample T- test using SPSS version 21. The anthropometric characteristics of the subjects and the findings of speed, strength and power tests of the players are presented below through table and bar graphs.

**Table 1. Anthropometric characteristic of the participants of the study (Mean,  $\pm$  SD)**

Height and weight were measured, and body mass index (BMI) was calculated by dividing weight (kg) by height (m<sup>2</sup>).

Table 1: Anthropometric characteristic of the participants of the study (Mean,  $\pm$  SD)

		Groups		
		EG	CG	Total
Age (years)	Mean (X)	21.13	21.07	21.10
	N	15	15	30
	Std. Deviation(SD)	1.846	1.580	1.689
Weight (Kg)	Mean(X)	61.87	62.93	62.40
	N	15	15	30
	Std. Deviation	2.949	2.865	2.908
Height (m)	Mean (	1.7180	1.7187	1.7183
	N	15	15	30
	Std. Deviation(SD)	.02704	.02949	.02780
Body Mass Index	Mean	21.0513	21.3260	21.1887
	N	15	15	30
	Std. Deviation(SD)	.74325	.72086	.73284

*N= Number of players in a group, EG= Experimental Group, CG = Control Group, X= Mean Value, SD= Standard Deviation,*

## 4.2 Effect of Plyometric Training on Speed

Table 2: PT, DTT and PoT 10 M and 30 M Speed Test Results of the Groups

GROUPS	N	PT (X, $\pm$ SD)	DTT (X, $\pm$ SD)	PoT (X, $\pm$ SD)	$\Delta$ X	P
					(PoT - PT)	
ST1 result of EG	15	2.620 $\pm$ .3200	2.393 $\pm$ .3127	2.2453 $\pm$ .3224	-.375	.000
ST1 result of CG	15	2.6467 $\pm$ .3461	2.540 $\pm$ .3924	2.4473 $\pm$ .4564	-.193	.050
ST2 result of EG	15	5.247 $\pm$ .3640	5.0873 $\pm$ .4826	5.0193 $\pm$ .50473	-.195	.020
ST2 result of CG	15	5.3100 $\pm$ .3405	5.2653 $\pm$ .357	5.2420 $\pm$ .30050	-.068	.046

EG= Experimental group, CG =CONTROL group, ST1= speed test one (10m speed test), ST2= speed test two (30 m speed test), PT = pre test result, DT = during test result, PoT = Post test result, N= Number of players in a group, X = Mean, SD= Standard Deviation,  $\Delta$ X =Mean difference of PT and PoT, P = Significance level

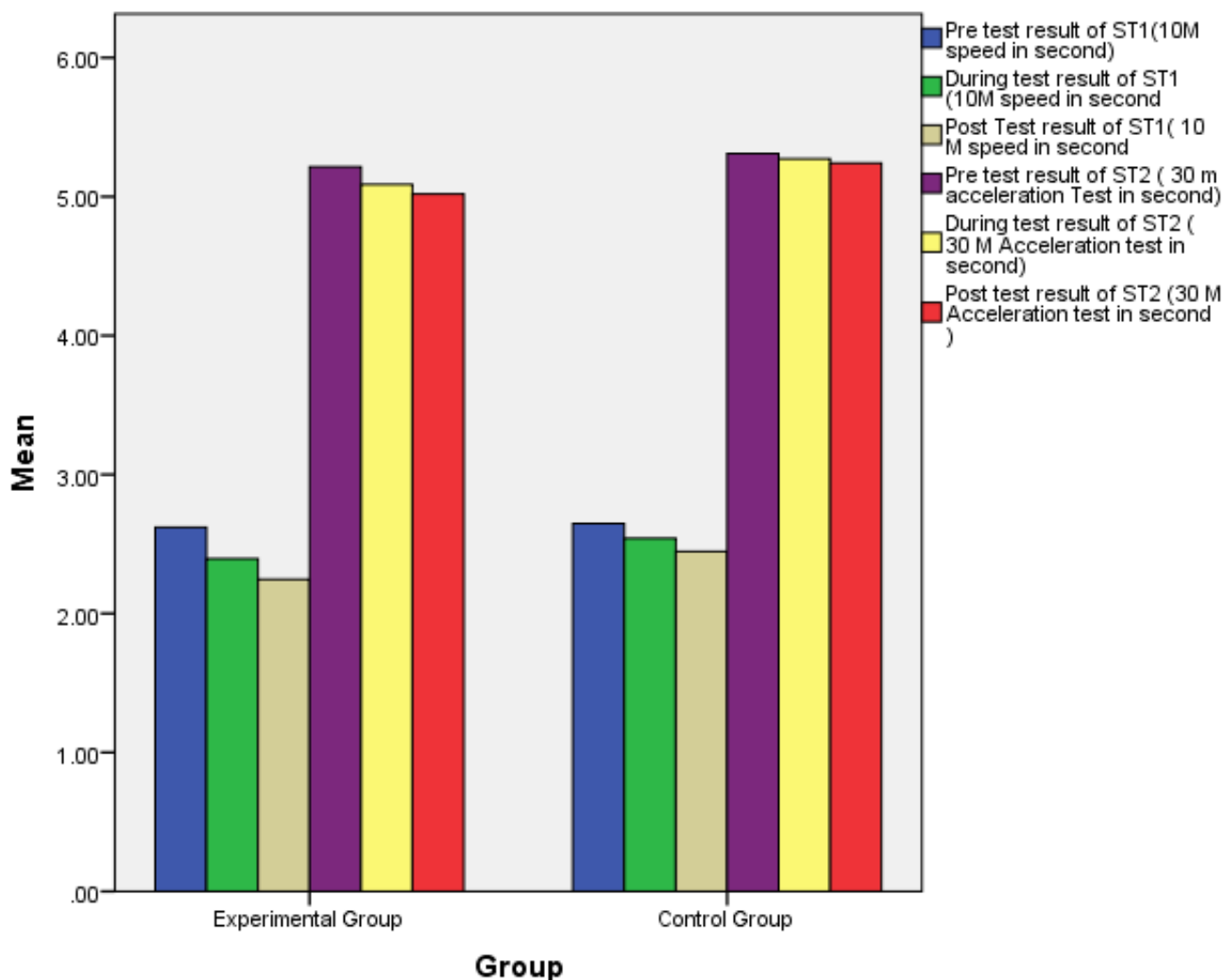
**10 m Sprint** As Table 2 showed, the EG was significantly faster than the CG in the 10-m sprint ( $p = 0.00$ ). Plyometric Training led to a significant decrease in mean value of EG (2.6207 to 2.393 to 2.2453 seconds with  $\Delta$ X (PoT-PT) = - 0.3574;  $p = 0.000$ ) in sprint time for the EG, whereas no significant alteration of the CG performance was recorded (2.6467 to 2.5400 to 2.4473 mean value with  $\Delta$ X (PoT-PT);  $p = 0.05$ ).

It indicated that plyometric training has a positive effect on speed of football players, and it was supported by Meyelen and Malatesta (2009) on the study conducted on effect of in-season plyometric training within soccer practice on explosive action of young players showed that a significance changes were observed on the EG ( $P= 0.02$ ) and no significant change was observed in CG ( $P=0.15$ ) on 10m sprit test recorded data after 8 weeks plyometric training was implemented.

In addition Mathisen ( 2014 ) on the study which was conducted on effect of high speed and plyometric training for 13 years old male soccer players on acceleration and agility performance ,plyometric training was showed a significance effect ( $P < 0.01$ ) as 10m sprinting recorded data were showed.

**30m acceleration test** As table 2 showed, Before training all of the team players had almost similar pretest result of mean value on 30m acceleration test 5.2147 and 5.3100 for (EG) and respectively CG (Table 2). Plyometric Training affected the players speed profile of EG in 30 m acceleration test ( $P = 0.02$ ). In the EG the mean value at the 30m acceleration test was decreased (5.2147 to 5.0873 to 5.0193 with  $\Delta X$  (PoT-PT) = - .1954,  $P = 0.02$ ) Even if the mean value of 30m acceleration test in CG significant changes were observed from 5.3100 to 5.2653 to 5.2420 seconds with  $\Delta X$  (PoT-PT) = -.068;  $P = 0.046$ ) (table 2) the significance level ( $P = 0.046$ ) was greater than the significance level of EG ( $P = 0.02$ ). It indicated that plyometric training with regular football training had a greater effect on the speed of football players than regular football training only. These results were consistent with Michailidis (2014) on the study conducted on effect of plyometric training on athletic performance in preadolescent soccer players, Mohebi, *et al.*, (2012) and Tahir *et al.*, (2014) but did not match with Thomas *et al.*, (2009). A number of factors such as muscle length, strength, age, gender, temperature, body shape, force and flexibility can have profound impacts on speed. Probably plyometric exercises led to speed improvements by affecting muscle length, force, muscle temperature, strength and flexibility during the 12 weeks.

**Figure 6:** Graphical Presentation of Effect of Plyometric Training on Speed of Football Players



As observed in table 2 and in the graph above plyometric training showed a significance effect on EG result of both 10m sprinting ( $P= 0.00$ ) and 30m acceleration test ( $P= 0.02$ ) results, but 10m sprinting test result showed no significance change for CG ( $P= 0.05$ ). Even though 30m acceleration test result showed a significance change on CG ( $P= 0.46$ ) it was less than the change that observed on EG ( $P= 0.02$ ). The results showed that 12 weeks of plyometric training had significant effects on speed records reduction of 30m acceleration test. The presented study accepted alternative hypothesis 1 which was plyometric training improves the speed of football players, and rejected the null hypothesis.

### 4.3 Effect of Plyometric Training on Strength

Table 3 PT, DDT, and PoT Results of Squat and Wall Sit Tests of EG and CG

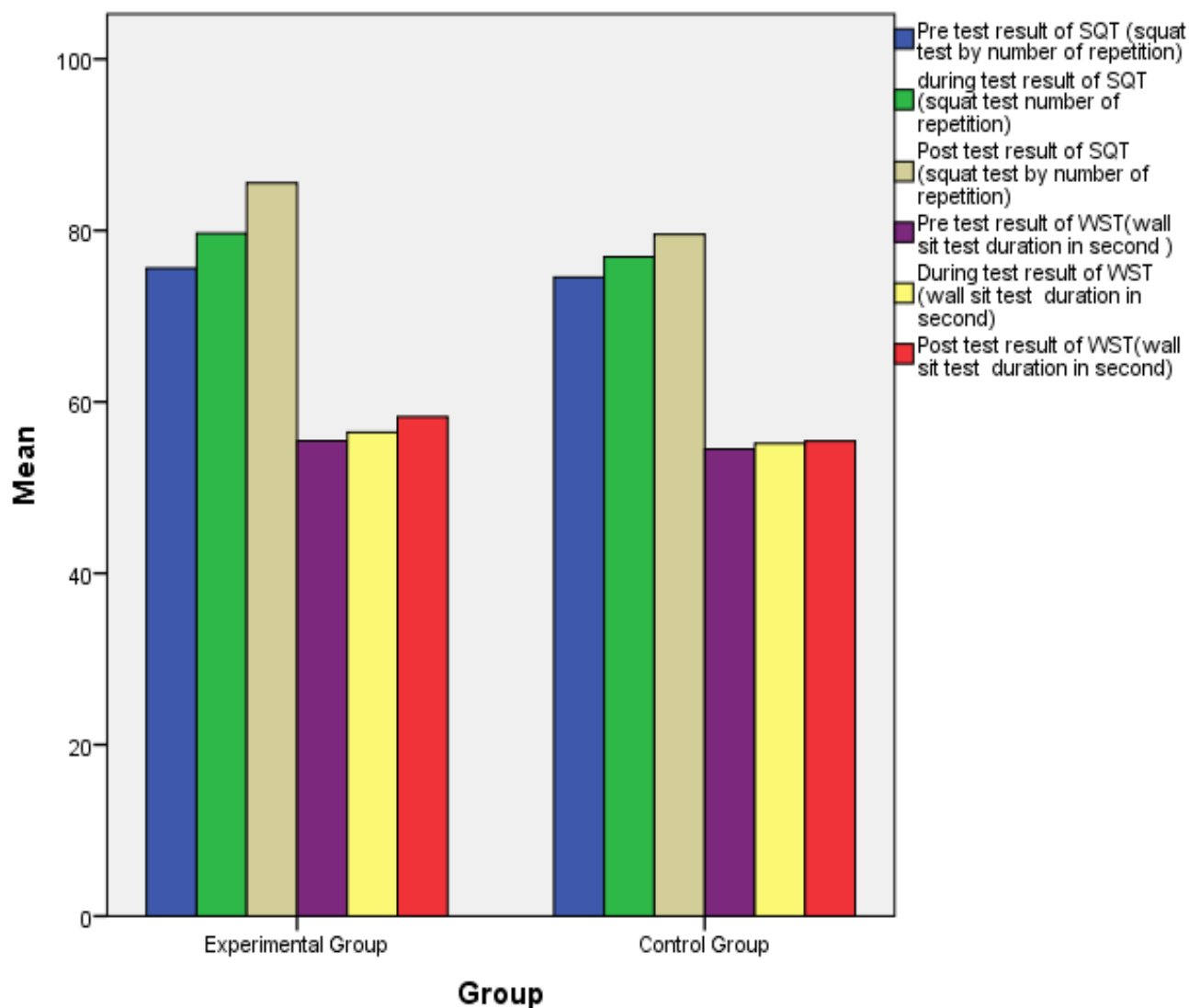
GROUPS	N	PT (X, $\pm$ SD)	DT (X, $\pm$ SD)	PoT (X, $\pm$ SD)	$\Delta$ X (PoT - PT)	P
SQT result of EG	15	75.60 $\pm$ 13.948	76.67 $\pm$ 12.111	85.53 $\pm$ 10.927	9.933	.000
SQT result of CG	15	74.53 $\pm$ 10.656	76.93 $\pm$ 8.506	79.53 $\pm$ 7.689	5.00	.040
WST result of EG	15	55.460 $\pm$ 3.1475	56.464 $\pm$ 1.932	57.617 $\pm$ 2.411 3	1.843	.030
WST result of CG	15	54.5067 $\pm$ 2.0943	55.1447 $\pm$ 1.96	55.412 $\pm$ 2.412	0.908	.077

*EG= Experimental group, CG =Control Group, SQT= Squat test, WST = Wall Sit Test, PT = pretest result, DT = during test result, PoT = Post test result, N= Number of players in a group, X = Mean, SD= Standard Deviation,  $\Delta$ X =Mean difference of PT and PoT, P = Significance level*

According to table 3, even though the improvements observed in both group when the SQT pre, during and post results mean value (X), mean difference ( $\Delta$ X) and level of significance level (P) were compared the plyometric training program meaningful difference was found in EG (Pretest / During test /Posttest / (X) = 75.60/79.67/85.53 with  $\Delta$ X= 9.933, P = 0.000) than CG ((Pretest / During test /Posttest / = 74.53/76.93/79.53 with  $\Delta$ X = 5, P = 0.04).

Before training the mean value WST were almost similar between EG (X= 55.46) and CG (54.50).At during training and post training wall sit time demonstrated an incline in EG (from pre training (X) =55.46 to during (X) = 55.46 then to post (X) = 58.27 with  $\Delta$ X = 2.816, P = 0.03) but CG did not indicated a significant inclination (from pre (X) = 54.50 to during training (X) = 55.14 then to post (X) = 55.41 with  $\Delta$ X = 0.90, P= 0.77).

**Figure 7:** Graphical Presentation of Effect of Plyometric Training on Strength of Football Players



As clearly presented in table 3 and figure 2 EG group showed a greater change in both SQT and WST test results than CG due to plyometric training. In SQT result EG had 0.00 significance value (P) whereas CG had (0.04) significance level (P); therefore, EG showed a better improvement than CG. In WST result the significance value of EG was (P = 0.03) which was a meaningful change in contrast (P= 0.77) was the significance level of CG which proved no significance difference was observed.

Consequently, it was found that 12-week plyometric training in addition to regular football training programs contributed to strength development among footballers.

The presented study accepted alternative hypothesis 2 which was plyometric training improves the strength of football players, and rejected the null hypothesis. The finding of this study is in agreement with the results reported by Rehman and Naser, (2005) on the study conducted on the effect of plyometric, weight and plyometric – weight training on anaerobic power and muscular strength, the squat result of plyometric training showed an improvement on the strength of the muscle. Similar results also reported by Ying – Chun and Zhang, (2016) on the study conducted on effects of Plyometric Training on Soccer Players, revealed that plyometric training has a positive effect on strength of soccer players. Vaczi, *et al*, (2013) on the study short - term high intensity plyometric training program improves strength, power and agility in male soccer players found that plyometric training has an effect on strength of soccer players and Rahin *et al.*, (2014) on the effect of strength and plyometric training on anaerobic power, explosive power and strength quadriceps femoris muscle in soccer players proved that plyometric training had a positive effect on quadriceps muscle of football players.

#### 4.4 Effect of Plyometric Training on Power

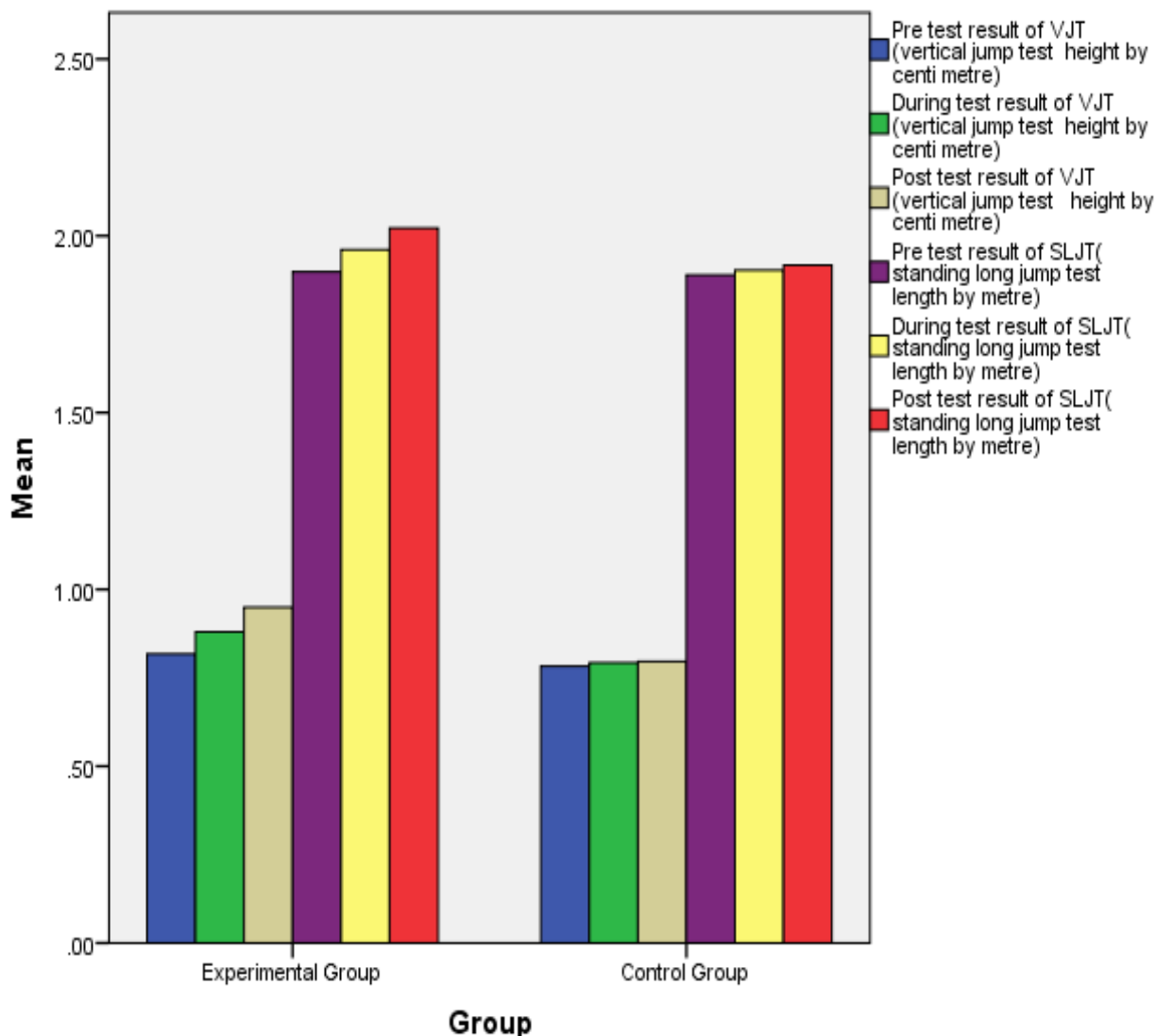
Table 4: PT, DDT and PoT results of VJT and SLJT tests of EG and CG

<b>GROUPS</b>	<b>N</b>	<b>PT (X,±SD)</b>	<b>DDT (X,±SD)</b>	<b>PoT (X,±SD)</b>	<b>ΔX (PoT - PT)</b>	<b>P</b>
VJT result of EG	15	.8173±.8013	.880±.9502	.9493±.11591	.132	.000
VJT result of CG	15	.7827±.04949	.7927 ± .05311	.7967 ± .0653	.0140	.046
SLJT result of EG	15	1.8980 ± .13116	1.9607 ± .1021	2.0220 ± .8801	.124	.001
SLJT result of CG	15	1.8893 ± .0309	1.9027 ± .0974	1.9173 ± .02411	.028	0.47

*EG= Experimental group, CG =Control Group, VJT= Vertical Jump Test, SLJT = Standing Long Jump Test, PT = pre test result, DT = during test result, PoT = Post test result, N= Number of players in a group, X = Mean, SD= Standard Deviation, ΔX =Mean difference of PT and PoT, P = Significance level*

Paired t-tests in table 5 showed that the EG showed a great significant increase in the vertical jump height (PT (X) =.8173, DT = .880 PoT = .9493 with ΔX = .132, P = .00) than C.G. PT (X) = .7827, DT = 79.27, PoT = 7967 with ΔX =.0140, P=.046). According to SLJT results, mean value (X), mean difference (ΔX) and P values of experiment group (PT=1.8980, DT=1.9607, PoT = 2.0220 and mean value, (X), mean difference (ΔX) and P values of the control group (PT=1.8893, DT =1.9027, PoT =1.9173, with (ΔX) =.028, P =.047). The results indicated that football training was capable of improving the vertical jumping ability and anaerobic power but its combination with plyometric training is even more beneficial.

Figure 8: Graphical Presentation of Effect of Plyometric Training on Power of Football Players



As clearly presented in table 4 and in figure 3, even though both EG and CG showed a significance change in both test VJ and SLJ, but the change on EG was greater than the change on CG; it was found that 12-week plyometric training in addition to regular football training programs contributed to power development among footballers. The results of this investigation are in accordance with previous studies A.

Memar zadela *et al.*, (2014) on the study conducted effect of plyometric training on skill performance in soccer players showed that plyometric training has a positive effect on the power of lower extremities of football players;

Ying – Chun and N. Zhang (2016) on the study plyometric training was a technique used to increase strength and explosiveness stated that plyometric training showed a great effect on the power of the body ; Bullard *et al.*, (2002); Luebbers *et al.*, (2003); R.Rahimi and N.Behpur (2005); Poul.E.L *et al.*, (2003) most of these studies found significant increases between both groups, but for participants who also were plyometric training during the football-training period. Therefore the present study accepted alternative hypothesis 3 which was there is a significance increase on power of football players after plyometric training program applied and rejected null hypothesis.

## 5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Summary

The purpose of the present study was to investigate the effects of plyometric trainings on speed, strength and power of Gohatsion football players. In the present research, 15 experimental group (age  $X = 21.13$  years, body weight  $X = 61.87$  kg, height  $X = 1.718$  m, BMI = 21.05) and 15 control group (age  $X = 21.07$  years, body weight  $X = 72.93$  kg, height  $X = 1.718$  cm, BMI = 21.32), the total of 30 team football players of Gohatsion football team were participated in the present research. Before the training, pre-test scores of (10m sprint test and 30m acceleration test for speed; squat and wall sit tests for strength and vertical jump and standing long jump tests for power) were recorded. 40 minutes plyometric trainings, 2 days a week, for 12 weeks were conducted on the experimental group in addition to their regular football training. Control group participants followed their regular football training program only. The tests were also recorded during the training program and at the end of the trainings post-test scores of both groups were recorded by two experts in the field in accordance with the protocol. In order to evaluate the effects of 12-week plyometric training of the speed, strength and power development of footballers, paired t test was utilized for between groups and in-group comparisons. In EG the results were found for 10m sprint test ( $p = 0.00$ ), 30m acceleration test ( $p = 0.02$ ) whereas in a CG the results were found for 10m and 30m ( $p = 0.05$ ) and ( $p = 0.046$ ) respectively, with both groups showing improvements in VJ and SLJ power tests, but the improvement in EG (VJ)  $P = 0.00$ , (SLJ)  $P = 0.001$ ) greater than CG (VJ)  $P = 0.046$ , (SLJ)  $P = 0.047$ ). On the other hand, the EG improved in their squat test result (SQT)  $P = 0.00$  and (WST)  $P = 0.04$ ) significantly more than players in the CG ((SQT)  $P = 0.040$  and (WST)  $P = 0.077$ ). Consequently, it was observed that 12-week plyometric training in addition to football trainings contributed to the speed, strength and power development among footballers.

## 5.2 Conclusions

In the present investigation the researcher hypothesized that 12 weeks of plyometric training, comprising with football training, would produce improvements in speed, strength, and power of soccer players. Based on the major findings and with the possible limitation of the study, the following points were stated as a conclusion;

- Based on the results of 10m sprinting and 30m acceleration tests the present research demonstrated those 12 weeks of plyometric training had a beneficial impact on speed of football players.
- The finding of the current research would be that plyometric training combined with soccer training leads to greater improvements in strength of football players than soccer training alone
- It was found that the 12 weeks plyometric training program significantly improved power of football players' based on vertical jump and standing long jump performance of test results.

Generally, the results of this study provided the effect of plyometric training for the improvement of players' speed, strength and power.

## 5.3 Recommendations

Based on the major findings and conclusions of the study, it is important to state the following points as a recommendation:

- ❖ It is highly expected from professionals of sport science, physical trainers and related fields to educate and to create awareness the values of well planned plyometric training on the performance of football players. Accordingly, plyometric training can be advised for football trainers, who work for development football teams and football clubs, as it contributes to on speed, strength and power of their players.

- ❖ It's feasible and effective using plyometric training for soccer players in addition to their regular football training programs, but the training needs to be continuous throughout the season with proper recovery time. To become more beneficial from the training program the coaches and physical trainers need to assess the players' performance, health status and it needs to be support by a good nutritional status.
- ❖ To increase the effectiveness of plyometric training coaches, physical trainers should consider progressive increases in the volume, frequency and intensity of the training program and ensure exercises are performed on soft landing surfaces, reducing the probability of player injury.
- ❖ Other researchers' need to examine the long term effect of plyometric training on the other components of football; especially techniques and physical fitness of the players.

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## **7. APPENDICES**

## Appendix- A

### Information record form

The questionnaire prepared for studying the **effect of plyometric training on speed, strength and power of football players in Gohatsion football team players, North Shoa zone, Oromia regional state**. So you are kindly requested to give appropriate information for the following question regarding to your current health status.

**THANK YOU!**

#### I. PLAYERS INFORMATION

Name: \_\_\_\_\_ Date of Birth \_\_\_/\_\_\_/\_\_\_ Age: \_\_\_\_\_

Address: \_\_\_\_\_

Phone: \_\_\_\_\_

Emergency Contact: \_\_\_\_\_

Address \_\_\_\_\_ phone no \_\_\_\_\_

## II. Personal health status

Please answer the following questions by ticking 'X' on the given space on the table. And please give a description for your answer if necessary

Table 1: Personal Health Status

No	Questions	YES	NO
1	Have you ever had an injury to a bone, muscle, ligament, or tendon that caused you to miss a practice or a game?		
2	Have you ever had any broken or fractured bones or dislocated joints?		
3	Have you ever had an injury that required x-rays, injections, therapy?		
4	Do you have groin pain or a painful bulge or hernia in the groin area?		
5	Have you ever had discomfort, pain, tightness, or pressure in your chest during exercise?		
6	Have you ever had a stress fracture?		
7	Do you regularly use a brace, orthotics, or other assistive device?		
8	Do you have a bone, muscle, or joint injury that bothers you?		
9	Do any of your joints become painful, swollen, feel warm, or look red?		
10	Do you have any history of juvenile arthritis or connective tissue disease?		

[http://www.newcastle.edu.au/2012/pre activity questionnaire](http://www.newcastle.edu.au/2012/pre%20activity%20questionnaire)

11. Are you currently taking any medication/s? Yes \_\_\_\_\_ No \_\_\_\_\_

**If you say YES please describe:**

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I have read and understand the form and I have given accurate information regarding to my personal information and health status.

Signature for participant player \_\_\_\_\_ Date \_\_\_\_\_

Signatures for investigator \_\_\_\_\_ Date \_\_\_\_\_

## **Appendix – B**

### **Fitness training and test consent form**

Researcher's Name: Getasew Gashaw

Major Advisor's Name: Wegene Waltenegus (PhD)

Co-Advisor's Name: Desta Enyew (PhD)

**Thesis title: Effect of Plyometric Training on Speed, Strength and Power of Male Football Players in Case of Gohatsion Football Team Players, North Shoa Zone, Oromia Regional State.**

### **Purpose of the study:**

The purpose of this study was to assess the effect of plyometric training on speed, strength and power of football players.

### **Procedure and duration:**

You are kindly requested to participate in this research study as described below. This study will be governed by the regulation on human beings. These regulations require that researcher should obtain a signed agreement (consent) from you/the players/ to participate in this research project.

Even if taking such type of fitness training and fitness test is one component of your regular soccer training program, the researcher will explain detail about the purpose of the project, the procedure will be used, the potential benefit and the possible risk of participation in this thesis. And you can ask the researcher any question and doubts that you have about the study and you shall expect satisfactory responses regarding your questions. So if you are interested and ready to participate. Please confirm your agreement by your signature. You can discontinue at any time from the study if you choose to do so. A basic explanation of the project will be summarized below.

**Risk and safeguard:**

Since subjects are somehow experienced and had regular soccer training for the last 3 and more years the expected injury in administering such fitness training and tests for you may be little. But while in application of the regular soccer trainings and administering the tests you may experience muscle fatigue, usually happened soccer related injuries such as: muscle soreness and sprain may exist due to intense demand of soccer game but not the training and test only.

But if any unexpected physical injuries occur, appropriate first aids will be provided, but no financial compensation will be given.

**Confidentiality:**

The information obtained from the participants (you) will be kept in confidence, but it will be free to release to their own owners, to the local word's, zonal as well as regional sport federation offices if it is needed.

And all the collected information will be used only for scientific purpose through grouping without identifying them as an individual.

**Rights:**

Participation in this study will be a fully voluntary based. You have the right to declare to participate or not in the study. And if you decide to participate, you have the right to withdraw from the study at any time and this will not label you for any loss of benefits which you otherwise are entitled.

**Contact address:**

If there is any questions or enquires any time about the study or the procedures, please contact in the following address:

Institutional research ethics review committee (IRERC) at +251256661899

Wegene Waltenegus (PhD) (Advisor) +251923670360 Or,

Desta Enyew (PhD) (Co Advisor) +251938310940

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Email: [getaome11@gmail.com](mailto:getaome11@gmail.com) or [sewgeta11@yahoo.com](mailto:sewgeta11@yahoo.com)

## Appendix – C

### FITNESS ASSESSMENT FORM

Players Name: \_\_\_\_\_

Position of play \_\_\_\_\_

Examiners Name: \_\_\_\_\_

Pre-Test Date: \_\_\_\_\_ During Training Test date \_\_\_\_\_ Post-Test Date: \_\_\_\_\_

Comment

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Table 2: Fitness Assessment Form

Fitness to be measured	Tests to be measured	Test code	Pretest score	During test score	Post test score	Difference
Speed	10m sprinting test	ST2				
	30 acceleration Test	ST <sub>2</sub>				
Strength	Squat test	SQT				
	Wall Sit Test	WST				
Power	Standing Long Jump	SLJT				
	Vertical Jump Test	VJT				

The form is modified from NSCA.com, 2017/fitness assessment form

## Appendix- D

### Test protocols / Norms

#### 1. Speed test

Table 3 : Normative data for the 30 meter test

The following are national norms for 16 to 19 year olds.

30 meter Sprint Rating	Male	Female
Excellent	< 4.0	< 4.5
Above Average	4.2 - 4.0	4.6 - 4.5
Average	4.4 - 4.3	4.8 - 4.7
Below Average	4.6 - 4.5	5.0 - 4.9
Poor	> 4.6	> 5.0

Reference: Davis B. et al; Physical Education and the Study of Sport; 2000

Table reference: Davis B. et al; Physical Education and the Study of Sport; 2000

Table 4: Normative data for the 10 meter sprint test

Distance Segment	10-Meter Split Time (sec)	Cumulative Time (secs)
0-10m	1.89	1.89
10-20m	0.99	2.88
20-30m	0.90	3.78
30-40m	0.86	4.64
40-50m	0.83	5.47
50-60m	0.82	6.29

Table reference: [www.topendsports.com](http://www.topendsports.com)

## 2. Strength tests

Table 5 :Test Protocol for Squat

Squat test (Men)	Age					
	18-25	26-35	36-45	46-55	56-65	65+
<b>Rating</b>						
Excellent	>49	>45	>41	>35	>31	>28
Good	44-49	40-45	35-41	29-35	25-31	22-28
Above average	39-43	35-39	30-34	25-38	21-24	19-21
Average	35-38	31-34	27-29	22-24	17-20	15-18
Below Average	31-34	29-30	23-26	18-21	13-16	11-14
Poor	25-30	22-28	17-22	13-17	9-12	7-10
Very Poor	<25	<22	<17	<9	<9	<7

Brian Mackenzie, 2005; *101 Performance Evaluations*

Table 6. Normative data of wall sit test

Gender	Excellent	Above Average	Average	Below Average	Poor
Male	>102 s	102 - 76 s	75 - 58 s	57 - 30 s	<30 s
Female	>60 s	60 - 46 s	45 - 36 s	35 - 20 s	<20 s

Table reference: [www.topendsports.com](http://www.topendsports.com)

### 3. Test protocol for power tests

Table 7: Test Protocols of Standing long Jump Test

<b>Test protocol for standing long jump</b>					
		<b>males</b>		<b>females</b>	
<b>rating</b>	<b>(cm)</b>	<b>(feet, inches)</b>	<b>(cm)</b>	<b>(feet, inches)</b>	
Excellent	> 250	> 8' 2.5"	> 200	> 6' 6.5'	
very good	241-250	7' 11" — 8' 2.5"	191-200	6' 3" — 6' 6.5'	
above average	231-240	7' 7" — 7' 10.5"	181-190	5' 11.5" — 6' 2.5"	
Average	221-230	7' 3" — 7' 6.5"	171-180	5' 7.5" — 5' 11"	
below average	211-220	6' 11" — 7' 2.5"	161-170	5' 3.5" — 5' 7"	
Poor	191-210	6' 3" — 6' 10.5"	141-160	4' 7.5" — 5' 2.5"	
very poor	< 191	6' 3"	< 141	< 4' 7.5"	

Table reference: [www.topendsports.com](http://www.topendsports.com)

Table 8: Test Protocols of Vertical Jump Test

rating	Males		Females	
	(inches)	(cm)	(inches)	(cm)
<b>Excellent</b>	> 28	> 70	> 24	> 60
<b>very good</b>	24 – 28	61-70	20 – 24	51-60
<b>above average</b>	20 – 24	51-60	16 – 20	41-50
<b>Average</b>	16 – 20	41-50	12 – 16	31-40
<b>below average</b>	12 – 16	31-40	8 – 12	21-30
<b>Poor</b>	8 – 12	21-30	4 – 8	11-20
<b>very poor</b>	< 8	< 21	< 4	< 11

Table reference: [www.topendsports.com](http://www.topendsports.com)

## **Appendix – E**

### **Description of the training program**

The purpose of this study training was to develop speed, strength and power of Gohatsion football team players by using proper and well planned plyometric training for 12 weeks. The training plan is tried to designed and supervised by following FITT and other training principles.

Prior to the intervention the Experimental Group received all necessary information, completed a medical history which they were screened for any possible injury or illness, and successfully passed a physical exam and implemented the training for the successive 12 weeks.

### **Rules of plyometric training**

The following list of rules should help prevent serious injury to soccer athletes who perform plyometrics:

1. Athletes must not ignore any aches or pains in the lower back, knees, ankles, or feet. A certified health professional should evaluate the pain before the athlete continues.
2. To help absorb landing forces, players should wear a sturdy training shoe with a solid mid-sole and forefoot construction.
3. Athletes should perform a thorough flexibility routine and warmup before training
4. Make sure the landing surface is resilient. Portable mats or grassy areas are acceptable surfaces. Gymnasium floors are not.
5. Do not begin a plyometric workout schedule without the benefit of a comprehensive training program.
6. Preadolescent athletes should avoid plyometrics because of the stress on immature bones and connective tissues. Strength at this age will be sufficient for increasing speed and power without the use of plyometrics.
7. As a rule, athletes weighing more than 220 pounds should not depth jump from a platform higher than 18 inches. ([www.soccercoaching.com](http://www.soccercoaching.com))

**Frequency of the training**

The training schedule was completed two days per a week. Tuesday and Thursday are the days that were selected to implement the training program.

**Intensity of the training**

Intensity is paramount to successful plyometric training. Each exercise tried to perform at a maximal effort and intensity is determined by number of foot strikes or touches. The intensity of the exercise was loaded by two ways; the first one by vary the types of the plyometric drills which are grouped as low, moderate and high intensity exercises by Salisbury Strength and Conditioning and the second one was by increase the volume of the exercise depend on the sets and repetitions of the exercises.

**Training volume**

According to NSCA, (2003) for the elite athlete a high intensity plyometric workout may consist of about 200 – 400 touches or foot strikes. The beginning or intermediate athlete is in the range of 60 – 150 touches. Based on this, the intervention was consisted of 60-70 number of foot contacts.

**Progression of the training**

Progression is vitally important. The progression through plyometrics tried to follow intentional, beginning with low intensity jumping activities progress to high intensity activities and from 2 sets to 3 sets with 5- 10 repetitions.

### **Duration of the training program**

During short duration, high intensity exercises, such as plyometrics, the body uses the phosphagen system to provide the energy (ATP) needed for muscle contraction. Once ATP stores are depleted it takes time to resynthesize them. Approximately 70% of ATP is re synthesized after about 30 seconds and 100% after three minutes. Therefore, the rest periods used when performing plyometrics should be from 30 seconds to 3 minutes depending on the individual. If a maximal effort is demanded of each touch or foot strike, then it is important to allow for adequate rest between bouts is allowed (NSCA, 2003)

From the standing point of NSCA, (2003) statement the duration of this study training program was 40 minutes with proper warming up and cooling down which took 10 minutes for each. The rest time between each set of the exercise session was fixed, 2 minutes.

### **Types of the exercise**

According to Salisbury strength and conditioning the following exercises which were used for this study training program are classified in to three based on their intensity.

Table 9: Intensity of The Exercises

<b>Low Intensity Exercises</b>	<b>Moderate Intensity Exercises</b>	<b>High Intensity Exercises</b>
Squat jump	Double leg hop	Double leg vertical jump
Split squat jump	Double leg zigzag hop	Single leg vertical jump
Jump and reach	Alternate leg bound or single leg hop	Single leg tuck jump
Cycled split squat jump	Standing triple jump	

<http://www.salisburystngthandconditioning.com>

## Appendix- F

**Table 10: Plyometric Training Program For first month (November, 2017)**

Week	Training days	Drills	Time	Warming up	Intensity	Training volume (SXR)	Rest Interval	Duration In Min for drills. (20 M)	Cooling down
One	Tuesday	Squat jump	40	10min	Low	2x8	3 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	
	Thursday	Squat jump	40	10min	Low	2x8	2 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	
Two	Tuesday	Squat jump	40	10min	Low	2x8	2 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	
	Thursday	Squat jump	40	10min	Low	2x8	2 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	
Three	Tuesday	Squat jump	40	10min	Low	2x8	2 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	
	Thursday	Squat jump	40	10min	Low	2x8	2 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	
Four	Tuesday	Squat jump	40	10min	Low	2x8	2 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	
	Thursday	Squat jump	40	10min	Low	2x8	2 min b/n each set	5 min	10min
		Jump and reach			Low	2x8		5 min	
		Split squat jump			Low	2x7		5 min	
		Cycled split squat j			Low	2x7		5 min	

The above training program was implemented in every week of November, 2017

Table 11: Plyometric Training program for Second month December, 2017

Week	Training days	Drills	Time	Warming up	Intensity	Training Volume (S X R)	Rest Interval	Duration In Min for drills.	Cooling down
One	Tuesday	Squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10 mi
		Jump and reach			Low	2x10		5 min	
		Double leg hop			Mod	3x5		5 min	
		Double leg zigzag hop			Mod	3x5		5 min	
	Thursday	Squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10 mi
		Jump and reach			Low	2x10		5 min	
		Double leg hop			Mod	3x5		5 min	
		Double leg zigzag hop			Mod	3x5		5 min	
Two	Tuesday	Squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10 mi
		Jump and reach			Low	2x10		5 min	
		Double leg hop			Mod	3x5		5 min	
		Double leg zigzag hop			Mod	3x5		5 min	
	Thursday	Split squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10 mi
		Cycled split squat jump			Low	2x10		5 min	
		Single leg hop			Mod	3x5		5 min	
		Standing triple jump			Mod	3x5		5 min	
Three	Tuesday	Split squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10mi
		Cycled split squat jump			Low	2x10		5 min	
		Single leg hop			Mod	3x5		5 min	
		Standing triple jump			Mod	3x5		5 min	
	Thursday	Split squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10 mi
		Cycled split squat jump			Low	2x10		5 min	
		Single leg hop			Mod	3x5		5 min	
		Standing triple jump			Mod	3x5		5 min	
Four	Tuesday	Squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10mi
		Jump and reach			Low	2x10		5 min	
		Double leg hop			Mod	3x5		5 min	
		Double leg zigzag hop			Mod	3x5		5 min	
	Thursday	Split squat jump	40	10 mi	Low	2x10	2 min b/n each set	5 min	10m
		Cycled split squat jump			Low	2x10		5 min	
		Single leg hop			Mod	3x5		5 min	
		Standing triple jump			Mod	3x5		5 min	

The above training program was implemented in every week of december,2017

Table 12: Plyometric Exercise Program for Third Month (January, 2017)

Week	Training days	Plyometric Drills	Time	Warming up	Intensity	T. volume SXR	Rest Interval	Duration In Min for drills.	Cooling down
One	Tuesday	Squat jump	40	10 Mi	Low	2X10	2 Min	5 Min	10mi
		Double leg hop			Mode	3X6		5 Min	
		Single leg hop			Mode	3X6		5min	
		Double leg V.J			High	3X5		5min	
	Thursday	Jump and reach	40	10 Mi	Low	2X10	2 Min	5 Min	10mi
		Double leg hop			Mode	3X6		5 Min	
		Single leg hop			Mode	3X6		5 min	
		Double leg V.J			High	3X5		5min	
Two	Tuesday	Split Squat jump	40	10 Mi	Low	2X10	2 Min	5 Min	10mi
		Double leg zig zag J			Mode	3X6		5 Min	
		Standing triple Jum			Mode	3X6		5min	
		Single leg Vertical J			High	3X5		5min	
	Thursday	Cycled split squat J	40	10 Mi	Low	2X10	2 Min	5 Min	10mi
		Double leg zig zag J			Mode	3X6		5 Min	
		Standing triple Jum			Mode	3X6		5min	
		Single leg Vertical J			High	3X5		5min	
Three	Tuesday	Squat jump	40	10mi	Low	2X8	2min	5 Min	10m
		Double leg hop			Mode	2X8		5 Min	
		Double leg vertical			High	3X5		5 Min	
		Single leg vertical			High	3X5		5 Min	
	Thursday	Jump and reach	40	10mi	Low	2X8	2min	5 Min	10m
		Single leg hop			Mode	2X8		5 Min	
		Double leg vertical			High	3X5		5 Min	
		Single leg vertical			High	3X5		5 Min	
Four	Tuesday	Split squat jump	40	10mi	Low	2X8	2min	5 Min	10m
		Standing triple J			Mode	2X8		5 Min	
		Single leg V.J			High	3X5		5 Min	
		Double leg V.J			High	3X5		5 Min	
	Thursday	Cycled Split S.J	40'	10mi	Low	2X8	2min	5 Min	10m
		Double leg hop			Mode	2X8		5 Min	
		Single leg V.J			High	3X5		5 Min	
		Double leg V.J			High	3X5		5 Min	

The above training program was implemented in every week of January, 2017

## Appendix G

Table 13 :Descriptive Statistics of EG

		N	Mean	Std. Deviation
TEST 1	Pre test result of ST1(10M speed)	15	2.6207	.32006
	During test result of ST1(10M speed)	15	2.3933	.31275
	Post Test result of ST1( 10 M speed)	15	2.2453	.32224
TEST 2	Pre test result of ST2 ( 30m acceleration Test)	15	5.2147	.36408
	During test result of ST2 (30m acceleration test)	15	5.0873	.48263
	Post test result of ST2 (30m acceleration test )	15	5.0193	.50473
TEST 3	Pre test result of SQT (squat test )	15	75.60	13.948
	During test result of SQT (squat test)	15	79.67	12.111
	Post test result of SQT (squat test)	15	85.53	10.927
Test 4	Pre test result of WST(wall sit test)	15	55.4600	3.14752
	During test result of WST(wall sit test)	15	56.4640	1.93425
	Post test result of WST(wall sit test)	15	57.6173	3.15679
Test 5	Pre test result of VJT (vertical jump test)	15	.8173	.08013
	During test result of VJT (vertical jump test)	15	.8800	.09502
	Post test result of VJT (vertical jump test)	15	.9493	.11591
Test 6	Pre test result of SLJT( standing long jump test)	15	1.8980	.13116
	During test result of SLJT( standing long jump test)	15	1.9607	.10215
	Post test result of SLJT( standing long jump test)	15	2.0220	.08801

## Appendix H

Table 14: Paired Samples Test T test of EG

		Paired Differences					Df	Sig.(2 tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	Pre test result of ST1(10M speed) - Post Test result of ST1( 10 M speed)	.37533	.22061	.05696	.25316	.49750	14	.000
Pair 2	Pre test result of ST2 ( 30 m acceleration Test) - Post test result of ST2 (30 M Acceleration test )	.19533	.20504	.05294	.08179	.30888	14	.002
Pair 3	Pre test result of SQT (squat test ) - Post test result of SQT (squat test)	-9.933	4.527	1.169	-12.440	-7.426	14	.000
Pair 4	Pre test result of WST(wall sit tes) - Post test result of WST(wall sit tes)	-2.1573	3.4491	.89057	-4.0674	-.24726	14	.030
Pair 5	Pre test result of VJT (vertical jump test) - Post test result of VJT (vertical jump test)	-.1320	.05427	.01401	-.16206	-.10194	14	.000
Pair 6	Pre test result of SLJT( standing long jump test) - Post test result of SLJT( standing long jump test)	-.1240	.10762	.02779	-.18360	-.06440	14	.001

## Appendix I

Table 15: Descriptive Statistics of CG

		N	Mean	Std. Deviation
Test1	Pre test result of ST1(10M speed)	15	2.6467	.34614
	During test result of ST1(10M speed)	15	2.5400	.39243
	Post Test result of ST1( 10 M speed)	15	2.4473	.45642
Test 2	Pre test result of ST2 ( 30 m acceleration Test)	15	5.3100	.34059
	During test result of ST2 ( 30m acceleration test)	15	5.2713	.36024
	Post test result of ST2 (30m acceleration test )	15	5.2420	.30050
Test 3	Pre test result of SQT (squat test )	15	74.53	10.656
	During test result of SQT (squat test)	15	76.93	8.506
	Post test result of SQT (squat test)	15	79.53	7.689
Test 4	Pre test result of WST(wall sit test)	15	54.5067	2.09437
	During test result of WST(wall sit test)	15	55.1447	1.96496
	Post test result of WST(wall sit test)	15	55.4153	2.41213
Test 5	Pre test result of VJT (vertical jump test)	15	.7647	.06221
	During test result of VJT (vertical jump test)	15	.7733	.06388
	Post test result of VJT (vertical jump test)	15	.7780	.07331
Test 6	Pre test result of SLJT( standing long jump test)	15	1.8893	.11973
	During test result of SLJT( standing long jump test)	15	1.9027	.09743
	Post test result of SLJT( standing long jump test)	15	1.9187	.09288

## Appendix J

Table 16: Paired Sample T Test of CG

		Paired Differences					Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	Pre test result of ST1(10M speed) - Post Test result of ST1( 10 M speed)	.19933	.23054	.05953	.07166	.32700	14	.050
Pair 2	Pre test result of ST2 ( 30 m acceleration Test) - Post test result of ST2 (30 M Acceleration test )	.0680	.12013	.03102	.00147	.13453	14	.046
Pair 3	Pre test result of SQT (squat test ) - Post test result of SQT (squat test)	-5.00	5.720	1.477	-8.167	-1.833	14	.040
Pair 4	Pre test result of WST(wall sit test) - Post test result of WST(wall sit test)	-.908	1.8458	.47659	-1.9308	.11353	14	.077
Pair 5	Pre test result of VJT (vertical jump test) - Post test result of VJT (vertical jump test)	-.013	.02350	.00607	-.02635	-.00032	14	.046
Pair 6	Pre test result of SLJT( standing long jump test) - Post test result of SLJT( standing long jump test)	-.029	.04818	.01244	-.05601	-.00265	14	.047

## Appendix K

Table 17: Pre, During and Post Raw Data of Speed Tests (10m sprint and 30m Acceleration test)

NO	Code/Name	pre ST1	during ST1	Post ST1	Pre - ST2	during ST2	Post ST2
1	EG1	2.8	2.5	2.1	5.39	5.33	5.18
2	EG2	2.4	2.1	2	5.04	4.8	4.65
3	EG3	2.2	2.1	1.9	4.93	4.57	4.49
4	EG4	2.5	2.3	2.2	4.88	4.62	4.46
5	EG5	2.8	2.5	2.3	5.52	5.2	5.34
6	EG6	3.1	2.8	2.8	5.65	5.73	5.45
7	EG7	2.3	1.9	1.7	4.93	4.68	4.72
8	EG8	2.3	2.3	2.31	4.96	4.94	5.01
9	EG9	2.77	2.6	2.39	5.55	5.64	5.78
10	EG10	2.8	2.6	2.5	5.1	5.02	4.99
11	EG11	2.6	2.6	2.7	5.74	5.83	5.84
12	EG12	3.3	3	2.6	4.68	4.57	4.47
13	EG13	2.64	2.4	2.2	5.78	5.81	5.63
14	EG14	2.6	2.3	2.2	5.26	5.09	4.97
15	EG15	2.2	1.9	1.78	4.81	4.48	4.31
16	CG1	2.4	2.1	2	5.56	5.5	5.4
17	CG2	2.6	2.5	2.5	5.37	5.2	5.16
18	CG3	2.8	2.8	2.7	5.14	5.1	5.06
19	CG4	2.6	2.6	2.5	4.86	4.91	4.99
20	CG5	2.4	2.5	2.41	5.76	5.71	5.64
21	CG6	2.8	2.5	2.6	5.89	5.79	5.59
22	CG7	2.2	2.1	1.4	5.14	5.16	5.09
23	CG8	3.1	3.4	3.2	5.11	5.09	5.06
24	CG9	2.1	2	1.9	5.02	4.84	5.1
25	CG10	2.6	2.4	2.6	5.27	5.3	5.19
26	CG11	3	2.9	2.8	5.29	5.15	5.3
27	CG12	3.3	3.1	3.1	5.48	5.36	5.46
28	CG13	2.8	2.6	2.5	5.88	6.03	5.85
29	CG14	2.8	2.5	2.3	4.99	5.21	5.07
30	CG15	2.2	2.1	2.2	4.89	4.72	4.67

## Appendix L

Table 18 : Raw Data of Pre, During and Post Strength Tests (Squat and Wall Sit test)

NO	Code/Name	pre SQT	during SQT	Post SQT	Pre WST	during WST	post W
1	EG1	75	77	89	57.3	57.7	56.9
2	EG2	91	93	94	51.4	55	57
3	EG3	79	79	88	59.3	57.6	57.1
4	EG4	69	71	76	52.9	53.12	51.65
5	EG5	53	58	69	57	58.7	61
6	EG6	95	96	102	58.6	57.2	57.9
7	EG7	87	93	98	58.8	56.7	57
8	EG8	51	65	69	51	53.1	57.7
9	EG9	81	89	89	55	58	59
10	EG10	94	86	97	54.6	55.3	58.6
11	EG11	80	90	92	51.7	54	57.7
12	EG12	84	90	92	57.7	58.9	59.6
13	EG13	63	68	79	60.3	57.94	62.8
14	EG14	68	70	76	53.3	56.1	50.41
15	EG15	64	70	73	53	57.6	59.9
16	CG1	67	70	72	55	56.7	58.6
17	CG2	75	75	79	54.8	54.8	55.1
18	CG3	80	76	79	56	55.7	55.5
19	CG4	83	92	94	51	51.9	50.43
20	CG5	67	69	72	53.6	54.17	55.6
21	CG6	64	68	72	54.1	55	56.8
22	CG7	66	73	79	59.2	59.4	59.1
23	CG8	92	86	89	52.6	52.9	53.7
24	CG9	81	84	86	53	54.5	55
25	CG10	83	86	89	53.8	54.3	53.7
26	CG11	93	91	87	55	57.7	58
27	CG12	56	69	72	52.1	54	55.1
28	CG13	69	70	72	57	56.9	56.8
29	CG14	67	70	72	53.8	53.2	52.1
30	CG15	75	78	79	56.6	56	56.7

**Appendix M**

19 Raw data of Pre, during and post power tests (vertical and standing long jump tests)

NO	Code/Name	Pre VJT	During VJT	Post VJT	Pre SLJT	During SLJT	Post SLJT
1	EG1	0.88	0.96	0.99	1.81	1.89	1.97
2	EG2	0.77	0.85	0.89	1.80	1.87	1.99
3	EG3	0.86	0.94	1.02	1.73	1.95	2.03
4	EG4	0.76	0.81	0.89	1.74	1.8	1.92
5	EG5	0.67	0.72	0.79	1.81	1.89	1.97
6	EG6	0.76	0.82	0.88	1.89	1.94	2
7	EG7	0.73	0.78	0.83	2.05	2.02	2
8	EG8	0.84	0.88	0.92	2.11	2.09	2.01
9	EG9	0.85	0.89	0.95	2.1	2.1	2.07
10	EG10	0.79	0.83	0.86	1.78	1.86	1.93
11	EG11	0.91	0.97	1.2	1.95	2.01	2.13
12	EG12	0.84	0.9	0.99	1.91	1.99	2.14
13	EG13	0.74	0.81	0.87	1.86	1.93	1.97
14	EG14	0.89	0.93	0.99	2.08	2.17	2.24
15	EG15	0.97	1.11	1.17	1.85	1.9	1.96
16	CG1	0.76	0.76	0.77	1.66	1.75	1.79
17	CG2	0.87	0.89	0.91	1.81	1.83	1.85
18	CG3	0.77	0.8	0.81	1.91	1.95	1.97
19	CG4	0.83	0.86	0.85	1.92	1.88	1.9
20	CG5	0.75	0.76	0.78	1.97	1.99	2.02
21	CG6	0.89	0.89	0.92	2.04	2.06	2.02
22	CG7	0.8	0.78	0.78	2.12	2.04	2.07
23	CG8	0.78	0.8	0.81	1.94	1.89	1.9
24	CG9	0.75	0.77	0.78	2.01	2.04	2.07
25	CG10	0.76	0.75	0.75	1.77	1.81	1.83
26	CG11	0.72	0.74	0.75	1.81	1.83	1.87
27	CG12	0.76	0.77	0.74	1.89	1.91	1.86
28	CG13	0.81	0.84	0.85	1.76	1.79	1.81
29	CG14	0.72	0.73	0.7	1.83	1.84	1.85
30	CG15	0.77	0.75	0.75	1.9	1.93	1.95

*EG= Experimental Group, CG= Control Group*

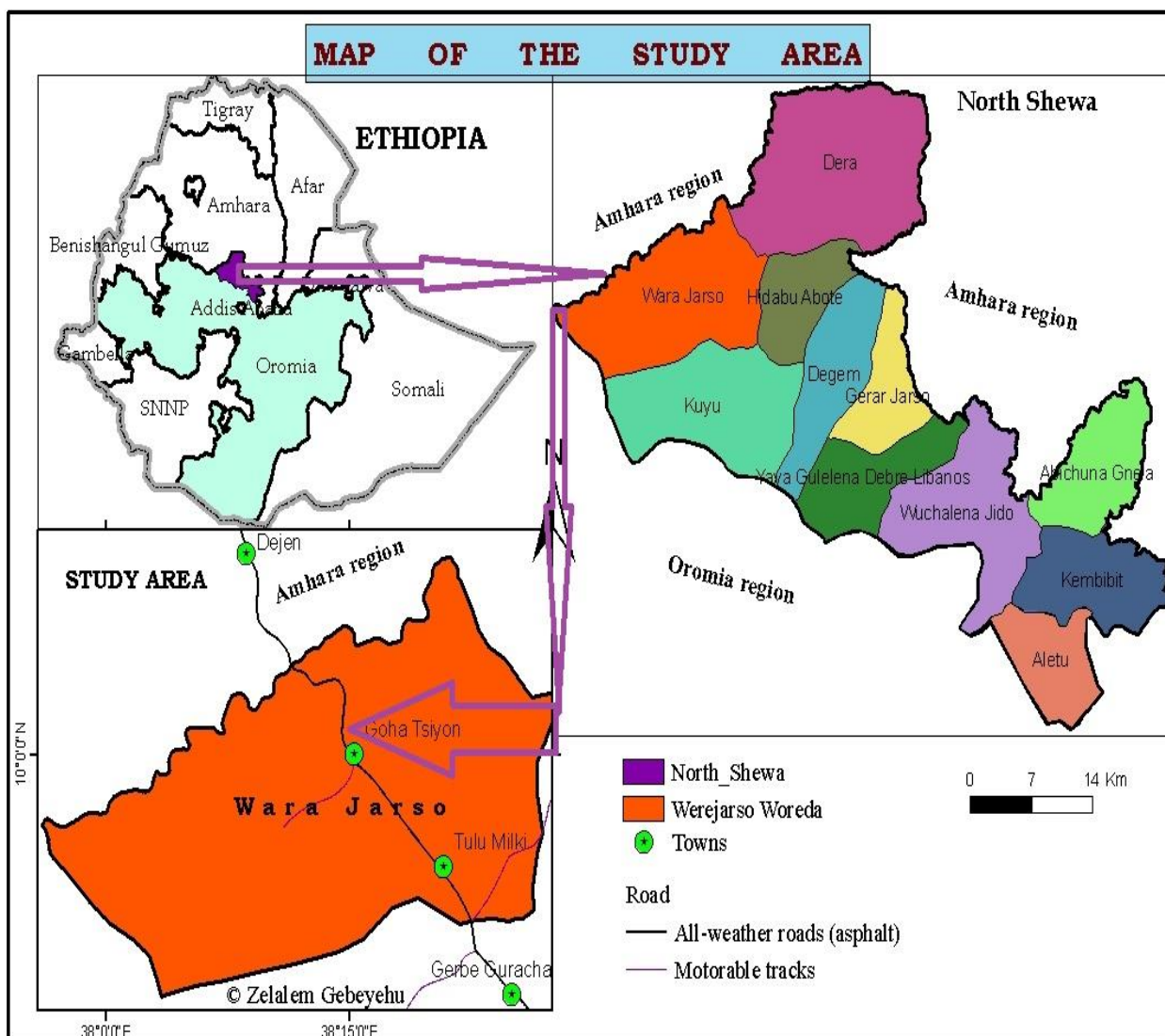
## Appendix N

Table 20: Anthropometric characteristics of EG and CG

NO	Code/Name	Age (y)	Weight (kg)	height (m)	BMI (kg/m <sup>2</sup> )
1	EG1	20	62	1.72	21.37
2	EG2	22	64	1.75	20.91
3	EG3	22	60	1.7	20.76
4	EG4	19	58	1.69	20.3
5	EG5	24	62	1.74	20.52
6	EG6	23	67	1.75	21.89
7	EG7	25	68	1.76	22
8	EG8	19	59	1.69	20.7
9	EG9	20	60	1.7	20.76
10	EG10	20	63	1.7	21.79
11	EG11	19	60	1.74	19.86
12	EG12	22	61	1.75	19.93
13	EG13	21	63	1.7	21.79
14	EG14	21	63	1.69	22.1
15	EG15	20	58	1.69	21.09
16	CG1	21	62	1.7	21.45
17	CG2	20	63	1.74	20.86
18	CG3	20	64	1.74	21.19
19	CG4	23	66	1.75	21.56
20	CG5	21	59	1.71	20.2
21	CG6	22	61	1.7	21.1
22	CG7	22	60	1.68	21.27
23	CG8	21	63	1.73	21.07
24	CG9	20	68	1.76	22
25	CG10	24	65	1.69	22.8
26	CG11	19	67	1.74	22.18
27	CG12	19	63	1.7	21.79
28	CG13	23	58	1.66	21.09
29	CG14	19	64	1.73	21.4
30	CG15	22	61	1.75	19.93

Appendix O

Figure 1: Map of the Study Site



Source: <http://www.ethiomapping.com>