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EFFECT OF PLYOMETRIC TRAINING ON SELECTED TECHNICAL SKILLS PERFORMANCE OF U- 15 MALE HAND BALL PROJECT PLAYERS

SOLOMON, HABTAM

BAHIR DAR UNIVERSITY

GRADUATE STUDIES OFFICE

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SOLOMON HABTAMU DEMISIE

A THESIS SUBMITTED TO THE SPORT ACADEMY OF BAHIR DAR UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN COACHING HANDBALL.

PRINCIPAL ADVISOR: ZEMENU TESHOME (ASSISTANCE PROFESSOR)
CO-ADVISOR: SISAY ADUGNA (ASSISTANCE PROFESSOR)

JUNE, 2021
BAHIR DAR

ADVISOR'S APPROVAL SHEET

BAHIR DAR UNIVERSITY

GRADUATE STUDIES OFFICE

SPORT ACADEMY

DEPARTEMENT OF SPORT SCIENCE

I hereby certify that I have supervised, read, and evaluate this thesis entitled "effect of plyometric training on selected technical skills performance of u- 15 male handball project players by Solomson Habtamu prepared under my guidance. I recommend the thesis be submitted for oral defense.

_____	_____	_____
Advisor's name	signature	date
_____	_____	_____
Co-Advisor's name	signature	date

EXAMINER'S APPROVAL SHEET

BAHIR DAR UNIVERSITY

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SPORT ACADENMY

DEPRTEMENT OF SPORT SCIENCE

As members of the board of examiners, we examined this thesis entitled "effect of plyometric training on selected technical skills performance of u- 15 male handball project players by Solomon Habtamu. We hereby certify that the thesis is accepted for fulfilling the requirements for the award of the degree of "Master of Science in Handball Coaching".

Board of examiners

External examiner's name	Signature	Date
Internal examiner's name	Signature	Date
Chair person's name	Signature	Date

DECLARATION

I, hereby that this thesis for the partial fulfillment of the requirement for the Degree of Master of Science in Coaching handball on the title of “Effect of Plyometric Training on Selected Technical Skills Performance of U- 15 Male Handball Project Players is my real original work and all sources of materials used in this thesis have been acknowledged. It has not previously formed on the basis for the award of any Degree, Diploma of any University, Other institution of higher learning or publication except where due acknowledgement is made in acknowledgements.

_____	_____	_____
Name of the candidate	Date	Place

DEDICATION

I dedicate this thesis manuscript to my mother and beloved friends. As well as the researcher extended his dedication to the man who contribute even a piece of advice throughout in my life to reach in this stage.

Mr. Solomon Habtamu

Signature:-_____

Date: _____

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LIST OF ABBREVIATIONS

CG ----------Control group

EG ----------Experimental group

FITT----------Frequency, Intensity, Time and Type of exercise

IHF ----------International Handball Federation

NSCA ----------Nation Strength and Conditioning Association

PT----------Plyometric training

SAQ ----------Speed, Agility and Quickness

SSC ----------Stretch - shortening cycle

ABSTRACT

The purpose of this study was to investigate the effects of plyometric training on selected technical skills performance of u-15male handball project players at Borena woreda Ethiopia. The total subject for the study were twenty-four (n =24) male handball trainees of Borena woreda handball project players in Ethiopia 2013 E.C. The study populations were little; all are taken as a sample by using comprehensive sampling technique. Through randomization method trainees segregated in to two groups, an experimental group (n=12) and a control group (n=12). The experimental group (EG) performed twelve-week low to moderate plyometric training, 3-days per week for a total of 45 minutes and the control group (CG) did only their regular handball training 3 days per week for 60 minutes duration. The data was collected through field technical skill tests (jump shoot test to jumping accuracy, accuracy throw test to passing accuracy and obstacle dribbling test to speed dribbling).The data were analyzed by using Paired sample t-test and Independent sample t-test statistical tools SPSS version 23 with significance level of 0.05.Based on the analyzed data, the pre-posttest performance of EG were significantly improved in passing accuracy, shooting accuracy and speed dribbling ($p=0.000$, $p<0.05$).similarly, the independent t-test shows the posttest performance of these variables in EG were significantly more improved than posttest result of CG ($p=0.000$, hence $p<0.05$). The results of this study shows that 12 weeks plyometric training improves shooting accuracy, passing accuracy and speed dribbling of u-15 male handball project player's technical skills performance. Therefore the study recommend that coaches should give concentration to plyometric training in coaching handball projects.

Key words: shooting accuracy, passing accuracy, speed dribbling, power, stretch shortening cycle

CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Team Handball is a fast paced match of defensive and offensive action that includes specific movements of jumping, passing, throwing, checking and screening (Wagner, Wagner, H., Pfusterschmied, J., Tilp, M., Von Duvillard, S. P., & Müller, E., 2014).The level of performance in modern handball sport determined by players' psychological, social, technical and physical characteristics. All these elements are high importance in team handball and also closely interlinked making team handball a particularly complex type of sport (Michalsik, Aagared, and Madsen, 2013). Handball players are a thrower, sprinter, jumper all in one and they should accomplish these skills with speed and accuracy (Kruger et al., 2014). They repeatedly achieve receiving, shooting, dribbling, and passing skills (Karadenizli, 2016).

In handball, as in other team sports, shooting a ball at the goal is the final of an offensive phase. Success or failure depends on whether a team attains its ultimate aim, that of scoring a goal. Shooting efficiency is the key to winning or losing matches. It depends largely on the accuracy and speed of a throw (Garcia, Grande, Sampedro and Tillar, 2011; Marques et al., 2007). Accuracy is one of the most important conditions in order to reach the needed result in team handball because of being high intensity intermittent types of sport. Shooting the ball hard is not enough to beat a goalie; accuracy is essential (Clanton & Dwight 1997). Shooting performance has been related to maximal force, the rate of force development and stretch shortening cycle capacity (Rimmer & Sleivert, 2000). To achieve a high shooting percentage and win a game, every team has to have players who can accurately shot in all periods of the game and under different physiological or psychological pressures. Consequently, it can be said that shooting accuracy is one of the most important technical skills in handball (Pojski, Separovic and Nin, 2011).

An additional variable that can potentially affect the technical skill performance difference in team handball players is passing accuracy. It is important, therefore, in handball is regarded as basic parameters of performance during the competition (Pori & Sibila, 2003).

Another important variable that has a great influence to contribute to technical skill performance in handball is speed dribbling. Relating to speed dribbling (Suresh, Mohan, Rajeswaran, (2014) contended that speed dribbling is an important technique for handball players. It helps a handball player to move with the ball towards the opponent's goal under the control of the ball within the free space. Similarly, speed dribbling in handball is the skill of running as fast as possible while keeping the ball out in front, available to be closely controlled by the dribbler. Speed dribbling is not throwing the ball and sprint after it. Moreover, it is used offensively when there is a clear free space. It helps a player to move with the ball through open space (Suresh, Suresh, K., Mohan, K., &Rajeswaran 2014).

The capacity to improve performance in athletes and recreationally trained individuals is the primary goal of sport performance. Plyometric training is ranked among the most frequently used methods for the development of the above mentioned profiles in team sport. Performance in most competitive sports depends on an athlete's ability to produce force quickly. For athletes looking to jump higher, run faster, throw farther, or hit harder, plyometric training is the answer (Jackie Lebeau). Plyometric training involves exercises that generate quick, powerful movements involving explosive concentric muscle contraction followed by eccentric muscle action. Plyometrics occur in any sport that involves cutting, change of direction, sprinting and jumping. A high level of muscle power is necessary for the effective use of technique during handball competitions. The applied techniques (passes, throws, jumps, starts, changes of running direction), as well as proper technical and tactical behaviors (e.g., ball handling, individual defensive actions, direct contact with opponents, etc.) often require the player to develop high values of power in a very short time. This means that the effectiveness of a technique in sports competition is largely dependent on the level of competitor's anaerobic power (Gorostiaga, Gorostiaga, M., Granados, C., Ibanez, J., Izquierdo, M., 2005; Povoas, Povoas, S., Seabra, A., Ascensao, A., Magalhaes, J., Soares J., &Rebelo,

A, 2012; Thorlund et al., 2008; Wagner, Wagner, H., Pfusterschmied, J., Tilp, M., Von Duvillard, S. P., & Müller, E., 2014). In the same way another study showed that, the majority of specific handball actions involve stretch shortening cycles, based on the fact that a concentric action produces higher peak torque when preceded by an eccentric contraction (Enoka, 1997; Hakkinen et al., 2000; Komi, 2000). Consequently plyometric training is very important to develop technical skill of handball players.

Additionally, international numerous studies have discovered positive effects of short-term plyometric training on jumping performance in basketball (Brown et al., 1986; Matavulj et al., 2001), soccer (Ramirez-Campillo, Ramirez-Campillo, R., Meylan, C., Alvarez, C., Henriquez-Olguin, C., & Martinez, C., 2014, 2015ab; Thomas, Thomas, K., French, D., & Hayes, P., 2009), volleyball (Martel et al., 2005; Milic, Milic, V., Nejic, D., & Kostic, R., 2008), handball (Chelly, Chelly, S., Hermassi, S., Aouadi, R., &Shephard, J., 2014; Hermassi, Hermassi,S., Gabbett, T., Ingebrigtsen, J., van den Tillaar, R., Chelly, M., &Chamari, K., 2014) and other team sport. In our country plyometric training effect on team handball technical abilities had discovered such as (wubliker, 2020) and (Yordanos, 2020). It has been reported that plyometric training impr oves shooting accuracy and speed dribbling performances.

However, the effect of plyometric training related to the technical skills performance of handball project players remains to be unanswered task for coaches and researchers. Plyometric training along with high technical skill performance was considered to the major factor leading to positive accomplishments of each handball team player throughout the competition season (Frost, 2013). However, there is still unconcluded interest among researchers as to what extent plyometric training better improve the technical skill performance of handball project players. Therefore, the researcher motivated to investigate the effect of 12 weeks plyometric training on technical skill performance of handball players at Borena Woreda u-15male handball project players.

1.2 Statement of the problem

Handball is a very attractive modern sport with fast and exciting action. Successful performance in handball requires good shape abilities, technical and tactical skills to achieve success within the competition (Van den, 2004) and to accomplish the required result. Passing accuracy, shooting accuracy and dribbling speed are the most decisive factors to handball sport. However, derived from the researcher's observation, Borena woreda u-15 male handball project players had a big problem to shoot a ball accurately and powerfully, to pass a ball accurately to their teammates and to dribble a ball quickly and properly. The researcher lives near to the project. That is why; the researcher got the opportunity to observe a variety of aspects of their training session and training methods of Borena woreda u-15 male handball project players. As the researcher observed it for the last two years, coaches have set fewer concentrations for plyometric training and players technical skills. The players were not good in executing handball skills completely and successfully. All training activities were only handball game oriented and physical fitness exercises. This might place the players developing poor technical skills performance. In fact, players showed restriction on technical skill performance when the researcher's observation in their training program and when played the game. Accordingly, the investigator believes that if the trainer gives enormous concentration to plyometric training on their training program, it would have an impact on player's technical skill performances. Because of performance in most competitive sport depend on an athlete's ability to produce force quickly. For athletes looking to jump higher, run faster, throw farther, or hit harder, plyometric training is the answer (Jackie Lebeau).

Different researchers and analyses are being attentive to the consequences of plyometric training on technical skill performance in team handball. Such as, Yahya, Bahador, Mohammed, (2014) conduct a study on the effect of Plyometric exercise on shooting accuracy of handball payers and proved that plyometric training has no significant effect on shooting accuracy. On the contrry, Surendra (2018), Wubliker (2020) and Yordanos (2020) proved that plyometric training had a big effect on jumping and shooting accuracy of handball players. These previous research works indicated that there is a controversial research issue about the effect of plyometric training on shooting

accuracy of handball players and these listed studies had not addressed the effect of plyometric training on technical skills performance of u-15 male handball project players. Thus, this study conducted to fill the gap of these previous research findings.

In addition, Baouche et al. (2017) conducted a study on the impact of plyometric exercises within the development of explosive power and some basic skills of handball players. Hence, plyometric exercises had significantly developed the amount of performance of passing accuracy, receiving, speed dribbling, and jumping skill of handball players. Against this, Subash (2010) conducted on the effect of plyometric training on selected condition and skill performance variables of intercollegiate level men handball players. The study concluded that plyometric training group had no significantly improved speed dribbling and passing accuracy of intercollegiate level men handball players. Similarly, these previous research works had controversial conclusion. Therefore to fill the gap of the above two researchers' results, this study was conducted on the effect of plyometric training on shooting accuracy, passing accuracy, speed dribbling of handball project players at Borena woreda.

Recently, in Ethiopia Wubliker (2020) conducted a study on the effect of plyometric training on technical skill performance of handball team players at Debre markos town. The study was conducted on shooting accuracy, passing accuracy and speed dribbling performance. This research work also conducted on team players level. The study could not address project players and the test methods used in this study could not measure actual game performances. So this study will try to address the effect of 12 weeks plyometric training on shooting accuracy, passing accuracy and speed dribbling of u-15male handball project players at Borena woreda.

Moreover, Yordanos (2020) conducted a study on the effect of plyometric training on Shooting Performance and Some Selected Physical Fitness qualities in Case of Ethiopia Adet Town u-17male handball Project Players. The study conducted on only one technical skill performance of handball that is shooting accuracy. This research work also doesn’t answer plyometric effect on passing accuracy, and speed dribbling skills of

handball players. So this study tried to address another technical skills (passing accuracy and speed dribbling, of u-15male handball project players of Borena woreda.

Still, in Ethiopia, there is no specific research into plyometric training in related to speed dribbling, passing accuracy, and shooting accuracy of u-15male handball project players. Despite the extensiveness of the problem, this study look into the plyometric training in regard to speed dribbling, passing accuracy and shooting accuracy in Ethiopia especially in Amhara Regional State in South wollo Zone Borena Woreda u-15 male handball project players as a point of interest, there is no study conducted on the effect of plyometric training on technical skill performance of u-15male handball project players. Therefore, the purpose of the study was to investigate effects of plyometric training on selected technical skills performance of u-15 handball project players.

1.3 Objectives of the study

1.3.1 General objective

The general objective of the study was to investigate the effect of plyometric training on selected technical skills performance of u-15male handball project players.

1.3.2 Specific objectives

In line with general objective, the study was organized under the following specific objectives:

1. To examine the effect of plyometric training on shooting accuracy performance of u-15 male handball project players.

2. To identify the effect of plyometric training on passing accuracy performance of u-15 male handball project players.

3. To determine the effect of plyometric training on speed dribbling performance of u-15 male handball project players.

1.4 Hypothesis of the study

This thesis had conducted under the following hypotheses:

H.1 Plyometric training has significant effect on shooting accuracy performance of u-15 male handball project players.

H.2 Plyometric training has significant effect on passing accuracy performance of u-15 male handball project players.

H.3 Plyometric training has significant effect on speed dribbling performance of u-15 male handball project players.

1.5 Significance of the study

This study has provided different information for the concerned bodies such as, coaches, trainees, and other researchers who are motivated to do research in this area. So, the findings of this study may have a great contribution to add new ideas to the existing knowledge of the coach and to design appropriate training program for those handball players. Motivate players to engage in plyometric exercises regularly for the improvement of technical skill. Provide proper and fertile ground for handball coaches to allocate time for plyometric training when they design training program for the improvement of technical skill. Promote technical skill test methods to handball players especially for shooting accuracy, passing accuracy and speed dribbling. In addition to this, the study will help the trainees as well as the coach to know their skill level and this training method will develop their technical skill performance level or not.

Moreover, this study has provided important baseline information and reference data on the effect of plyometric training on technical skill performance of handball project players for coaches, instructors, and trainees. Furthermore, since there is a shortage of research study on handball sport in Ethiopia the findings of this study will be reference materials for future researchers on the same title in different perspectives.

1.6 Delimitation of the study

In research, delimitations address how the study is narrowed in scope (Creswell, 2012). This study was designed to investigate the effect of plyometric training on selected technical skills performance of u-15 male handball project players, but it was delimited in the following areas:

- Participants were selected only from Borena woreda male u-15 project players.
- The independent variable was plyometric training with different variations of exercises.
- As because of the training participants were u-15 year the training intensity was delimited on low to moderate plyometric training.
- Handball includes a form of technical skills that are important for achievement in handball competition. This includes passing, shooting, feinting, goal keeping, dribbling and catching. But this study was delimited on the effect of plyometric training on shooting accuracy, passing accuracy and speed dribbling of u-15male handball project players.
- Only field tests those are easily administered were used to measure the selected technical skills.
- The training program was delimited to 12 weeks, 3days per week with 45 minutes duration per session.
- The study delimited the particular project performance of the training season 2020/2021 G.C.

1.7 Limitations of the study

Despite the attempts made to ensure reliability and validity of data to make this research complete, the following points might be considered as limitations of the study.

- The study focused on plyometric training; hence, the findings may not be generalize and applicable to the other factors for shooting accuracy, passing accuracy and speed dribbling. Because other different factors or skills possess distinctive features, they require respective investigations.

- On the other hand, the sample players were taken regardless of players' position, so that the difference responsibilities of the players may have an impact on the results of this study.
- As the subjects participating in this study belong to various schools, therefore the factors such as nutrition, training, regular life activity, psychological and emotional strength etc, may be different and may not be controlled.
- The skill training given to the selected subjects by their coaches will not be taken into consideration for this study.

This may have considered as the limitation of the current study, though, important steps were taken to systematically handle this possible limitation.

1.8 Operational definitions of key terms

For the sake of keeping consistency throughout this research, the researcher identified a list of key terms and their definitions, which appeared often within the study, are presented below.

Borena: district found in Amhara regional state, South wollo zone.

Passing accuracy: the ability to give the ball as much as possible to the teammate exactly and accurately in a very fast manner without interrupted by an opponent, accurate passing ensures the pace and continuity of team plays and keeps the pressure on the defense by allowing each attacker the chance to make a scoring chance.

Plyometric training: Plyometric could be a variety of exercise that trains muscles to provide power. It involves a stretch of the muscles, immediately followed by a contraction of the same muscles. It includes vertical and broad jumps additionally as pushups. Jumping squats, depth push up, zigzag hops, split squat jump, clapping wall push -up, single leg vertical jump and clapping push-ups are samples of plyometric exercises.

Project: is a long term that is carefully planned and structured in order to improve handball Player's fitness and skills level.

Shooting accuracy: the power to control one's movement and shot the ball as hard as possible a player can to a particular target within which the goalkeeper and defenders cannot easily reach the ball and defend or block it.

Speed dribbling: is that the skill of moving as fast as possible by bouncing a ball with the ground with fingers while keeping the ball goes forward. It will be used when there's no defense before of the player and there's an open space towards the opponent goal.

Training: is a process by which an athlete prepared for the highest level of performance

Technique: a practical ability in some field or practice or a method of achieving something or carrying something out, especially one require some skill or knowledge.

Skill: capacity to do something well; skills are usually acquired or learned.

Performance: the degree how much the skill has been accomplished.

1.9 Organization of the study

This research was organized in five chapters. In the first chapter, presented the background to the study, statement of the problem, research hypotheses, general objective of the study, specific objectives, significance of the study, delimitation of the study, limitation of the study, operational definitions of key terms and organization of the study also described in detail.

Chapter two concentrates on a review of related literature. In this section, relevant research works of both conceptual and empirical analysis was thorough and deeply reviewed so as to support and contradict the problem and the findings of the study utmost and the missing part that needs to be fulfilled.

The third chapter of this study explains the research methods that include, description of the study area, the research approach, research design, study population, sample and sampling techniques, inclusion and exclusion criteria, source of data, data collection instrument, method and procedure of data collection, training protocol, method of data analysis, and ethical consideration were discussed in detail.

The fourth chapter deals with introduction of result, presentation, analysis and discussion of the data, and the last chapter five deals with the summary of the findings, conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Short description of handball sport

Handball is a team sport in which two teams of seven players each six outfield players and a goalkeeper pass a ball using their hands with the aim of throwing it into the goal of the other team. A standard match consists of two periods of 30 minutes, and the team that scores more goals wins. A regular handball match in case of male and female teams (over 16) lasts 2x30 minutes with a 10 minute break in between. During the match there is a chance to have 3x1 minute time-out, but the attacking team can only do it only one time in the last 5 minute. The team consists of maximum 16 players. Maximum 7 players can be present in the playing field at a time (International Handball Federation, 2019).

2.2 Handball skills and techniques

Fundamental movement skills are the basis of any sport specific technical skills. Knowing these skills is the first step toward gaining a greater understanding of the technical skills required to play handball. As a coach good lesson planning decisions start with this understanding of the relationship between basic movement skills and technical skill acquisition. It is well known that the modern handball player has to be a very skillful and complex athlete. They are jumper, thrower, sprinter, strength athlete with very high coordination and balance all in one, and must perform these skills at high speed and with accuracy. Individual technical handball skills which are essential to perform in a game can be divided into three categories: attack skill, defense skill, goal keeper skill. Encompassment of all skills leads to more effective play and to enjoyment from the game. Basic Attacking Skills can be sub divided into attacking skill with ball and without ball. Ball handling, passing, shooting, move with ball (dribbling/bouncing), creating space and faking are most type of attacking skill with ball these players used during the game. Available to teammates, receiving the ball, faking, use free space and creating space are attacking skill without ball IHF, (2019).

2.2.1 Ball handling

Good techniques of ball handling allow player to: take information about other factors and action without having to concentrate on the ball, move up the court quickly, fake with greater certainty of success, shooting and passing with greater precision and rotation of the ball. The player should hold a ball with the fingers. The thumb is almost opposite the little finger, and the last phalanges grip a ball strongly so that the player in motion, or in various activities, does not lose control of the ball. Players can play the game and learn a correct throwing technique with balls whose sizes correspond to the size of their hands. The most common error is to carry the ball in the palm of the hand. Therefore, check to make sure there is a small gap between the palm and the ball. While playing, players shouldn't focus on the ball itself, but should perceive other factors as well (e.g., own position, positions of teammates, positions of opponents, position of goalkeeper) IHF, (2019).

Figure 1 proper ball handling

2.2.2 Catching

Catching the ball is a major technical skill in handball. Accurate catching is very important and ensures a fast, smooth and efficient game. Catching the ball with two hands is the best technique for beginners. Fingers should be relaxed and properly placed on the ball, providing shock absorption during impact. An additional element, which is important while catching, is the speed of movement, proper positioning in regard to the path of a ball and immediate preparation for the following activity. Receiving the ball includes whole body positioning, most importantly the relation to teammates and opponents on the court. The attacker must try to receive the ball in a way which will

allow them to take the ball into space and away from pressure. The most basic two-handed catching is done at chest level (face-to-face and sideways). But there is a huge variety, depending on the situational constraints, such as at upper and lower levels, in mid-air, after bouncing, from the ground (with the help of the other hand), etc. One handed catching is an advanced skill for the majority of learners. A player rotates the upper part of the body, stretches their arms in the direction of the flying ball. Fingers are spread, index fingers and thumbs point to the other hand and create the shape of an inverse heart. In the moment of contact of ball and fingers, the arms bend at elbows, withdrawing to the direction of the chest (this lessens the impact of the pass), and after taking control, they immediately move into throwing position. When catching the ball below the waist, a player performs an underarm catch of the ball. Arms are stretched in the direction of the flying ball, fingers spread, little fingers pointing to each other. After contact, the arms bend at the elbows and move near to the chest, directing the ball forwards, preparing for the pass. Good techniques of catching allow player to: make next action (faking, passing, dribbling, shooting, etc.) quickly and be immediately dangerous to opponent IHF, (2019).

Figure 2 proper upper catching and lower catching

2.2.3 Passing

Passing is basic building blocks of an attack, the simplest connection between two attacking players. The player with the ball is responsible for passing the ball to a teammate. The player needs to take into consideration the direction, distance, timing and choice of the right kind of a pass. A pass must be accurate (not too strong and not too

weak), fast (make decision of the situation quickly) and tactically useful (teammate in a good position, ready to receive the ball). Fundamental techniques of passing are passing with dominant/non-dominant hand, put arm with the ball behind and over the head and upper than shoulder, and step with leg opposite of throwing arm. Feet pointed to goal, rotate upper part of the body to the direction of pass, movement of the arm with the ball forward starting with the shoulder and finishing the movement with wrist and fingers giving the ball extra speed and direction and player should coordinate and balance because player can obtain extra power in the pass by rotating the body and following through. fundamental tactics of passing are take in the information of which teammate is in the better position (what is the position of the defenders), take in the information if the teammate is ready to receive the ball, passing should be as simple as possible (without additional moves), ball should be passed in front of teammate, considering the player's speed, passing player is responsible for quality of the pass and a good pass is a pass that a teammate can catch IHF, (2019).

Passing can be divided according to many aspects based on to the usage of arms: two-hand passes (sticking from the chest, from behind the head), dominant-handed pass and non-dominant-handed pass, according to the distance of flying: short pass, medium pass and long pass, according to the path of flight: straight pass, bounce pass, lob pass (curl pass) and upper, half-upper, near hip, lower, or in particular situation, according to the position in relation to a teammate: forward pass, side pass, backward pass, pass from behind the back and pass from behind the head and according to the characteristics of the activity performed by a passing player: pass from a stationary position, running passes (in motion),and jump pass (preliminary stride, vertical). Good quality techniques of passing allow teammate to catch the ball easier and in good timing and teammate to get into an advantageous position. Players need to recognize that passing is quicker than movement of the attacker with the ball. For short distances and fast passes, wrist or forearm passes are a fast and accurate way to pass the ball to a teammate. . Research was conducted on this fundamental skill of handball. For example, Ezhilmaran (2016) conducted the study on "effect of specific drills with plyometric training on selected skills performance variables of school level men handball players" and proved that experimental group

showed progress in selected skill performance variable was passing due to effect of specific drills with plyometric training.

Figure 3 basic position of passing

2.2.3.1 Throwing accuracy

Throwing ability is one of the most significant skills for a handball player, in order to be successive in handball (Gorostiaga et al., 2005). The combination of throwing velocity and accuracy is two of the most important factors when it comes to pass, because a fast and accurate throw to teammate makes the defenders and goalkeeper less time to defend the shot (Gorostiaga et al., 2005). For that reason, the number of researches centered on the throwing accuracy and velocity in handball has increased during the last years (Raeder et al., 2016), but the studies focus on analyzing the speeds registered in training situations (Hermassi et al., 2015). Accuracy has to do with the ability to control one's movement in relation to a specific target.

Likewise, many physical education activities involving accuracy of movement for throwing, hitting and shooting and the success dependent on this factor. Accuracy is no doubt interrelated with other factors such as co-ordination, balance and visual perception but it is sufficiently different to make it an entity in itself. In some cases, the existing possible relations between throwing velocity and the anthropometric variables were studied (Debanne &Laffaye, 2011), in other cases, biomechanical analyses of the throwing speed in handball players were carried out (Van den Tillaar et al., 2013). Also, the possibility of relations between the development of conditional capabilities and the throwing speed in handball has been studied (Sabido et al., 2016) or whether the opposing actions can modify the throwing speed (Rivilla et al., 2010).

Throwing plays a vital role in many sports. The faster the ball, the ball is thrown far apart. If an athlete's throwing is impaired, it puts him/her disadvantage when compared to other athletes with better throwing power. For a successful handball player, it is necessary for the player to be able of throwing the ball with power and accuracy from one point to the next point of play. Although all the game has different throwing techniques, but the same muscle actions may be used in throwing action. It is possible that the physical factors and other factors affect the powerful and accurate throw in handball sport or game. However, an effective throw is the result of good technique and physical fitness components. Technique does indeed play a major role in the throwing motion. But the efficiency of the force passed onto the ball is judged in terms of the speed, distance, and direction of the ball after releasing the ball. The speed and distance of the ball that is thrown is directly related to the magnitude of the force used in throwing and to the speed of the moment of the ball release. Because the joint actions in the shoulder, elbow, wrist, and fingers contribute to the speed of the ball (Rivilla et al., 2010).

Throwing in handball is the most key action in success or failure in the offensive phases of the game. While comparing the results of the throwing accuracy the significant results found in between the pre & post data of speed, agility and quickness group. Speed, agility and quickness group have a higher scoring rate of throwing accuracy after training. The results of the present study showed that experimental group improves their throwing accuracy because of different components of training schedule (Gursharan, 2017). Another study in 2014 indicates that six-week handball specific skill training had significant effect on throwing accuracy and over all playing ability of inter-collegiate men handball players (Suresh et al., 2014).

2.2.4 Dribbling

Dribbling helps a player to move with the ball towards the opponent goal under the control of the ball within the free space. In handball, medium-high dribbling is used more often by attackers than low or high dribbling. In this manner, the ball is led alongside the body so that a player doesn't kick it and can also protect it from an opponent. The ball is pushed down by moving the arm, forearm and wrist toward the ground. A player can dribble in place, when walking or while running, with a dominant hand (right hand for a

right-handed person), with a non-dominant hand (left hand for a right-handed person) and by alternating between right and left hands. Good techniques of dribbling/bouncing permit player to keep the position of the ball longer than 3 seconds move up the court and avoid an opponent IHF, (2019).

Figure 4 basic position of dribbling

2.2.4.1 Speed dribbling

Speed dribbling in handball, is the skill of running as fast as possible while keeping the ball in front, available to be closely controlled the ball by the dribbler at that moment. It is not throwing the ball and sprint after it. It is used offensively when there is open space towards the opponent goal. Dribbling helps a player to move with the ball through the open space towards the opponent (Suresh et al., 2014). Likewise, speed dribbling skill enhances the possession of the ball on a fast-break with no teammate to pass and no defender between you and the opponent goal. If used three steps in a one-on-one situation to successfully fake a defender, then see an open space to the goal, one dribble will permit to a player and an additional three steps to continue to the goal for a shot. When unable to pass to a teammate, dribbling will allow you to avoid a 3-second violation resulting in a free-throw for the opponent (Barbara, 2011).After receiving the ball and before dribbling a player holds the ball with both hands. The ball is being dribbled sideways at hip level when there is an opponent near to a player. Bouncing on the ground is performed by the combined action of the elbow and wrist joints. The angle of the bounced ball depends on the speed that the player is moving at. The faster the run the more the angle becomes obtuse. If an opponent comes closer, a player must lower his position as well as the dribbling, protecting the ball from being taken by the opponent

(Barbara, 2011). When a player dribbles the ball use open hand on top of the ball and flex your elbow. Extend your elbow, fingertips direct the ball to the floor. Flex your elbow and hyper extend your wrist as the ball rises, use open hand on top of the ball and extend your elbow for another dribble. Keep your head. Bouncing on the ground is performed by the combined action of the elbow and wrist joints. The angle of the bounced ball depends on the speed that the player is moving at. The faster the run the more the angle becomes imperceptive. If an opponent comes closer, a player must lower his position as well as the dribbling, protecting the ball from being taken by the opponent (Barbara, 2011).

Researches were conducted on the area of dribbling ability of handball players. For instance, Gursharan (2017) conducted a study on the effects of 12 week SAQ training program on handball skill variables of handball player's. It is evident from the results of the zigzag dribbling variable that there is significant difference found between pre and post data of speed, agility and quickness groups. The findings of the current study showed a steady increase in the performance of zigzag dribbling after the speed, agility and quickness training of 12 weeks. It might be due to the fact that during speed, agility and quickness training in week two some of the important agility drills such as zigzag jump drill or dot drill or lateral agility ladder was introduced to improve zigzag dribbling skill among handball players (Gursharan, 2017). Also, Ezhilmaran (2016) conducted the study on "effect of specific drills with plyometric training on selected skills performance variables of school level men handball players" and proved that experimental group showed improvement in selected skill performance variable was dribbling and passing due to effect of specific drills with plyometric training. These findings are similar to the results of Kamalakkannan and Mahadevan (2012). These findings are in forced with Shallaby (2010). He conducted a study to estimate the "effectiveness of plyometric exercises on the special physical abilities and skillful performance of basketball players" has also found that an improvement in the dribbling skillful performance.

2.2.5 Shooting

The aim of shooting is to move the ball into the goal according to the rules of handball. Shooting is the ending of attacking activity of a team. The success of shooting is influenced by a series of factors such as Power (velocity), rotation, placement of shot, kinetics of the whole body of the shooter (when standing, walking, running, while falling, while jumping), distance and the angle with respect to the goal, the suitability of a playing situation IHF, 2019).

There are many ways to shoot the ball. The names of shots have been derived from the way the players move on the court and the position of their body to the ground. In team handball, shooting is the final action in an attacking movement. There are four basic handball shots, the "set shot" is the most natural of all shooting actions and is simply the overhand pass thrown hard. The "jump shot" is the most used shot in handball. Developing the ability to jump and shoot over the defense, as well as jumping inside the goal area, will make you a more effective scoring threat (Hartz, 2018). The wing shot is the jump shot performed at a difficult shooting angle.

Finally, the fall shot is the fundamental technique of the circle runner. It allows you to receive the ball around the 6-meter line and shoot without using three steps while shooting. The player must be able to choose and execute the appropriate shot as the opportunities present themselves no matter what position they play. In team handball, shooting to score goals is one of the most important aspects of the game. In order for a shot to be successful, it must have maximum ball velocity and accuracy for an element of surprise for the goalkeeper (Wagner & Muller, 2008). Right-handed players should perform shooting from the left side position is better. Left hander players should perform shooting from the right side position is better. When in the air, the player performs jump shots (Hartz, 2018). Shooting can be divided according to path of the ball is straight, lob, bouncing off the ground, with rotation, and placement within a goal (the goal is divided into six/nine parts according to the view of the shooter). High-quality shooting is the result of several activities that precede it moving without the ball, receiving the ball, coordination of the body, dissociation of movements, rhythm and timing of motion, situation evaluation, and choice of shooting and placement of shot.

Figure 5 set shoot

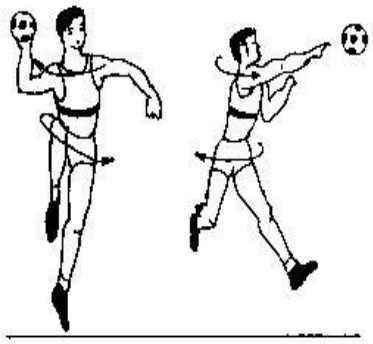

Figure 6 Vertical Jump Shot

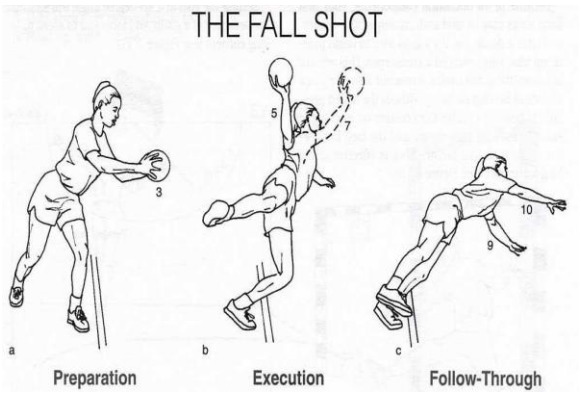

Figure 7 Falling Shot

2.2.5.1 Shooting accuracy

Shooting is considered as one of the most significant offensive skills that play a major role in tip the team on the other. The goal of performing the fundamental skills of handball provides a player an opportunity for one of the players to reach a better position to shot the ball towards the opponent goal in different ways, without any obstacle defense from the opponent (Wagner et al., 2008). Different researchers have agreed that the most common shooting in team handball against the goal keeper was done by executing jumping shoot. Two basic factors are of importance with regard to the efficiency of shots. This includes shooting accuracy and shooting velocity. Naturally, the faster the ball is thrown at the goal, the less time defenders and goalkeeper have to save the shot (Kilani& Finch, 2001).

Handball coaches and scientists who have investigated on shot agreed shooting velocity and accuracy depends on technique of motion, anthropometric and physical fitness. By training, the physical fitness and technique can be improved. The offensive players however, attempt to shot a ball on goal from a position without being tackled or obstructed by the opposing defensive players. Recent studies analyzing the shooting movement in team-handball suggest that different shooting techniques result in different ball velocities (Tillaar &Ettema, 2004; Wagner &Mlllller, 2008). The faster the ball is shot at the goal; the less time the goalkeeper will have to save the shot. In order for a shot to be successful, the velocity at ball release and accuracy is required during the game (Zapartidis et al., 2007). Accuracy is something defined as variable. It is hitting the target with keeping one's own movement and concentration. Thus in the analyzing performance of players, researchers came out to judge the players shooting effectiveness in performing the skill that players during the game are notably affected by shooting accuracy or ball velocity.

Shooting accuracy is one of the key technical skills performances that determine successful playing of handball (Erculj &Supej, 2006). Some previous studies have shown the importance of shot accuracy in distinguishing winning and losing handball teams (Pojskic et al., 2009). In order to achieve a high shooting percentage and victory, every team has to have players who can accurately shoot in all periods of the game and under different physiological or psychological pressures. Consequently, it can be said that shooting accuracy is one of the most important skills in handball (Pojski et al., 2011).

Researches were conducted on the area of shooting accuracy. For instance, when comparing the mean value of shooting accuracy, it has been observed that after 12 weeks of SAQ training players gain the good level of shooting accuracy. SAQ training more affect the shooting accuracy of players. The basic reason behind this could be that during shooting stability and strength is required, so speed, agility and quickness drills develop lower explosive strength in players which improve the stability and conversion rate during shooting. From the findings it was evident that the treatment given to speed, agility and quickness training found to enhance the handball skills performance of players for pre to post (12 weeks) test because the tabulated value was found higher than required

value to be significant. The reason for this may be that the players have been exposed first time to SAQ drills training program which is highly scientific and systematic in nature because of which optimum adaptation and enhancement in skills performance has been seen (Gursharan, 2017). According to a study in 2014 indicates that six-week handball specific skill training had important effect on shooting accuracy and over all playing ability of inter-collegiate men handball players (Suresh et al., 2014).

2.3 Concept of plyometric training

Plyometric training was first introduced in the United States by a Track and Field coach, Fred Wilt in 1975. Plyometric training is the lengthening of muscle (eccentric phase), followed by a powerful shortening of the same muscle (concentric phase) (Baechle, 2008). Plyometric training involves powerful muscular contractions in response to a rapid stretching of the involved muscle. It is a type of training that develops the ability of the muscles to generate force with speed. This pattern of muscle contraction is known as the stretch-shorten cycle (Chu et al., 2006) which involves stretch of the muscle immediately followed by an explosive contraction of the muscle (Cherif, 2012). These powerful contractions are not a pure muscular event. In fact, they primarily involve the nervous system. Plyometric training is now a common element of team sports training programmers, and is increasingly used by other athletes and their coaches. Plyometric exercises are based on the understanding that a concentric (shortening) muscular contraction is much stronger and it immediately follows an eccentric (lengthening) contraction of the same muscle. Plyometric exercises develop this recoil or, more technically, the stretch/reflex capacity in a muscle. With regular exposure to this training stimulus, muscle fiber should be able to store more elastic energy and transfer more quickly and powerfully from the eccentric to the concentric phase.

However, to get the best out of plyometric one needs adequate preconditioning and that is where weight training can play a crucial role. Moreover, when it comes to selecting the right plyometric moves, the coach or athlete needs to consider the specifics of their sport, the athlete's maturity, his level of pre-conditioning and his ability to pick up what can be a complex skill. It is logical for athletes to seek to increase the rate of

force development, because most sporting movements involve fast movements, for which forces must be generated quickly (Yessis, 2013).

Moreover, plyometric training is a type of exercise training that focuses on improving how quickly muscles produce force. Success in most activities depends on how fast muscle force is generated. Therefore, to improve performance, we must teach our body how to generate force quickly. A progressive exercise program that incorporates plyometric training allows us to do this. This type of training involves powerful muscular contractions in response to a rapid stretching of the muscles being used (Wathen, 2013). As our muscles stretch, they store potential elastic energy. Once they shorten, the stored potential energy is turned into kinetic energy, which creates movement. The faster we become at stretching and shortening, or loading and unloading our muscles, the more quickly we can generate force, and the more powerful we will be. Many plyometric exercises for the lower body involve jumping, whereas upper body plyometric exercises involve the use of medicine balls or explosive bodyweight movements. There are different levels of plyometric exercises that can be used in an exercise program based on the desired goals and abilities of the exerciser. Caution should be taken when incorporating plyometric training into an exercise program due to their intense nature. It is easy to do too much too soon, which could potentially lead to injury (Holcomb et al., 2008). In addition, plyometric training is mainly shortening, explosive actions that improve strength, power, speed, quickness and agility. Think bouncing ball when jumping, ball hits ground (jumping down) it swells (contracted air-thigh muscles contract) due to impact weight and pressure forces ball to regain shape (stretches back-thigh muscles stretch) creating explosive force to bounce back (jumping up). Beginners must progressively integrate this form of training to reduce injury and intermediate to advanced may enhance with bands and medicine-balls for added resistance (Markovic, 2007).

2.3.1 Three phases of plyometric training

There are three separate phases involved in plyometric training, including the eccentric or loading phase, the amortization phase or transition phase, and the concentric or unloading phase (Chmielewski, et al 2006).

2.3.1.1 Eccentric Phase

The first stage of a plyometric movement can be classified as the eccentric phase, but has also been called the deceleration, loading, yielding, counter movement, or cocking phases (Lundin, 1985). This phase increases muscle spindle activity by pre stretching the muscle before activation (Kubo, et al, 2001). Potential energy is stored in the elastic components of the muscle during this loading phase much like stretching a rubber band.

2.3.1.2 Amortization Phase

This phase involves dynamic stabilization and is the time between the end of the eccentric muscle action (the loading or deceleration phase) and the initiation of the concentric contraction (the unloading or force production phase) (Wilk et al, 1993,). 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 (Voight & Wieder, 1991). A prolonged amortization phase results in less than optimal neuromuscular efficiency from a loss of elastic potential energy (Wilson, Wood, Elliott, 1991). A rapid switch from an eccentric loading phase to a concentric contraction leads to a more powerful response (Wilk et al, 1993, and Voight & Wieder, 1991).

2.3.1.3 Concentric Phase

The concentric phase (or unloading phase) occurs immediately after the amortization phase and involves a concentric contraction (Wilk et al, 1993, Voight & Wieder, 1991 and Ishikawa, Niemelä and Komi, 2005) resulting in enhanced muscular performance after the eccentric phase of muscle contraction. This is synonymous with releasing a rubber band after it was stretched.

2.3.2 Basic principle of training

The principles of training help a steady and specific increase in physical ability by specifically adapting a training load and program to the needs of a sport and most importantly to the individual needs of each player. A training program to improve performance should follow the following principles of regular training.

2.3.2.1 Overload

To bring about positive changes in an athlete's state, an exercise overload must be applied. The training adaptation takes place only if the magnitude of the training load is above the habitual level. The principle of overload states that there should be greater than normal load. It means that the training loads should be increased for improving the performance of players or athletes. The normal training load cannot improve the performance. If the training load remains static, the effectiveness of the load diminishes the performance of athletes. It can only maintain achieved adaptation of load. It means that for the continuous improvement of performance, the training load should be increased after the adaptation of previous training load (Young, 2006).

2.3.2.2 Specificity

Sports preparation in a specific sport is characterized by specificity. The athlete improves his or her performance in specific activities to that sport which are the content of a specific sports discipline. For instance, to improve LE of an athlete, an athlete must engage specifically to lower extremity plyometric exercise. Specificity is an important principle in sport training, where the exercise must be specific to the type of sport event required and is therefore related to the particular demands of the event (Vincent et al, 2013).The coach should have knowledge of the predominant types of muscular activity associated with his/her particular event, the movement pattern involved, and the type of fitness required. Although specificity is important, every schedule must include exercises of a general nature. These exercises may not relate too closely to the movement of any athletic event, but they do give a balanced development and provide a strong base upon which highly specific exercise can be built (Young, 2006).

2.3.2.3 Progression

Particularly applicable in sport training, this principle means that as you improve it is necessary to increase progressively the demands you are making upon your body (i.e. gradually increase the intensity and duration of exercise). To steadily improve fitness levels, technique an athlete must gradually increase training load. If the training demand is increased too quickly, players will be unable to adapt and may break down. If the

demand is not adequate, they will not reach optimal fitness levels. The appropriate adaptation of load which is in the form of plyometric training is only possible when load is in progressive manner. Subsequently, Lioyd and Oliver (2014) recommend that due to the high neural demands placed on the neuromuscular system during plyometric actions, athletes should be gradually introduced to plyometric training. Plyometric training should be done in the form of easy to complex, low to high intensity, two legged jumps to one legged jumps, raising box jump and heights, increasing resistance of elastic band, increase weight of medicine ball and increasing number of hurdles (Himansu, 2012).

2.3.2.4 Individualism

Everyone is different and responds differently to training. Some people are able to handle higher volumes of training while others may respond better to higher intensities. This is based on a combination of factors like genetic ability, predominance of muscle fiber types, other factors in your life, chronological or athletic age, and mental state (Burgess, 2017).

2.3.2.5 Variation

After training for several hard days, players should train lightly to give their bodies a chance to recover. Training cycles should be used over the course of the year to vary the intensity and volume of training to help achieve peak levels of fitness for competition. This principle also implies that exercises and activities should be changed regularly so that players do not overstress a certain part of the body (Vincent et al., 2013).

2.3.2.6 Reversibility

When player stops training, their gains will disappear quicker than they were gained. The rate of decline for athletes will depend on the length of training before detraining, the specific muscle group and other factors. Maintaining a moderately high level of fitness year-round is easier than detraining at the end of the season and then retraining at the beginning of the next (Zaryski& Smith, 2005).

2.3.2.7 Recovery

The body cannot repair itself without rest and time to recover. Both short periods like hours between multiple sessions in a day and longer periods like days or weeks to recover from a long season are necessary to ensure your body does not suffer from exhaustion or overuse injuries. Motivated athletes often neglect this. At the basic level, the more you train the more sleep your body needs; despite the adaptations you have made to said training. Recovery is important to prevent injuries, overtraining and to determine the primary emphasis of the plyometric program. Because of the intense demands on the body with plyometric training, longer recovery periods between sets may be appropriate. There is limited research on the optimum recovery times, but recovery between training sessions is usually 48 to 72 hours between exercise bouts with plyometric is recommended. The effectiveness of a plyometric training session depends on maximal effort and a high speed of movement for each repetition. Rest intervals between repetitions and sets should be long enough to allow almost complete recovery. As much as 5-10 seconds may be required between depths jumps (Wathen, 2013).Perhaps, the most important principle of training is rest. Exercising too frequently and too intensely hinders the body's ability to recover and adapt. As a rule of thumb, the harder you train, the more recovery you should allow for.

2.3.3 FITT guidelines of plyometric training

2.3.3.1 Mode of Plyometric Exercise

There are many plyometric exercises for both the upper and lower body. As with other forms of sports training, exercise selection should base the movement patterns of the sport as closely as possible. Lower body plyometric exercises are suitable for many sports such as basketball, handball, track and field athletics, sprinting, football, baseball and so on. In fact, performance in any sport that involves jumping, sprinting or kicking can be improved with lower body plyometric exercises (Holcomb et al., 2008).Competitive sports and recreational activities often require athletic movements that combine both strength and speed to create the byproduct known as power. For years, numerous clinicians including strength and conditioning specialists, performance enhancement coaches, and athletic trainers have sought ways to increase power in order

to enhance performance. No more than six plyometric exercises are performed per one training session (Chmielewski et al., 2006). In an effort to return athletes to play at the highest levels, rehabilitation professionals also have come to rely on the use of plyometric exercises. In the LE, plyometric exercises are often performed through jumping, bounding, and hopping. Some example of Lower body plyometric exercises includes Standing jumps, multiple hops and jumps, Squat thrusters, diagonal single leg hope, Alternating lunge jumps, depth jump, Frog squat jump and long forward jump hurdle jump, power skip, horizontal jump (Himansu, 2012).

Upper Body Plyometric exercise are also important in sports such as basketball, volleyball, handball, softball, baseball, tennis, badminton, golf and the throwing events in athletics can also benefit with upper body plyometric exercises. Also, certain position players such as goal keepers in handball will find these drills useful. Most upper body plyometric exercise requires the use of a medicine ball (Holcomb et al, 2008). Upper Body Plyometric exercise includes: push-up (jumping/clapping pushups), Depth push-ups, Plyo pull-ups, and Ball throws. Plyometric exercise should be performed for 40 – 60 minutes per training session (Himansu, 2012).

2.3.3.2 Plyometric Exercise Intensity

Intensity is the actual percentage of effort required by the athlete to perform the activity. In plyometric, the type of exercise performed controls the intensity. Plyometric exercises can come in many forms and intensities. Some activities such as bilateral jumping to a box are lower level plyometric while others such as single leg jumps from a box are intense. These variables must be considered when designing conditioning or rehabilitation programs (Himansu, 2012). The research work of Lioyd and Oliver (2014) recommend that due to the high neural demands placed on the neuromuscular system during plyometric actions, athletes should be gradually introduced to plyometric training. Such an approach is also important to ensure that the training emphasis is placed on movement quality, correct landing mechanics, short ground-contact time, recruitment of a large number of motor units, high stimulation of rate of force development and utilization of the stretch reflex (Lloyd & Oliver, 2014). The intensity of plyometric exercises varies

greatly. Skipping exercises are classed as low intensity, while reactive depth jumps (drop jumps) from 32in (80cm) and above are the highest intensity of the plyometric exercises

Table 1 Plyometric Exercise and their intensity

Type of plyometric exercise	Examples	Intensity
Standing based jumps	Tuck-jumps, split-jumps, squat-jumps	Low
performed on the spot		
Jumps from standing	Standing long jump, Standing hop,	
	Standing jump for height	
Multiple jumps from standing	5 consecutive bounds	
	2 x 6 bunny jumps	
	Double-footed jumps over hurdles	Medium
	Double footed jumps up steps	
Multiple jumps with run up	3 x 2 hops and jump into sand pit with	
	6 stride approach	
	2 x 10 bounds with a 6 stride run up	
Depth Jumping (Recommended drop height	2 x 6 jumps - down and up	
40-100cm). The higher the		
height the greater the strength		
component, the lower the		
greater the speed		High
Speed bounds	4 x 20m	

Source: adopted from, Jonathan (2008).

Table 2 Examples of Progression of Plyometric Exercises for the Upper Extremity

Beginner	Intermediate	Advanced
Wall dribbling with two arms Medicine ball throw clap push up	Medicine ball throw Clap wall pushups Clap pushups	Medicine ball throws (increase weight, frequency, intensity) Clap pushups Clap-push-up with vertical jump

Source: Adopted from Chmielewski et al. (2006)

2.3.3.3 Frequency of plyometric exercise

This refers to the number of plyometric workouts per week in a given training cycle. The frequency of plyometric type of training should be determined per week depending on the training loads from other areas. The intensity of the drills will play a role in determining the frequency of the sessions and the rest between sets and/or sessions. It is important to allow adequate recovery between plyometric training sessions (Kimberly, 2008). Typically, 2-3 sessions of plyometric can be completed in a week. Alternatively, recovery time between sessions can be used to prescribe frequency and is recommended at 48-72 hours. It is not recommended that plyometric training be scheduled for the day after a heavy weight training session when muscles may still be sore. This poses a planning problem for athletes that may need to strength train 3-4 times per week. The phase of the training program will also determine how many plyometric training sessions are suitable per week. For example, a track and field athlete may require 3-4 sessions during the preparation phase reducing to 2-3 session in-season. A handball player on the other hand may require only 2-3 sessions pre-season reducing to 1-2 sessions during the competitive season (Wathen, 2013).

2.3.3.4. Duration of plyometric exercise

One the component in the FITT principle of training is time or how long you should be exercising for. The common agreement for the duration of plyometric training session is a minimum of 45 minutes and a maximum of 60 minutes (George et al., 2015).

2.3.4 Plyometric training considerations

2.3.4.1 Safety considerations

As with any training an adequate warm up is required before completing a plyometric training session. The Nation Strength and Conditioning Association recommended that jogging and harmonized arm to leg movements be included as part of the warm up to prepare for plyometric exercise. Warming-up took place 10-15 minutes consist of jogging, running and stretching as well as in cooling down players did jagging, light running and stretching for 5- 10 minutes (Parno, 2016).

Because plyometric exercises are high intensity and high impact, those with osteoporosis or who are susceptible to breaking bones should not perform them. If you are a beginner, establish a solid base of strength, speed and balance prior to learning the proper techniques of plyometric drills. Proper warm-up is also necessary before plyometric drills.

To reduce the risk of injury, do plyometric workouts no more than two times a week on nonconsecutive days (NSCA, 2009). Limited data exists as to whether there is any increased risk of injury through plyometric training. However, due to the stress that repeated shock-tension exercises can place on joints and connective tissue, several safety guidelines have been proposed. Balance is also an important factor in the safe performance of plyometric exercises. Again, it has been recommended that athletes can stand on one leg for 30 seconds in order to complete less intense exercises. For more advanced exercises they should be able to stand on one leg for 30 seconds in a semi-squat position. However, to be effective, plyometric training requires numerous, repeated maximal efforts. It is the structured nature of training that may pose an over-training risk to younger individuals (NSCA, 2003).

Finally, the landing surface must possess adequate shock absorbing qualities. Good choices include grass, a suspended floor and an exercise mats (NSCA, 2003). The training should be done in progressive overload principle of training. First low intensity, moderate and high and every two weeks increase the set and repetition of the exercise. Plyometric exercises are extremely effective. However, this does not mean that more is

better. On the contrary, low frequency (2-3 sessions per week) and low volume (2-5 sets of 2-10 repetitions) are most appropriate. Getting the most out of a program requires mastering the movements of the exercises themselves. For most athletes three to six plyometric exercises at any one time is sufficient for attaining movement mastery and obtaining considerable benefit and the training load should have increased in the principle of progressive overload (NSCA, 2009).

2.3.5 Importance of plyometric training for handball sport

Plyometric training is widely known as a potential tool for improving sports performance. During PT, the muscles switch rapidly from an eccentric to a concentric phase of contraction. The decreased duration of the amortization phase exploits stored elastic energy and the stretch reflex, allowing a greater than normal release of power during the concentric phase of movement (Ramirez et al., 2015; &Saez de Villarreal et al., 2015).

PT programs are often implemented during the pre-season to bring young players to an appropriate initial level of fitness. In addition, it is strongly recommended that handball coaches implement in-season PT to enhance the performance of their players. PT inculcated into the standard training improved parts, which are important to handball performance, particularly, the explosive actions, such as sprinting, jumping and ball throwing velocity (Chelly et al., 2014).In line with this argumentation, research of Hermassi et al. (2014) indicated that in-season 8-week PT including lower limbs can positively affect jump ability and absolute leg power in elite adolescent male handball.

Chelly et al. (2014) performed an eight week in season plyometric training program on elite adolescent handball players and found that the participants increased their ball throwing velocity. Van den Tillaar et al. (2015) also suggest that a short in-season 6-week squat or PT program can improve the physical performance of the lower body in young handball players.

On the other hand, recent reviews on the topic suggest that PT should include vertical and horizontal movements to enhance vertical and horizontal jumping power of handball players (Ricotti, 2011). Supporting this, most previous papers of PT have also observed increased velocities, VJ and HJ height performances of handball players (Ozbar, 2015). It is recommended to conduct PT on stable rather than unstable surfaces if the goal is to enhance VJ and sprint performances in young sub-elite handball players (Büsch et al., 2015). Another previous paper shows that PT can be considered an effective alternative stimulus to improve agility in young handball players (Thomas et al., 2009).

The importance of plyometric revolves around the basic concept that a pre-stretched muscle is capable of generating more force. The muscle must be stretched before the concentric movement, and it must occur immediately before the concentric movement. Simply jumping up in the air fulfills these requirements. However, plyometric can be performed with upper body routines as well; it is not only for lower body things to improve leg speed which will improve running and jumping ability of athlete (Agilonu &Kiratli, 2015).

One can also perform exercises such as clap push-ups or medicine ball throws off a wall or either straight up in the air. Medicine balls are a great aid to have in order to improve upper body plyometric abilities. It is also proven that plyometric training mixed with strength training can result in greater gains in both upper and lower extremities. However, it is recommended not to perform each on the same day to also avoid overtraining and getting the most energy out of each workout. Plyometric training will bridge the gap between strength and speed. It will benefit athletes of all ages if done correctly (Chu et al., 2006).

Plyometric exercises constitute a natural part of most sport movements because they involve jumping, hopping, and skipping. Plyometric training has been advocated as an appropriate approach for sports that require explosiveness and vertical jumping ability enhancement. Generally, plyometric trainings are the best way to provide power / speed to react immediately during the game and also to provide the player to jump higher and to improve the jumping ability of the leg muscles. It provides the opportunity to train

specific movement patterns in a biomechanically correct manner at a more functionally appropriate speed (Andrejic, 2012). This provides functional strengthening of the muscle, tendon, and ligaments specific to the demands of everyday activities and sports (Wilkerson et al., 2004). In these exercises, muscles undergo a rapid elongation followed by an immediate shortening, utilizing the elastic energy stored during the stretching phase (Markovic, 2007). This confirms (Vissing et al., 2008), which states that plyometric training does provide such training stimuli and has shown evidence to improve explosive actions in young and pubertal populations.

Moreover, plyometric training consists of quick, explosive movements designed to increase speed and power. This can be achieved through performing multiple exercises that focus on training our bodies and brains to activate more muscle fibers, more quickly, in order to increase the efficiency and speed of our muscle contractions. Doing so will ultimately increase our power. To dive into this a little further, we need to cover something called the stretch-shortening cycle (SSC), which is the basis of all plyometric exercises (Masamoto, 2003). In most dynamic movements the muscle is first stretched (eccentrically) before it contracts (concentrically). For example, if you do a dip before a vertical jump, your center of mass will be lowered quickly and in so doing your muscles will be stretched.

The goal of plyometric is to maximize muscle contraction, quickly, which essentially means that a byproduct of plyometric training is that you will develop power. Obviously having a high level of physical power is desirable in athletics but in order to increase your power, you need to increase and strengthen the muscle fibers that are responsible for converting strength into speed. Fittingly, these fibers are referred to as fast-twitch fibers and plyometric training can strengthen them and increase the ratio of fast-twitch fibers to slow-twitch in your body. The stronger the fast-twitch fiber, the faster the muscle contraction, which leads to an increase in power output PT also increase vertical and horizontal jump ability of players in team sport (Lohindren& Adorable, 2013).

Certainly, with great power, comes great performance. All the previous benefits of plyometric training listed above has made it an attractive addition to many an athlete’s

training program especially for those whose sports require explosive movements. Crucially, plyometric can help to decrease the time it takes for a lifter to reach maximum force and improve their power output and vertical jumping ability of handball players (Adibpour et al., 2012).

In addition, a study in the Journal of Strength and Conditioning Research (2009) found that a combination of squat and plyometric training provided a significant increase to hip and thigh power production, resulting in a greater increase to vertical jumping ability than could be achieved from training solely with one program or the other. Plyometric training may be important for basketball, handball, football, rugby, sprinting and volleyball players.

2.3.6 The effect of plyometric training on handball technical skills performance

Various researchers and analyses are paying interest to conduct a study on the area of the effects of the plyometric training program on technical skill performance of handball players in different year and area. For example, Aguilar et al. (2012) conduct a study on the effect of power training on throwing velocity in team handball. The author said that power training has a significant effect on throwing velocity of handball players. Yet, this researcher missed whether power training has an effect or not on shooting accuracy, speed dribbling and passing accuracy.

Ezhilmaran (2016) conducted the study on effect of specific drills with plyometric training on selected skills performance variables of school level men handball players. The specific drills with plyometric training group had radically improved on dribbling and passing ability of school level handball players due to the effect of specific drills with plyometric training program. The control group did not change on selected skill performance variables. But the author does not address the effect of specific drills with plyometric training on shooting accuracy.

Moreover, Surendra (2018) study the effects of plyometric training program on jumping and shooting accuracy of handball players. Thus, plyometric training had a significant effect on jumping and shooting accuracy of handball players. Even if, the

interventions are plyometric and functional training, the author doesn't address their effect on passing accuracy and speed dribbling of handball players. Likewise, Yahya et al. (2014) conduct a study on the effect of Plyometric exercise on shooting accuracy of handball payers and plyometric training has no significant effect on shooting accuracy.

Baouche et al. (2017) conducted a study on the impact of proposed exercises in the method of plyometric training in the development of explosive power and some basic skills of handball. Hence, the planned exercises in the plyometric training method significantly developed the level of performance of passing, receiving, dribbling and jumping skill of handball players. Still, the author does not addressed the effect of proposed exercise in the method of plyometric training has an effect or not on shooting accuracy and also does not address effect of plyometric training on skill performance of u-15 male handball players.

Also, Emel and Yeliz (2012) conducted a research on the effect of strength training on jump shot performance in young team handball players. However, this author had not been addressed the effect of strength training on the passing accuracy and speed dribbling of handball players and has ignored whether plyometric training that considered as an effect on speed dribbling, throwing and shooting accuracy or not of u-15 male handball players.

In addition, Subash (2010) carried out a study on the effect of plyometric training on selected physical fitness and skill performance variables of inter collegiate level men handball players. The study was conducted on passing accuracy, speed dribbling and jumping ability of handball players. As the researcher declared, plyometric training group had no significantly improved speed-dribbling, passing accuracy and jumping ability of inter collegiate level men handball players due to the effect of plyometric training program. However, this finding was not addressed the effect of plyometric training on shooting accuracy and the effect of plyometric training on skill performance of u-15 male handball players.

Recently in our country Yordanos (2020) conducted a study on the effect of plyometric training on shooting performance and some selected physical fitness qualities

in case of Adet town u-17 handball project players. As the researcher stated that plyometric training had significant effect shooting accuracy of players. The study conducted on only one technical skill of handball that is shooting accuracy. This research work also does not addressed passing accuracy and speed dribbling of handball players and also does not address u-15 male handball players.

Moreover, Wubliker (2020) conducted a study on the effect of plyometric training on technical skill performance of handball team players at Debre Markos town and showed that plyometric training had significant effect on shooting accuracy and speed dribbling, but had not on passing accuracy of team players. The study was conducted on advanced team players. It does not address project players.

To sum up, thus all the above studies do not address the effect of plyometric training on shooting accuracy, passing accuracy and speed dribbling performance of u-15 male handball project players. This show that the effect of plyometric training on passing accuracy, shooting accuracy and speed dribbling on the context of u-15male handball project players has been given little attention.

CHAPTER THREE

RESEARCH METHODS

This chapter contains research methods. These includes, research approach, description of the study area, research design, population, sample and sampling technique, source of data, research variables, data collection instrument, data collection procedures, data analysis methods and ethical considerations.

3.1 Description of research area

This study was conducted at Borena woreda u-15 male handball players. The project is located in the north east region of Ethiopia in Amhara regional state South wollo zone Borena woreda in 020 kebele in Tewa sub city in Tewa general primary school. Debre Sina now Borena is one of the woredas in the Amhara Region of Ethiopia. Part of the South Wollo Zone, Borena is bordered on the south by Wegde woreda, on the west by the Abbay River which separates it from the East Gojjam Zone, on the north by Mehal Sayint, on the northeast by Sayint, and on the east by Legambo woreda. The administrative center is Mekane Selam. It far from Adiss Ababa which is the capital city of Ethiopia by 600 km, from Bahir dar which is administrative city of Amhara region by 279 km, from Dessie which is South Wollo Zone administrative center by 196 km and from Mekane Selam which is administrative city of Borena woreda by 14 km to south.. The altitude of this woreda ranges from 500 meters above sea level at the bottom of the canyon of the Abbay to 3200 meters in the northeast corner. Its climate is classified as warm and temperate. In Borena woreda the average annual temperature is 16.6/ 1323 mm of perception annually.

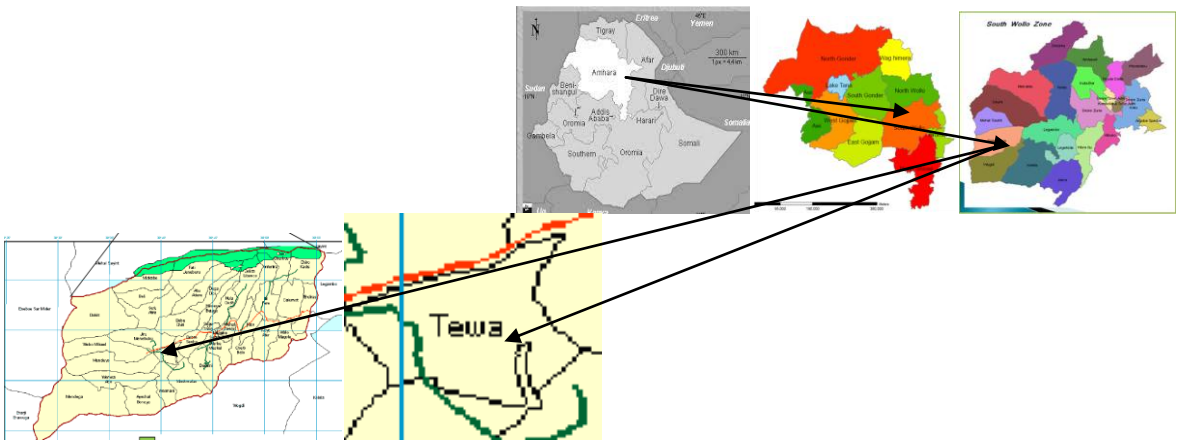

Figure 8 map of study area

3.2 Research approach

The research approach is a plan and scheme for lookup that span the steps from broad assumptions to specific methods of data collection, analysis, and interpretation. The approach to this study was quantitative approach, because this approach can test objective theories by examining the effects among variables. These variables, in turn can be measured, typically on instruments, so that numbers those recorded was accumulated and analyzed using statistical approaches (Creswell, 2012).

3.3 Research design

Research design is the master plan specifying the methods and procedures for collecting and analyzing the needed information in a research study. It is a blueprint to conduct a research study, which involves the description of sampling size, sampling technique, tool and methods of data collection, and data analysis to answer specific research questions or for testing research hypotheses. The purpose of this study was to investigate the effect of plyometric training on selected technical skills performance of u-15male handball project players. To achieve the objective of this study the pretest posttest control group experimental research design was utilized. To sustain the appropriateness of the pre and post test data, the study was employed experimental research design to examine, identify, and determine the effect of independent variable on the dependent variables. Besides that, the experimental research design is a method to evaluate the cause and effect link among variables. The study had experimental and control groups. Both Experimental and control groups attended standard handball training sessions. In addition, the experimental group included detailed plyometric training program. The layout for this study was as follows:

Table 3 Research Design out line

Intervention	Both upper and lower limp plyometric training
Training weeks	12 weeks
Number of training sessions	3 days per week
Duration of training	45 minute
Training intensity	Low and moderate
Training time	8:00-8:45Am /5:00-5:45 pm

Source: Adapted from Hammami et al (2020) and Jonathan (2008).

3.4 Population, sampling and sampling techniques

The target population of this study was u-15 male handball project players who found at Borena woreda. The total numbers of players found at this project were 24. All are males and the populations are little in number, all players were taken as a sample by using comprehensive sampling technique. In this study, an experimental research method based on a pre-test and post-test system with a control group has been used. The participants were randomly assigned into two groups of twelve players: the experimental group (plyometric training), EG (n=12) and the control group, CG (=12). The procedure of randomization was as follows. First, the study participants were requested to create a circle, and the researcher was stand at the center of the circle. Secondly, the researcher was rotate three times in the position, and point to one of the research participants to decide the beginning point and assign as number one and proceed up to number 24 to the clockwise direction. Thirdly study participant numbers 1 and 2 are expecting to choose the lottery which will put on the table and grant to the researcher, which was composed as a control and experimental group. Every even number in between 1- 24 were assigned as experimental group and every odd number were assigned as a control group of the research.

3.5 Source of data

To achieve the purpose of the study, the investigator used primary data sources to gain enough information concerning the effect of plyometric training on skills performance of u-15 male handball project players. As a result, the primary sources of data were Borena woreda u-15 male handball project players of pre and post skill test results in the field.

3.6 Research variables

3.6.1 Independent variable

It is the variable that is used to evaluate the effect in the dependent variable. Thus, the change in its values leads to the change in the values of other variables related to it (Morris, 2013). Hence, in this study, the independent variable was plyometric training.

3.6.2 Dependent variable

It is defined as the variable that changes as a result to the independent variable effect or it is the variable which we want to know the effect of the independent variable on it (Morris, 2013). Accordingly, in this study, the dependent variables were shooting accurac y, passing accuracy and speed dribbling.

3.7 Data collection instruments

As the research design was experimental research design, the data was collected by field skill tests of study participants. For instance, the data was collected through field tests of shooting accuracy, passing accuracy, and speed dribbling of handball project players at Borena woreda u-15 male handball players.

3.7.1 Selecting test items:

As Kansal, (2008) declared that a test is said to be a good test if it is precise, reliable, objective, valid, administratively feasible and bound to lead to excellence. Moreover tests items should be representative of the actual game skill. In order to make skill tests more related to the game situations. Jump shots are generally performed in three steps and over the defender, therefore Jump Shoot test is constructed in such a way that player needs to take three steps and shoot from outside the free throw line and has to shoot accurately at the corners of the goalpost to gain maximum points. In handball, during the match, player performs variety of passes accurately mainly in two forms either short or long passes. Hence Accurate Pass test is better to test short pass and long pass ability of the player by performing shoulder pass. Dribbling skill is generally performed in straight direction by dodging the opponent players, so obstacle dribble test is constructed in which player is supposed to cross or evade the obstacle and complete a straight distance in minimum time (yogesh, 2016).

Accordingly, the field tests were jump shoot test for shooting accuracy, accuracy throw test for passing accuracy and obstacle dribbling test for speed dribbling. Before the experimental group went to plyometric training, the pretest was taken from both control and experimental groups. Posttest was also taken from both groups after 12 week plyometric training programs completed for experimental groups.

3.8 Data collection procedure

The investigator followed standard procedures for testing the selected variables and registered the score in tests record sheet under the direct supervision of subjects. In order to investigate the effect of plyometric training on selected variables, all pretest measurements were done within the first week prior to the application of the 12-week plyometric training program, while post testing was performed within first week following the completion of the program. The participants were performed enough warming up and stretching exercise to all tests at the beginning. The testing session consisted of warm-up and test interspersed with rest. All tests were explained and demonstrated. Before testing, subjects given practice trials to become familiar with the testing procedures. Subjects were performed each test as pretest procedure and the scores of best trials were taken for this study. Moreover, each test procedure is discussed below. The detailed descriptions of each skills test procedures these were conducted on the study participants were as follows

3.8.1. Jump Shoot

Purpose: To measure the shooting accuracy of handball players.

Equipment: A marked level floor or ground with a smooth surface, a stop watch, standard inflated number two handballs, rope or string, measuring tape, score cards or recording sheets, and pencil/Pen.

Procedure: Goal post was divided in three parts, i.e. 40 cm on both side and the middle part. Each part was assigned a certain number of points reflecting the difficult of shooting the ball into that area. As player mostly shoots at the ends of the goalpost as goalkeeper stands in the middle, 5 points awarded for the two parts of the either side & 0 points in the rest of the part of the goal post. In the game situation players attempt the jump shoot mostly from three places i. e. from left in, Centre back & right in. Therefore out of 10 jump shots, players were asked to attempt 3 jump shoot from Left in & Right in each and 4 jump shoot from Centre Back. All shoots must be made from behind the free throw line (9- meter line). If ball hits the court surface before it reaches the goal no points are scored. Outside shoots are counted as attempts.

Three Step Jump Shoot: The player can take three steps before releasing a ball but the last step must be executed outside the 9 m free throw line.

Scoring: The score for ten shoots is the sum of points awarded on each shoot or attempt. A maximum of fifty points are possible.

No Points will be given if

- An Athlete touch/ cut the free throw line before release of the ball
- The ball hits the court surface before it reaches the goal
- An Athlete has not performed Three Step Jump Shoot
- An Athlete loose the control of the ball
- The ball shoots outside the goalpost

****** Athlete has to shoot again if ball hits on the string which divides the goal post**

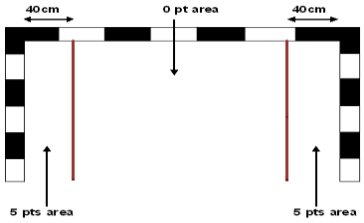

Figure 9 Measurement of Goal Post

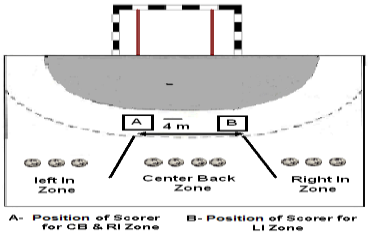

Figure 10 Jump Shoot test

Adopted from Yogesh, (2016)

3.8.2. Accuracy Throw Test

Purpose: To measure the accuracy of short & long pass of handball players.

Equipment: a marked level floor or ground with a smooth surface, a smooth wall, standard inflated number two handballs, color chalks, measuring tape, score cards or recording sheets, and pencil/pen.

Procedure: Two circles are marked on the wall. The innermost circle is marked from the height of 1.5 m from the ground with the 0.15 m radius and outermost circle is also marked from the same height with radius of 0.25 m. Two boxes (1 x 1 m) are marked on the floor at distance of 7 m and 10 m from the wall. In handball, during the match, player performs variety of passes accurately mainly in two forms either short or long passes.

Short Pass: The player, with a handball, stands behind a line on the floor marked at 7 meters distance from smooth wall. On the signal "go", the player throws the ball at the target, using one-armed throw (Shoulder Pass). Five throws are compulsory and all must be executed from behind the restraining line (7m).

For Long Pass: The player, with a handball, stands behind a line on the floor marked at 10 meters from smooth wall. On the signal "go", the player throws the ball at the target, using one-armed throw (Shoulder Pass). Five throws are compulsory and all must be executed from behind the restraining line (10 m).

Scoring: Five points are scored for each throw hitting the center circle, and three points for hitting the outer circle. Ball hitting on a line was counted as hitting in the area of the higher score. The score is the total for ten throws (Five throws for short and long pass each). A maximum of fifty points are possible.

No Points will be given if

- ✓ An Athlete touch/ cut the restraining line before release of the ball
- ✓ An Athlete loose the control of the ball
- ✓ The ball shoots outside the target

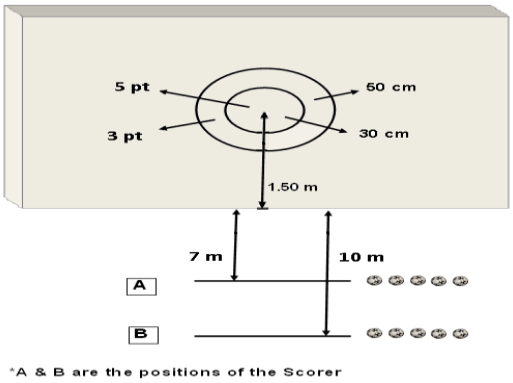

Figure 11 Accuracy Throw

Adopted from Yogesh, (2016)

3.8.3. Obstacle Dribble

Purpose: To measure the speed with which a player can dribble a handball around obstacles in team.

Equipment: A level floor or smooth surface ground, a stop watch, standard number two inflated handballs, Four Obstacles (Cones, Wooden Blocks etc)

Procedure: The player stands behind a starting line with a ball in hand and on the signal "go", starts with a dribble forward and continues to dribble towards Finishing Line. Distance between Start & Finish line is 16 meters. First and last Obstacle is 4 meter away

from Start Line & Finish line. The distance between second to last obstacle is 3 m, 2m and 3 m respectively.

Scoring: The score is the time in seconds. Time is started on the signal "GO" and stopped the instant the player crosses the finish line.

Retrial if: 1. An Athlete looses the control of the ball

2. An Athlete fell down due to imbalance

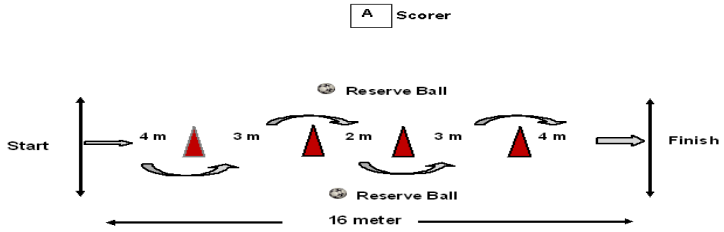

Figure 12 Obstacle Dribble

Adopted from Yogesh, (2016)

3.9 Test reliability and validity

A test is called reliable there are reasons for believing the test to be stable and trustworthy and The validity of a test depends on the fidelity with which it measures what it supposed to measure. There for, as Yogesh (2016) put on his study development of skill tests of team handball game for junior level male players, jump shoot test is very easy to administer as compared to the previous available shooting test, front shoot test resembles the game like situation. The test has high correlation coefficient of reliability (0.98), Validity (0.81) to junior level male handball players. In the accuracy throw test the height of the circles in which players are supposed to throw the ball is lowered and distance was reduced to the 7 meter and 10 meter where it was 12 meter and 15 meter in the previous test. The test has high correlation coefficient of reliability (0.99), Validity (0.89). Obstacle Dribble test is constructed more in game like situation. Test is designed in such a way that player is supposed to some obstacles by dodging them while dribbling in straight direction. The test has high correlation coefficient of reliability (0.97), Validity (0.88) to junior level male handball players. This study was also conducted on similar sex and age level on u-15 male handball players. Therefore the test items were more valid, reliable, easily administered and updated tests.

3.10 Training protocol

Plyometric training had given to experimental group on (Tuesdays, Thursdays and Saturday) for 12 weeks a total of 36 days were given in three month (February, March and April/2021) for 45 minutes per day. Plyometric sessions were performed immediately after the warm-up program and technical-tactical handball drills followed after PT. The intervention included, upper limp (medicine ball chest pass, wall clamp push up and clamping push up) and lower limb (standing long jump, depth jump, tuck jump and standing high jump) Plyometric exercises. Recovery between sets was for 60s to 120s. All plyometrics were performed with maximal effort, minimizing contact time in each repetition, and no resting was allowed between jumps. On the other side control group performed only their regular handball training.

3.11 Method of data analysis

To conduct this study, the researcher used computerized statistical Package for social sciences software (SPSS) version 23.The data was presented as mean and standard deviation statistical data analysis coupled with paired Samples t-test and independent sample t-test. To compare pre-test before the intervention of plyometric training and post-test after the intervention of plyometric training between the group independent sample t-test was used. To evaluate within-group pre-to-post performance changes, paired sample t-tests were applied. The level of statistical significance for the study was set at $p \leq 0.05$.

3.12 Ethical considerations

Ethical Considerations were specified as one of the most important parts of the research. Before beginning the research, the researcher obtained permission from the coach, woreda sport office and all the players and their parents had clear information about the purpose of the study. All participants and their parents/legal representatives were fully informed about the experimental protocol and its potential risks and benefits. In this study, the following ethical considerations were considered. These include, research participants, should not be subjected to harm, respect for the dignity of research participants should be prioritized, full consent had obtained from the participants their parents prior to the study. The protection of the privacy of research participants had to be

ensured. An adequate level of confidentiality of the research data should be ensured. Besides, the secrecy of individuals participating in the research had to be ensured. Likewise, any deception or exaggeration about the aims and objectives of the research was avoided and affiliations in any form, sources of funding, as well as any possible conflicts of interests, were declared. Furthermore, any type of communication in relation to the research should be done with honesty and transparency and also any type of misleading information, as well as representation of primary data findings in a biased way, were avoided.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter deals with the analysis of pre and post test data collected from experimental (n=12) and control (n=12) groups under the study and discussion. The purpose of this study was to investigate the effect of 12 weeks plyometric training on selected technical skills performance of u-15 male handball project players. The selected technical skills variables for this study were shooting accuracy, passing accuracy and speed dribbling. Pre-test and post-tests were taken from both experimental and control groups before and after 12 weeks of plyometric training intervention on experimental group, and the scores were recorded. The collected data were analyzed using paired sample t-test to analyzed pre-test and post-test results of shooting accuracy, passing accuracy and speed dribbling for both groups and used independent t-test to compare pre test and post test results of control and experimental group. Under this chapter the researcher briefly described the demographic characteristics of the respondents including age, weight, height, BMI, training age and the results of the study.

4.2. Results of the study

4.2.1. Demographic characteristics of study participants

Table 4 Descriptive Statistics of Demographic Characteristics of study participants.

Group	N	Sex	Age (year)	Weight(kg)	Height(m)	Training age(year)	BMI(kg/m2)
			Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Experimental group	12	Male	14.25 ± 0.75	42.17 ± 2.20	1.44 ±0.60	2.08 ± 0.67	19.95±1.48
Control group	12	Male	14.42 ± 0.67	42.50 ± 1.89	1.46 ±0.49	2.25 ± 0.75	20.19±1.57

As shown from on table 4, descriptive characteristics of 24 study participants from Borena woreda u-15 male handball project players of age (EG=14.25 ± 0.75, CG=14.42 ± 0.67) height (EG=1.44 ±0.60, CG=1.46 ±0.49) weight (EG=42.17 ± 2.20, CG=42.50 ± 1.89) training age (EG=, 2.08 ± 0.67, CG=2.25 ± 0.75) and BMI (EG=19.95±1.48, CG=20.19±1.57). As we could saw on the table 4 the study subjects' relatively had the similar age, height, weight, training experience and BMI. In addition to this, the researcher used the comparisons between the group pretest results of each variable using independent sample t-test.

Table 5 Pretest result differences between the Experimental Group and Control Group

Variables	Group	N	Mean	Std. Deviation	p-value
shooting accuracy pre test	Experimental	12	12.50	5.00	.840
	Control	12	12.92	4.98	
passing accuracy pre test	Experimental	12	22.75	3.54	.850
	Control	12	23.00	3.07	
speed dribble pre test	Experimental	12	15.08	1.24	.738
	Control	12	14.91	1.16	
*. The mean difference is significant at the 0.05 level					

As the above table 5, indicated that the mean values of handball skill variables pretest with regard to experimental and control group were 12.50 and 12.92 for shooting accuracy and the standard deviation was 5.000 and 4.98 respectively. On the other side in case of passing accuracy, the mean values of the experimental and control group were 22.75 and 23.00 and the standard deviation values were 3.54 and 3.07 respectively. And also the mean values of experimental and control groups in speed dribbling were 15.08 and 14.91 and standard deviation values of were 1.24 and 1.16 respectively. The p-value of shooting accuracy was .840, for passing accuracy was .850 and for speed dribbling was .738. The findings of the study show that experimental group and control group have no significant difference in speed dribbling, passing accuracy and shooting accuracy observed in pre-testing(*P>0.05).* Therefore, these randomized groups as experimental and control were most probably equivalent in their pretest results.

Table 6 Descriptive Statistics of experimental group

Performance Variables	N	Mean	Std. Deviation
shooting accuracy pre test	12	12.50	5.00
shooting accuracy post test	12	38.33	4.25
passing accuracy pre test	12	22.75	3.54
passing accuracy post test	12	38.17	3.38
speed dribble pre test	12	15.08	1.24
speed dribble post test	12	10.83	1.19

Key: - N= number of experimental group participants

The above table 6 shows that the pre and post test results of selected technical skill performance result for experimental group. As the above table indicated that the mean values of shooting accuracy score was 12.50 and 38.33 and the standard deviation was 5.00 and 4.25 of pre and posttest respectively. On the other side, the mean value of passing accuracy score was 22.75 and 38.17 and standard deviation value was 3.54 and 3.38 of pre and posttest respectively. And finally the mean value of speed dribbling score was 15.08 and 10.83 and standard deviation value was 1.24 and 1.19 of pre and posttest respectively.

This implies that, there was mean difference between the post and pretests, yet it is impossible to tell here if the differences are statistically significant. Hence a paired sample t-test comparing the pretest and post test scores of the variables and which was computed to examine whether this number show statistical difference between pre and post test score of technical skill performance of experimental group. The paired t- test result was presented in the table as follows.

Table 7 Pre and post test paired sample t-test results of the experimental groups

Performance Variables	Paired Differences					Df	p-value
	MD	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
shooting accuracy pretest - shooting accuracy post test	-25.833	6.965	2.011	-30.259	-21.408	11	.000
passing accuracy pretest - passing accuracy post test	-15.417	5.501	1.588	-18.912	-11.921	11	.000
speed dribble pretest - speed dribble post test	4.25000	2.050499	.591928	2.947175	5.552825	11	.000

*. The mean difference is significant at the 0.05 level. MD= mean difference
DF= degree of freedom

The above table 7 shows that the test of significance differences of the experimental group pre and post test results performance variables. According to the data presented in the table, the pre and post test result of shooting accuracy showed a statistically significant difference in experimental group. The result suggests that experimental group significantly improved shooting accuracy when measured in shooting accuracy post training test (MD=25.833, SD=6.965, p=0.000) when exposed to 12 weeks plyometric training. Hence, *(P <0.05)* Post-training shooting accuracy scores was significantly improved than pre-test scores for the experimental group.

The second performance variable pre and post test result of passing accuracy showed that statistically significant difference in experimental group. The result suggests that experimental group significantly improved passing accuracy when measured in passing accuracy post training test (MD=15.417, SD=5.501, p=0.000) when exposed to 12 weeks plyometric training. Hence, *(P < 0.05)* Post training passing accuracy score was significantly improved than pre-test score for the experimental group.

Finally the third performance variable speed dribbling pre and post test result of experimental group showed that statistically significant difference in control group. The result suggests that experimental group does significantly improved speed dribbling when measured in speed dribbling post training test (MD=4.250, SD=2.050, p=0.000). When exposed to 12 weeks plyometric training. Hence, *(P < 0.05)* Post training speed dribbling score was significantly improved than pre-test score for the experimental group.

Table 8 Descriptive Statistics of control group

Performance Variables	N	Mean	Std. Deviation
shooting accuracy pre test	12	12.92	4.98
shooting accuracy post test	12	13.17	4.76
passing accuracy pre test	12	23.00	2.79
passing accuracy post test	12	22.92	2.53
speed dribble pre test	12	14.91	1.16
speed dribble post test	12	14.92	1.31

Key: - N= number of control group participants

The above table 8 shows that the pre and post test results of selected technical skill performance result for control group. As the above table indicated that the mean values of shooting accuracy score was 12.92 and 13.17 and the standard deviation was 4.98 and 4.76 of pre and posttest respectively. On the other side, the mean value of passing accuracy score was 23.00 and 22.92 and standard deviation value was 2.79 and 2.53 of pre and posttest respectively. And finally the mean value of speed dribbling score was 14.91 and 14.92 and standard deviation value was 1.16 and 1.31 of pre and posttest respectively.

This implies that, there was mean difference between the post and pretests, yet it is impossible to tell here if the differences are statistically significant. Hence a paired sample t-test comparing the pretest and post test scores of the variables and which was computed to examine whether this number show statistical difference between pre and

post test score of technical skill performance of control group. The paired t- test result was presented in the table as follows.

Table 9 Pre and post test paired sample t-test results of the control groups

Performance Variables	Paired Differences					Df	p- value
	MD	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
shooting accuracy pretest - shooting accuracy post test	-.250	1.357	.392	-1.112	.612	11	.536
passing accuracy pretest - passing accuracy post test	.083	.669	.193	-.341	.508	11	.674
speed dribble pretest - speed dribble post test	.000000	.852803	.246183	-.541845	.541845	11	1.000

*. The mean difference is significant at the 0.05 level. MD= mean difference

DF= degree of freedom

The above table 9 shows that the test of significance differences of the control group of pre and post test results performance variables. According to the data presented in the table, the pre and post test result of shooting accuracy showed a statistically not significant difference in control group. The result suggests that control group does not significantly improved shooting accuracy when measured in shooting accuracy post training test (MD=0.25, SD=1.357, p=0.536). Hence, *(P >0.05)* Post-training shooting accuracy scores was not significantly improved than pre-test scores for the control group.

The other variable passing accuracy pre and post test result of control group showed that statistically not significant difference in control group. The result suggests that control group does not significantly improved passing accuracy when measured in passing accuracy post training test (MD=0.083, SD=0.669, p=0.674). Hence, *(P >0.05)* Post-training passing accuracy scores was not significantly improved than pre-test scores for the control group.

Finally the third variable speed dribbling pre and post test result of control group showed that statistically not significant difference in control group. The result suggests that control group does not significantly improved speed dribbling when measured in speed dribbling post training test (MD=0.000, SD=0.852, p=1.000). Hence, *(P >0.05)* Post-training speed dribbling scores was not significantly improved than pre-test score for the control group.

Table 10 Posttest result differences between the Experimental Group and Control Group

Variables	Group	N	Mean	Std. Deviation	p-value
Shooting accuracy post test	experimental	12	38.33	4.25	.000
	Control	12	13.17	4.72	
passing accuracy post test	Experimental	12	38.17	3.38	.000
	Control	12	22.92	2.53	
speed dribble post test	experimental	12	10.83	1.19	.000
	control	12	14.91	1.31	
*. The mean difference is significant at the 0.05 level					

As the above table 10 indicated that the mean values of handball skill variables posttest of the experimental and control group were 38.33 and 13.17 in shooting accuracy and the standard deviation was 4.25 and 4.72 respectively. On the other side in case of passing accuracy, the mean values of the experimental and control group were 38.17and 22.92 and the standard deviation values were 3.38 and 2.53 respectively. And also the mean values of experimental and control groups in speed dribbling were 10.83 and 14.91 and standard deviation value was 1.19 and 1.31 respectively. The p-value of shooting accuracy, passing accuracy and speed dribbling was .000.The findings of the study presented that experimental group significantly improved shooting accuracy, passing accuracy and speed dribbling than control in post-testing(*P<0.05).*

4.3 Discussions of the study

The purpose of this study was to investigate the effect of 12 weeks plyometric training on selected technical skills performance of u-15 male handball project players. Handball has many technical skills performance however for this study purpose the selected performance variables were shooting accuracy, passing accuracy and speed dribbling. The subjects participated throughout the testing period and cooperated for the success of collection of necessary data. The experimental group participated in a 12-weeks plyometric training program while the control group did not participate in this selected plyometric training program but did their regular handball trainings. Experimental group were instructed not to start any additional programs during the 12-weeks period. Prior to the study, procedures and guidelines had presented orally and Subjects were agreed to participate. In this study plyometric training showed improvements in shooting accuracy, passing accuracy and speed dribbling. The finding of this study in each variable are discussed as follows:

The first objective of the study was to examine the effect of plyometric training on shooting accuracy. To analyze this, paired sample t-test within the group and independent sample t-test between the groups computed. The findings of the study revealed that there were significance differences before the training and after 12 weeks of plyometric training on players shooting accuracy when assessed in shooting accuracy post test. The result suggests that experimental group significantly improved shooting accuracy score (MD=25.833, SD=6.965, p=0.000). Hence, ($P < 0.05$) Post-training shooting accuracy was significantly improved than pre-test values for the experimental group. But in control group no significant difference were found (MD=0.25, SD=1.357, p=0.536), hence $p>0.05$ not significant at 0.05 level of confidence. As the data (table 5) showed the mean values of shooting accuracy were 12.50 in before plyometric training, which was improved to 38.33 after 12 week plyometric training, this means the shooting accuracy performance of experimental group increased by 25.83 point after 12 weeks of plyometric training. But the pre and post test score of control group stay very close, 12.92 and 13.17 pre and post test respectively. As a result of the independent sample t-test

indicated that experimental groups significantly improved than control groups as observed in post-testing *(p = 0.000, P<0.05).*

This result showed that experimental group of u-15male handball project players shooting accuracy was improved on the experiment. The improvement of the rate of this score in experimental group was indicator of the improvement of the players shooting accuracy performance. The reason behind this change was plyometric training that they were engaged in. Hence the researcher accepted hypothesis H.1at 0.05 level of confidence.

When studies in literature were searched carefully, it was seen that there are some of the results supporting the findings of this study result and some of the results arguing with the result of this study result. In relation to this, the data which has been found from the present study supported by research findings such as; Ismail, (1996) who's finding on the effects of training methods to improve explosive strength of legs and arms in shooting accuracy of handball players showed significant improvement. Nabeel et al, (2015) who investigated on effects of developing explosive strength & power training on shooting accuracy in juniors" handball. Gursharan (2017) showed that the effect of 12 weeks SAQ training has a significant effect on shooting accuracy of handball players. Likewise, Surendra (2018) stated that plyometric training had a significant effect on jumping and shooting accuracy of handball players. Recently in our country Wubliker, (2020) stated that plyometric training had significantly improved shooting accuracy of male team handball players and Yordanos (2020) stated that plyometric training had significant positive effect on shooting accuracy of u-17 male handball project players.

On the contrary, Yahya et al. (2014) defined that plyometric training has no significant effect on shooting accuracy and Saidi (2017) argued that the specific drills with plyometric training group had less significantly improved on shooting performance school level handball players due to the effect of specific drills with plyometric training program.

Further, handball shooting performance has been investigated by many researchers and muscle strength was found to be the most significant factor affecting the throwing

performance. In such a study, it was found out that the body flexors (abdominal muscles: rectus abdominals, external and internal oblique muscles) have a significant role in the determination of muscle strength and throwing action (Eliasz, 1998); a significant difference was found between maximal ball speed and other throw analyses during cross-step throw in. It was determined that the motor skill factors, the body's total muscle strength, the power of the body flexors and the angular speed of the maximal arm (shoulder joint) were definitely effective over the ball speed in the shooting accuracy techniques analyzed (Campos et al., 1994; Tillaar & Ettema, 2003; Zapartidis et al., 2009). Trainers should take into account these characteristics and training program should organize to improve the properties.

The second objective of the study was to determine the effect of plyometric training on passing accuracy. To analyze this, paired sample t-test and independent sample t-test computed. The findings of the study revealed that there were significance differences before the training and after 12 weeks of plyometric training on players passing accuracy when assessed in passing accuracy post test. The result suggests that experimental group significantly improved passing accuracy score test (MD=15.417, SD=5.501, p=0.000) Hence, ($P < 0.05$) Post-training passing accuracy was significantly improved than pre-test values for the experimental group. But in control group no significant difference were found (MD=0.083, SD=0.669, p=0.674), hence $p>0.05$ not significant at 0.05 level of confidence. As the data (table 5) showed that the mean values of passing accuracy were 22.75 and in before plyometric training, which was improved to 38.17 after12 week plyometric training, this means the passing accuracy performance of experimental group increased by 15.47 point after 12 weeks of plyometric training. But the pre and post test score of control group stay very close, 23.00 and 22.92 pre and post test respectively. As a result of the independent sample t-test indicated that experimental groups significantly improved than control groups as observed in post-testing *($p = 0.000$, $P<0.05$).*

This result showed that experimental group of u-15male handball project players passing accuracy performance was improved on the experiment. The change of the rate of this score in experimental group was indicator of the improvement of the players passing accuracy performance. The reason behind this change was plyometric training

that they were engaged in. Hence the researcher accepted hypothesis H.2 at 0.05 level of confidence.

The finding of this study supported by the research findings of, Baouche et al. (2017) conducted a study on the impact of proposed exercises in the method of plyometric training in the development of explosive power and some basic skills of handball and the proposed exercises in the plyometric training method significantly developed the level of performance of passing accuracy, receiving, speed dribbling and jumping skill of handball players. Similarly, of Ezhilmaran (2016) stated that the specific drills with plyometric training group had significantly improved on speed dribbling and passing accuracy of school level handball players due to the effect of specific drills with the plyometric training program.

On the contrary, Subash (2010) conducted a study on the effect of plyometric training on selected physical fitness and skill performance variables of intercollegiate level men handball players. This study was conducted on passing accuracy, speed dribbling, and jumping ability of handball players and the plyometric training group had no significantly improved on speed dribbling, passing accuracy, and jumping ability of intercollegiate level men handball players due to the effect of the plyometric training program. Similarly Wubliker (2020) conducted a study on the effect of 12 weeks plyometric training on the technical skill performance of Debre Markose team handball players. This study was conducted on shooting accuracy, speed dribbling and passing accuracy of team handball players and the plyometric training group had significant improved shooting accuracy and speed dribbling but not passing accuracy.

Handball passing performance has been investigated by many researchers and muscle strength and power was found to be the most significant factor affecting the throwing performance. Most researchers agreed that higher maximal power may be associated with an advantage in blocking, hitting, pushing and ball throwing accuracy (Marques & González-Badillo, 2006). Because plyometric training changes players' upper body and hand muscle strength and power and this change makes the players enable to throw a ball with maximum speed to the maximum distance target. Plyometric training proved that to be more effective in developing muscle power manifested during a

throw and it has positive influence on the development of abilities related to increasing speed of the ball to reach the target Michal and Mateusz (2018). When a ball has maximum velocity, it can resist any atmospheric pressure that may alter its direction to the target. In other way, the alternation of hand muscle strength and power due to plyometric training enables the player to catch a ball easily and properly. Therefore proper catching enables the players to pass the ball easily as they need to different distance and direction. That is the answer to how plyometric training improves passing accuracy.

Finally, the third objective of this study was to identify the effect of plyometric training on speed dribbling. To do this, paired sample t-test and independent sample t-test computed. The findings of the study revealed that there were significance differences before the training and after 12 weeks of plyometric training on players' speed dribbling when assessed in speed dribbling post test. The result suggests that experimental group significantly improved speed dribbling score test (MD=4.250, SD=2.050, p=0.000). Hence, ($P < 0.05$) Post-training speed dribbling score was significantly improved than pre-test values for the experimental group. But in control group no significant difference were found (MD=0.000, SD=0.852, p=1.000), hence $p>0.05$ not significant at 0.05 level of confidence. As the data (table 5) showed that the mean values of speed dribbling were15.08 in before plyometric training, which was improved to10.83 after 12 week plyometric training, this means the speed dribbling performance of experimental group increased by 4.25 point after 12 weeks of plyometric training. But the pre and post test score of control group stay very close, 14.91 and 14.92 pre and post test respectively. As a result of the independent sample t-test indicated that experimental groups significantly improved than control groups as observed in post-testing *($p = 0.000$, $P<0.05$).*

This result showed that experimental group of u-15male handball project players speed dribbling performance was improved on the experiment. The increment of the rate of this score in experimental group was indicator of the improvement of the players' speed dribbling performance. The reason behind this change was plyometric training that they were engaged in. Hence the researcher accepted hypothesis H.3 at 0.05 level of confidence.

The finding of this study supported by finding of Ezhilmaran (2016) that the specific drills with plyometric training group had significantly improved on speed dribbling and passing accuracy of school level handball players due to the effect of specific drills with the plyometric training program. Similarly, Shallaby (2010) stated that the effectiveness of plyometric exercises on physical abilities and skillful performance of basketball players and has also found that an improvement in the speed dribbling skillful performance. likewise, Baouche et al. (2017) conducted a study on the impact of proposed exercises in the method of plyometric training in the development of explosive power and some basic skills of handball and the proposed exercises in the plyometric training method significantly developed the level of performance of passing accuracy, receiving, speed dribbling and jumping skill of handball players.

Moreover recently in our country Wubliker (2020) conducted a study on the effect of 12 weeks plyometric training on the technical skill performance of Debre Markose team handball players. This study was conducted on shooting accuracy, speed dribbling and passing accuracy of team handball players and the plyometric training group had significantly improved shooting accuracy and speed dribbling of male team handball players.

Against this, Subash (2010) conducted a study on the effect of plyometric training on selected physical fitness and skill performance variables of intercollegiate level men handball players. This study was conducted on passing accuracy, speed dribbling, and jumping ability of handball players and the plyometric training group had no significantly improved on speed dribbling, passing accuracy, and jumping ability of intercollegiate level men handball players due to the effect of the plyometric training program. Consequently, in plyometric training, the speed of converting outward contractions into inward contractions increases, and the created tension in the muscle increases, as does the production power of the muscle, therefore reducing the duration of the speed run. Improvements in doing other sports are partly attributed to outward-oriented training programs and the use of the elasticity feature of muscles (Radcliffe and Farentinos, 1999). In team handball, it is essential to react quickly and perform powerful changes in direction, while moving quickly over short distances Michalsik et al,(2014).

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Under this chapter the main points of the study were summarized briefly, conclusions are given based on the result of the study and recommendation for researchers, coaches and concerned bodies had given based on the results of the study.

5.1. Summary of the study

The study was conducted on the effects of 12 weeks plyometric training on the selected technical skills performance of u-15 male handball project players. There are different technical skills of handball including passing, dribbling, shooting, feinting, goalkeeping, blocking, but this study was focused on the effect of plyometric training on shooting accuracy, passing accuracy, and speed dribbling performance of u-15 male handball players. The purpose of this study was to investigate the effect of plyometric training on selected technical skills performance of u-15 male handball project Players. For this purpose, the researcher reviewed the available literatures in order to decide the focus of the study and methodologies. In order to attain the general objective of the study, the following specific research objectives were formulated:

1. To examine the effect of plyometric training on shooting accuracy performance of u-15 male handball project players.
2. To identify the effect of plyometric training on passing accuracy performance of u-15 male handball project players.
3. To determine the effect of plyometric training on speed dribbling performance of u-15 male handball project players.

Based on the above specific objectives, the hypotheses were formulated. A quantitative research approach was used for this study and the research design that this study was used an experimental research design. The numbers of participants were 24 and all are taken as a sample by using comprehensive sampling technique. The participants were grouped into experimental and control groups through randomization. The experimental training group performed in a three-month of additional plyometric training program. However, the control group did not perform the selected plyometric training program. Nevertheless, they did perform as equal as normal training activities to

the experimental players for the regular handball training program. All subjects participated in all performance tests. The data was collected from study participants through field tests of shooting accuracy, passing accuracy, and speed dribbling, so the data source of this study was the primary source. Shooting accuracy was tested through the jump shoot test from 9m, passing accuracy through accuracy throw test from 7m and 10 m and speed dribbling through obstacle dribbling test. The data was gathered from the experimental and control groups results as in the form of pre-test and post-test method had been organized using appropriate and relevant statistical method of analysis. Paired t-test and independent t-test which assists to come up with findings had used. Through paired t-test and independent t-test the data was analyzed. Hence, the following major findings were investigated.

1. The finding of this study indicated that improvement in shooting accuracy score was observed in experimental group. Experimental groups had shown improveme nt as a result of the 12 weeks plyometric training, shooting accuracy score was improved better in EG. In CG no significant change was found in pre to post test.
1. The finding of this study revealed that passing accuracy was significantly improved in EG after 12 weeks of plyometric training. In CG no significant change was recorded in pre to post test.
2. Finding of this study indicated that there was a significant improvement of speed dribbling performance in experimental group as a result of plyometric training. Experimental group show decreased the time to cover the given distance in obstacle dribbling with the consequence of 12 weeks plyometric training but no significant improvement was found in CG.

5.2. Conclusions of the study

Based on the analyzed data, the researcher could reach the following conclusions: The main conclusion to be drawn from the results of the experimental statistics is that there was a significant difference between pretest and posttest result of shooting accuracy, passing accuracy and speed dribbling of an experimental group of u-15 male handball project players. Similarly, based on the major findings of the study, it was concluded that there is no significant difference between pretest and posttest of shooting accuracy, passing accuracy and speed dribbling of a control group of u-15 male handball project players. In addition, based on the results of the statistics is that there was no significant difference in pretest result of shooting accuracy, passing accuracy and speed dribbling performance between the experimental and control group, but there is a significant difference in posttest result of shooting accuracy, passing accuracy and speed dribbling performance between the experimental and control group of u-15 male handball project players. Therefore, based on the result of this study, the following points were reached as a conclusion.

- Plyometric training had a positive significant effect on improvement of shooting accuracy skill performance of u-15 male handball project players.
- Plyometric training had a positive significant effect on improvement of passing accuracy skill performance of u-15 male handball project players.
- Plyometric training had significantly improved speed dribbling skill performance of u-15male handball project players.

In general, the main finding of this study was handball technical skills performances such as; shooting accuracy, passing accuracy and speed dribbling performance. All these selected skills performance had significant improvement in u-15 male handball project players on the intervention of plyometric training program.

5.3. Recommendations

The purpose of this study was to investigate the effects of plyometric training on selected technical skills performance of u-15 male handball project players. Based on the conclusions drawn in light of the research findings, the following recommendations have been forwarded:

5.3.1. Recommendations for coaches

Based on the finding and conclusion of this study the following recommendation has been given:

- Coaches should use of plyometric training method with a scientific method of training because of its importance in developing some technical skill performance of handball players, and avoid using traditional methods of training.
- Plyometric training method should not be given more than three days per week. When applying the plyometric training method, the training loads will be based on the players' physical fitness level, training age, age and gender.
- Coaches should give both upper and lower extremities plyometric exercises for handball project players in order to develop some basic handball skills (shooting accuracy, passing accuracy and speed dribbling).
- It is necessary to develop awareness of the trainers about the importance of plyometric exercises to improve some technical skill performance of handball players.
- Plyometric training is the most frequently used method for conditioning in handball. Therefore, it would seem highly practical to implement plyometric training programs in handball training and in team sports abroad, due to its effect on performance.
- The plyometric training program should be a part of physical preparation of handball players and it is necessary to raise the awareness of the trainers with the importance of plyometric training in the direction of the skill, because of their significant influence on raising the level of the player physically and skillfully.

5.3.2. Recommendations for further study

- Other researchers should conduct this research on female handball players.
- Other researchers should conduct this research on female and male handball players by increasing or decreasing training week.
- Other researchers should conduct this research on u-15 male handball players by using another plyometric exercise.
- Other researchers should conduct this research on female and male above 15 age handball players.
- Other researcher should conduct these training effects by incorporating other technical skill of handball rather than passing accuracy, shooting accuracy and speed dribbling.
- Researcher who have an interest on the area should do research within the comparison of effects of plyometric training other training methods on technical skill performance of handball players.
- Researchers should conduct this researcher by considering the playing position of handball team players.
- Other researchers who are interested on this area should try to investigate a research on the effect of other training methods on these technical skill performances of handball players.

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Appendix A: Physical activity readiness questionnaires

Physical activity readiness questionnaire is the first step to take into consideration as one criterion to involve in regular physical exercise. Many health benefits are associated with participating in regular physical exercise. The physical activity readiness questionnaire is designed to identify participants for whom plyometric training might be appropriate and for whom it might be inappropriate. The following questions are prepared and distributed to participants regarding the health status for the participation of the designed training program.

Direction: please read the following questions carefully and indicate your response to each question by writing on blank space by putting tick (chooses: "yes" or "no" which is given below

Participants Name: _____signature: _____ Date _____

No	Questionnaires	Yes	No
1	Do you currently participate in regular exercise at least 3 days per week?		
2	Do you have a heart condition and should only do physical exercise recommended by a Physician?		
3	Is a physician currently prescribing medications for your blood pressure or heart Condition?		
4	Have you suffered from shortness of breath at rest or when you are doing physical Exercise?		
5	When you do physical exercise, do you feel pain in your chest?		
6	Do you have a joint or bone problem that may be made worse by a change in your Physical exercise?		
7	Do you have upper and lower extremities pain which has been aggravated by physical Exercise?		
8	Do you ever lose consciousness or do you lose your balance because of dizziness?		
9	In the past month, have you had chest pain when you were not doing physical activity?		

Adapted from Jamink et al, (2011)

Appendix B: Research participant's information consent

The following will provide you with information about the experiment that will help you in deciding whether or not you wish to participate. If you agree to participate, please be aware that you are free to withdraw at any time throughout the duration of the experiment without any penalty.

In this study, you will be asked to Participants voluntarily. You have read the participant's information sheet and clearly understood the purpose of the research, the procedures, the risk, and benefits. All information you provide will remain confidential and will not be associated with your name. If for any reason during this study you do not feel comfortable, you may leave the experiment or training program and receive credit for the time you participated and your information will be discarded. Your participation in this study will require approximately 60 minutes per day, three days per week, and a total of 12 weeks. When this study is complete, you will be provided with the results of the experiment if you request them, and you will be free to ask any questions. If you have any further questions concerning this study, please feel free to contact us through phone: 0914358120 or email: solomonhabtamu05@gmail.com.

Please indicate with your signature on the space below that you understand your rights and agree to participate in the experiment.

Your participation is solicited, yet strictly voluntary. All information will be kept confidential and your name will not be associated with any research findings. Therefore, you declare your voluntary consent to participate in this study with your signature as indicated below.

Name of research participants: _____Signature: _____ Date: _____

I certify that I have explained fully to the above participant about the purpose, procedures, confidentiality, right the potential benefits and the possible involved in this thesis study.

Name of researcher……..signature……Date ……..

Adapted from Wubliker, (2020)

Appendix C: Description of selected skill test

No.	Variables	Test item name	Unit of measurement
1	Shooting accuracy	Jump shoot	In Point
2	Passing accuracy	Accuracy throw	In Point
3	Speed dribbling	Obstacle dribbling	In second

Appendix D: Handball skill test score sheet

Handball player

Name _____

Team _____

Skill test 1: Jump shoot test

Three step jump shoot											
Position	Left in			Center back				Right in			Total
No. of shoots	1	2	3	1	2	3	4	1	2	3	10
Point scored											

Skill test 2: Accuracy throw test

Accuracy throw test											
Type of pass	Short pass from 7m					Long pass from 10m					Total
No of pass	1	2	3	4	5	1	2	3	4	5	10
Point scored											

Skill test 3: Obstacle dribbling test

Trials	Trail one	Trail two	Best
Finishing time in second			

Appendix E: Profile of experimental group

No.	Name	Age in year	Weight in kg	Height in meter	BMI	Training age in year
1	EG1	15	39	1.40	20.00	2
2	EG2	14	41	1.39	20.47	2
3	EG3	14	42	1.42	18.33	2
4	EG4	14	40	1.41	22.54	2
5	EG5	15	47	1.42	21.93	3
6	EG6	14	41	1.53	18.37	2
7	EG7	14	45	1.52	21.12	2
8	EG8	15	44	1.48	19.90	3
9	EG9	14	43	1.56	18.26	2
10	EG10	13	40	1.40	18.01	1
11	EG11	13	40	1.41	20.40	1
12	EG12	14	42	1.40	20.10	3

Appendix F: Profile of control group

No.	Name	Age in year	Weight in kg	Height in meter	BMI	Training age in year
1	CG1	15	43	1.50	19.89	2
2	CG2	14	43	1.45	21.24	2
3	CG3	14	43	1.55	20.89	2
4	CG4	14	46	1.43	20.20	3
5	CG5	15	40	1.40	23.38	3
6	CG6	15	43	1.53	17.52	2
7	CG7	15	45	1.46	19.48	3
8	CG8	15	43	1.47	20.09	2
9	CG9	15	40	1.48	17.69	3
10	CG10	14	40	1.49	20.40	3
11	CG11	13	42	1.40	20.10	1
12	CG12	14	42	1.41	21.42	1

Appendix G: Twelve-week plyometric training

Exercises	**Week** 1–2	**Week 3-4**	**Week 5-6**	**Week 7-8**	**Week** 9–10	**Week** 11-12	**Rest b/n Set in second**	**Duration in minutes**
Warming-up	Jogging & Synchronized movement of hands and leg, arm, static and dynamic stretching exercise							10
Upper limp	S × R	S × R	S × R	S × R	S × R	S × R		30
Wall clamp push up	4× 5	4 × 8	3 × 15	4× 15	4× 17	5× 20	60	
Medicine ball chest pass	2 × 3	2 × 4	3 × 4	2× 6	3× 6	3× 7		
clamping push- ups	4×4	4×7	4×9	4×12	4×15	4×20	60	
Lower limp	L × S × R	L × S × R	L × S × R	L × S × R	L × S × R	L × S × R		
Tuck jump	2 × 3	2 × 4	2 × 5	2 × 8	2 × 9	2× 10	120	
Depth Jumping	2 × 4	2 × 5	2 × 6	2 × 7	2 × 8	3 × 7	120	
Standing jump for height	2 × 3	2 × 4	2 × 5	2 × 8	2 × 9	2× 10	120	
Standing long jump	0.65 m × 2 × 6	0.75 m × 2 × 6	0.85 m × 3 × 6	0.95 m × 2 × 6	1.5 m × 2 × 6	1.10m × 2 × 6	120	
Cooling-down	Light movements and static stretching at the end of the session							5

*. L, length, S, set and R, repetition * weight of medicine ball= 1k.g

Source adapted from Jonathan (2008) and Hammami (2020).

Appendix H: Experimental group skill test pre and post test result

NO.	NAME	VARIBLES					
		Shooting accuracy		Passing accuracy		Speed dribble	
		Pre	Post	Pre	Post	Pre	Post
1	EG1	15	32	24	36	15.000	12.00
2	EG2	20	35	26	35	16.000	11.00
3	EG3	15	36	25	40	13.000	13.00
4	EG4	20	36	18	42	17.000	10.00
5	EG5	10	40	23	45	16.000	9.00
6	EG6	10	40	27	38	16.000	10.00
7	EG7	5	34	15	39	15.000	11.00
8	EG8	10	37	20	37	14.000	9.00
9	EG9	15	41	24	36	16.000	11.00
10	EG10	15	45	23	41	15.000	12.00
11	EG11	10	46	26	36	15.000	11.00
12	EG12	5	38	22	33	13.000	11.00

Appendix I: Control group skill test pre and post test result

NO.	NAME	VARIABLES					
		Shooting accuracy		Passing accuracy		Speed dribble	
		Pre	Post	Pre	Post	Pre	Post
1	CG1	20	19	26	26	14.000	15.00
2	CG2	20	21	25	25	16.000	17.00
3	CG3	15	15	24	24	14.000	13.00
4	CG4	15	16	23	23	17.000	16.00
5	CG5	15	15	18	18	16.000	16.00
6	CG6	15	15	20	21	15.000	16.00
7	CG7	10	12	21	20	14.000	14.00
8	CG8	5	8	20	21	14.000	13.00
9	CG9	10	10	22	22	16.000	16.00
10	CG10	5	5	25	24	15.000	15.00
11	CG11	10	8	27	26	15.000	14.00
12	CG12	15	14	25	25	13.000	14.00

Appendix J: Descriptive Statistics of experimental and control group profiles

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
age of respondents	Experimental	12	14.25	.754	.218
	Control	12	14.42	.669	.193
weight of respondents	Experimental	12	42.17	2.209	.638
	Control	12	42.50	1.883	.544
height of respondent	Experimental	12	1.4450	.06038	.01743
	Control	12	1.4642	.04907	.01417
body mass index	Experimental	12	19.9525	1.48441	.42851
	Control	12	20.1917	1.57586	.45491
training age	Experimental	12	2.08	.669	.193
	Control	12	2.25	.754	.218

Appendix K: Paired sample test SPSS result of experimental group

Paired Samples Statistics					
Performance variables		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	shooting accuracy pre test	12.50	12	5.000	1.443
	shooting accuracy post test	38.33	12	4.250	1.227
Pair 2	passing accuracy pre test	22.75	12	3.545	1.023
	passing accuracy post test	38.17	12	3.380	.976
Pair 3	speed dribble pre test	15.08333	12	1.240112	.357990
	speed dribble post test	10.8333	12	1.19342	.34451

Paired Samples Test									
Performance variables		Paired Differences					t	DF	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	shooting accuracy pretest - shooting accuracy post test	-25.833	6.965	2.011	-30.259	-21.408	-12.848	11	.000
Pair 2	passing accuracy pretest - passing accuracy post test	-15.417	5.501	1.588	-18.912	-11.921	-9.708	11	.000
Pair 3	speed dribble pretest - speed dribble post test	4.250000	2.050499	.591928	2.947175	5.552825	7.180	11	.000

Appendix L: Paired sample test SPSS result of control group

Paired Samples Statistics					
Performance variables		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	shooting accuracy pre test	12.92	12	4.981	1.438
	shooting accuracy post test	13.17	12	4.726	1.364
Pair 2	passing accuracy pre test	23.00	12	2.796	.807
	passing accuracy post test	22.92	12	2.539	.733
Pair 3	speed dribble pre test	14.91667	12	1.164500	.336162
	speed dribble post test	14.9167	12	1.31137	.37856

Paired Samples Test									
Performance variables		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	shooting accuracy pretest - shooting accuracy post test	-.250	1.357	.392	-1.112	.612	-.638	11	.536
Pair 2	passing accuracy pretest - passing accuracy post test	.083	.669	.193	-.341	.508	.432	11	.674
Pair 3	speed dribble pretest - speed dribble post test	.000000	.852803	.246183	-.541845	.541845	.000	11	1.000

Appendix M: Independent sample T- test SPSS pretest result of experimental and control group

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
shooting accuracy pre test	Experimental	12	12.50	5.000	1.443
	Control	12	12.92	4.981	1.438
passing accuracy pre test	Experimental	12	22.75	3.545	1.023
	Control	12	23.00	2.796	.807
speed dribble pre test	Experimental	12	15.08333	1.240112	.357990
	Control	12	14.91667	1.164500	.336162

Independent Samples Test

Performance variables		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
shooting accuracy pre test	Equal variances assumed	.005	.946	-.205	22	.840	-.417	2.037	-4.642	3.809
	Equal variances not assumed			-.205	22.00	.840	-.417	2.037	-4.642	3.809
passing accuracy pre test	Equal variances assumed	.199	.660	-.192	22	.850	-.250	1.303	-2.953	2.453
	Equal variances not assumed			-.192	20.867	.850	-.250	1.303	-2.962	2.462
speed dribble pre test	Equal variances assumed	.000	1.000	.339	22	.738	.166667	.491082	-.85177	1.185109
	Equal variances not assumed			.339	21.914	.738	.166667	.491082	-.85200	1.185342

Appendix N: Independent sample T- test SPSS post test result of experimental and control group

Group Statistics					
Performance variables	Group	N	Mean	Std. Deviation	Std. Error Mean
shooting accuracy post test	Experimental	12	38.33	4.250	1.227
	Control	12	13.17	4.726	1.364
passing accuracy post test	Experimental	12	38.17	3.380	.976
	Control	12	22.92	2.539	.733
speed dribble post test	Experimental	12	10.8333	1.19342	.34451
	Control	12	14.9167	1.31137	.37856

Independent Samples Test											
Performance variables		Levene's Test for Equality of Variances		t-test for Equality of Means							
									95% Confidence Interval of the Difference		
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper	
shooting accuracy post test	Equal variances assumed	.173	.682	13.717	22	.000	25.167	1.835	21.362	28.972	
	Equal variances not assumed			13.717	21.757	.000	25.167	1.835	21.359	28.974	
passing accuracy post test	Equal variances assumed	.831	.372	12.496	22	.000	15.250	1.220	12.719	17.781	
	Equal variances not assumed			12.496	20.416	.000	15.250	1.220	12.708	17.792	
speed dribble post test	Equal variances assumed	.538	.471	-7.978	22	.000	-4.08333	.51185	-5.14485	-3.02181	
	Equal			-7.978	21.807	.000	-4.08333	.51185	-5.14540	-3.02127	

Appendix-O: Photos during skill test

MEASURMENT OF GOAL POSTS

JUMP SHOOT TEST PLACE IN CENTER BACK ZONE

PLAYERS DURING JUMP SHOOT TEST IN CENTER BACK ZONE

PLYERS DURING JUMP SHOOT TEST IN LEFT IN ZONE

PLYERS DURING JUMP SHOOT TEST IN RIGHTIN ZONE

ACCURACY THROW TEST TARGET CIRCLES

ACCURACY THROW TEST 7&10M LINES

PLAYER DURING7 M ACCURACY THROWS TEST


PLAYERS DURING10 M ACCURACY THROW TEST


SPEED DRIBBLING TEST PLACE PLAYER DURING SPEED DRIBBLING TEST