2023-06

The Effects of Medicine Ball Training on Hand Grip Strength and Some Selected Handball Skills of Female Under-17 Handball Project Trainees

MELKAMU, ASRES

BAHIR DAR UNIVERSITY

SPORT ACADEMY
DEPARTMENT OF SPORT SCIENCE

THE EFFECTS OF MEDICINE BALL TRAINING ON HAND GRIP STRENGTH AND SOME SELECTED HANDBALL SKILLS OF FEMALE UNDER-17 HANDBALL PROJECT TRAINEES

BY

MELKAMU ASRES

JUNE, 2023G.C

BAHIR DAR, ETHIOPIA

BAHIR DAR UNIVERSITY

SPORTS ACADEMY

DEPARTMENT OF SPORT SCIENCE

THE EFFECTS OF MEDICINE BALL TRAINING ON HAND GRIP STRENGTH AND SELECTED HANDBALL SKILL OF FEMALE UNDER-17 HANDBALL PROJECT TRAINEES

BY

MELKAMU ASRES

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

ADVISOR

HAILEYESUS GEDEFAW (Ph.D.)

JUNE, 2023G.C

BAHIR DAR, ETHIOPIA

DECLARATION

This is to certify that the thesis titled "EFFECTS OF MEDICINE BALL TRAINING ON HAND GRIP STRENGTH AND SOME SELECTED HANDBALL SKILLS OF FEMALE UNDER-17 HANDBALL PROJECT TRAINEES" submitted in partial fulfillment of the requirements for the degree of Master of Science in Handball Coaching in the Department of Sport Science, Bahir Dar University, is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during this investigation have been duly acknowledged.

Candidate's Name: - Mr. Melkamu Asres

Signature: -_____

Date: -_____

ADVISOR'S APPROVAL SHEET
BAHIR DAR UNIVERSITY

SPORT ACADEMY

DEPARTMENT OF SPORT SCIENCE

I hereby certify that I have supervised, read, and evaluated this MSc thesis titled EFFECTS OF MEDICINE BALL TRAINING ON HAND GRIP STRENGTH AND SOME SELECTED HANDBALL SKILL PERFORMANCE OF FEMALE UNDER-17 HANDBALL PROJECT TRAINEES by Melkamu Asres prepared under my guidance. I recommend the thesis be submitted for oral defense.

Name of advisor	Signature	Date
Dr. Haileyesus G.	_____	_____

BAHIR DAR UNIVERSITY

SPORT ACADEMY

DEPARTMENT OF SPORT SCIENCE

BOARD OF EXAMINERS' APPROVAL SHEET

As members of the board of examiners, we examined this thesis entitled EFFECTS OF MEDICINE BALL TRAINING ON HAND GIP STRENGTH AND SOME SELECTED HANDBALL SKILL PERFORMANCE OF FEMALE UNDER-17 HANDBALL PROJECT TRAINEES by Melkamu Asres. We hereby certify that the thesis was accepted for fulfilling the requirements for the award of the degree of MASTERS OF SCIENCE IN COACHING HANDBALL.

Board of Examiners

External examiner name	Signature	Date
_____	_____	_____
_____	_____	_____
Internal examiner name	Signature	Date
_____	_____	_____
_____	_____	_____
Chairperson’s name	Signature	Date
_____	_____	_____

Acknowledgment

I want to first thank God for enabling me to perform my task. Then I would like to express my special thanks and sincere appreciation to my thesis advisor Dr. Haileyesus Gedefaw for his constructive suggestions, detailed comments, and encouragement in formulating and successful completion this thesis. Without his valuable cooperation and expert guidance this study could not be completed. My genuine pleasure is also extended to Ethiopian Police University for giving me this opportunity to pursue my education and providing me with different support.

Secondly, I would like to express my thanks to the Bahir Dar University Sports Academy Female handball project trainees who voluntarily participated in this study and for undergoing the testing procedures. Without their cooperation, voluntary and wholehearted support the study could not have been completed.

Thirdly I would like to express my sincere gratitude to instructor Mr. Sisay Adugna (Assistant Prof.) and instructor Mr. Yilkal Chalie to make smooth relations with their trainees for undergoing the test procedure, training program, and other activities from starting to the end.

Finally, I would like to give special thanks to my Family for their ideal and different support and also to Dr. Ephrem Tamrat who provided me with a Dynamometer to measure the hand-grip strength of players.

TABLE OF CONTENTS

Contents **page**

List of tables

List of figure

List of Abribbation

C.G	Control group
CSA	Cross sectional area
E.G	Experimental group
FITT	Frequency, Intensity, Time, and Type of exercise
HGS	Hand grip strength
IHF	International handball federation
K.G	Kilogram
Lb.	Libra
M	Meter
Mb	Medicine ball
MBT	medicine ball training
N	Numbers of participant
SAID	Specific adaptation to imposed demands
SAQ	Speed, agility, and quickness
Sec	Second
SPSS	Statistical package for the social sciences,

ABSTRACT

Team handball combines skills of running, jumping, catching, and throwing into a fast-moving, exciting game. Training with a medicine ball is one way to increase a person's general fitness as well as their fitness for a particular sport (Actor et al., 2021). But there is not enough literature on the effect of medicine ball training on grip strength and the handball skill performance. The purpose of this study was to investigate the effects of medicine ball training on hand grip strength and some selected handball skill performance of female under-17 handball project trainees. The population was little in number and then taken as a sample by using the compressive sampling technique. The subjects of the study were twenty (N=20) and randomly assigned to experimental (N=10) and control (N=10) groups. The experimental group participated in an 8-week medicine ball training program, 2 days per week for 60 minutes, in addition to the regular training session, whereas the control group participated only in the regular training. The data was collected through a strength test and field skill test and this data was analyzed by using paired sample t-test and independent sample t-test statistical tool SPSS version 26 with a significance level of 0.05. Based on the data analyzed through paired sample t-test, EG significantly increased in hand grip strength, (p= 0.000) shooting accuracy, (p= 0.001), and speed dribbling, (p= 0.000) but no performance improvement in throwing accuracy, (p=0.343). Similarly, the independent t-test shows the post-test performance of hand grip strength, shooting accuracy, and speed dribbling of EG was significantly improved than the post-test result of CG (hand grip strength, p=0.001, shooting accuracy, p= 0.028, and speed dribbling, P=0.000), but not throwing accuracy (p=0.911, p>0.05)). The experimental group improve hand grip strength, shooting accuracy, and speed dribbling compared to the control group (p<0.05). Therefore, it can be concluded that medicine ball training improves hand grip strength, shooting accuracy, and speed dribbling of female u-17 handball project trainees. Whereas medicine ball training had not improved in throwing accuracy skill performance of u-17 female handball project trainees.

Keywords: *Handball, medicine ball training, hand grip strength, shooting accuracy, speed dribbling, 0throwing accuracy, and technical skill performance.*

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Today's civilizations place sports competitions and events that have a great deal of significance on the developments of local and global levels (Metan & Küçük, 2022). Handball is an athletic discipline made up of offensive and defensive organizations. When adopting these organizations, involves moving quickly across small distances while passing, bouncing, shooting, and blocking activities occur (Eler & Eler, 2017).

Therefore, team handball combines skills of running, jumping, catching, and throwing into a fast-moving, exciting game that closely resembles basketball, having roughly the same number of players and utilizing dribbling, passing, pick and rolls, and fast breaks (Myklebust, 2009). From those activities, physical contact is permitted and includes throwing, sprinting, jumping, pushing, and blocking actions (Nuño et al., 2016).

Although it is very different from soccer, because in team handball sports each player actively participates in both offense and defense during a handball game, and multiple goal-scoring opportunities may arise during a single offensive play (Jebsen, 2018). In addition to this, team handball players need to have well-developed physical capabilities. In the closing stages of a game or a training session, it is common to see players' skills deteriorate, which is typically attributed to exhaustion (Nuño et al., 2016).

Likewise, handball is one of the sports that need to physically, technically, conceptually, and psychologically prepare the players for the greatest levels of competition because getting the team physically ready is a crucial part of getting them ready for their best performance possible during games (Khaled et al., 2018).

Players in handball frequently face both psychological and physical hardship. Physical fitness is the key prerequisite for mastering and developing a technical sports skill in handball (Nopianto et al., 2021). Handball technical training allows players to make the greatest use of opportunities that keep them interested in the game while also enabling them to preserve energy and handle

challenging game situations (Ion, 2014). Since strength is a crucial motor skill in handball, strength training helps to build muscle power and the capability of the body's energy production system (Marques et al., 2011). In various sports, handgrip strength is necessary for catching and throwing the ball (this is particularly true for the dominant handball) (Sciences & Sciences, 2007).

According to (Fallahi & Jadidian, 2011), in a variety of team sports, having a strong handgrip is essential for catching and tossing the ball. In the case of shooting several studies stated that the shooting technique in handball is one of the most crucial components of the play since the main objective is to score goals and accomplish the game in a good manner (Marković, 2020). Therefore, shooting is the determining factor in a team's victory (Pujianto et al., 2020). When a player can dribble effectively during a game, they have a significant advantage in scoring a goal (Khaled et al. 2018), and dribbling ability plays a significant role in determining the result of a handball game (Qowiyyuridho et al, 2021).

Another variable of handball skill is throwing accuracy, which is viewed as the most crucial technique in many sports areas. The player's body must be perfectly coordinated to perform well when throwing. It was revealed that 49.9% of the throwing velocity is based on stepping and body rotation, while 53.1% of it springs from arm movement (Çetin & Balcı, 2015) both exterior and internal shoulder movements determine the handball throw (Nopianto et al., 2021). Throwing performance is a key skill for success in competitive handball games (R et al., 2010).

Training has a broad definition; the term "training" refers to any planned, methodical educational procedure intended to improve a person's aptitude in terms of his physical, psychological, and intellectual attributes (Al-Shaarani & Al-Wazir, 2006). Athletic successes are largely determined by the training program used for that sport to succeed in the competition. This training is the most crucial one (Gokulakrishnan & Monisha, 2021). One key element in the success or failure of sporting events is the physical conditioning of ball players, which has been established over many years (Farley et al., 2020). According to Teodor & Claudiu (2012), sports training is described as a "systematic and continuous process developed gradually to teach the human body to adapt to the physical, technical, tactical, and psychological intensity to achieve high results in one of the forms of competitive practice exercise".

Medicine balls can be round, portable balls made of leather, plastic, or polyester that come in a variety of colors, sizes, and shapes (from 1 kg to over 10 kg, or about 2 to 22 lbs.) and have the potential to positively affect several health and fitness variables (Sad et al., 2017). Training with a medicine ball is one way to increase a person's general fitness as well as their fitness for a particular sport, such as strength, flexibility, and body coordination (Actor et al., 2021).

Training with a medicine ball is one way to create the unique movement patterns necessary to boost arm power, and the passing game would be speedier and more accurate with strong arm power (Dinata, 2021). Additionally, training with medicine balls significantly enhances female handball players' throwing velocity performance (R et al., 2010). Female ball players must engage in resistance training, for instance, medicine ball training, to get the best benefits and sustain performance, especially if they play sports like handball (Ignjatovic et al., 2012).

A combination of muscle strength, handball techniques, and competitive skills training can significantly enhance maximal and specific explosive strength of the upper limb over an 8- to 10-week training program (Luigi Bragazzi et al., 2020). Because of this, consideration should be given to how to best incorporate and supplement this component of a training program and have it integrated as part of a periodized progressive resistance training program (Earp et al., 2010).

But researchers or my observations there is not enough literature about the effects of medicine training on hand grip strength and handball skill performance and also not employed or provided medicine ball training for trainees in numerous handball projects. Given the above explanation, the study's objective was to find out how medicine ball training affected the under-17 female handball project participants' hand grip strength and skill performance variables of shooting accuracy, speed dribbling, and having to throw accuracy.

1.2. Statement of the problem

One of the main roles of the training process that results in the improvement of the player's performance is preparing the player physically, tactically, and technically for the demands of the handball game. A regular training program is among the best ways to raise handball players' performance levels. Sport training is the most crucial one for handball players to improve skill performance (Gokulakrishnan & Monisha, 2021). Both muscle CSA and grip force were higher in prepubertal boys than in girls (Neu et al., 2023).Training with a medicine ball is one way to

increase a person's general fitness as well as their fitness for a particular sport (Actor et al., 2021).

The use of medicine balls in pushing, throwing, and passing exercises is very important; they can be performed individually, in pairs, or collectively, as well as in other different situations and forms, such as standing, kneeling, sitting, lying, or hanging. This is one of the modern, unconventional training methods that emerged as a direct result of the scientific renaissance in the sports field to bring players to the top of sports achievement (Salameh, 2020). But there is not enough literature on the effect of medicine ball training on hand grip strength and the handball skill performance variable of female u-17 handball project trainees.

Following this Dinata (2021), researchers conducted a study on the effects of medicine ball training on the basketball passing abilities of high school basketball students. Because the study involved basketball players, the researcher did not take into account the impact of medicine ball training on hand grip strength, shooting accuracy, speed dribbling, or throwing accuracy. So, this study aims to investigate how medicine ball training affects trainees in handball projects on hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy.

Also, Pujianto et al. (2020) conducted a study to determine the impact of medicine ball training on handball players' shooting accuracy, and it was found that the training is effective and significant in improving shooting accuracy. However, the researcher did not address the effects of medicine ball training on hand grip strength and handball technical skills like speed dribbling and throwing accuracy; as a result, this study also includes shooting accuracy, hand grip strength, speed dribbling, and throwing accuracy on female handball project trainees.

Moreover, Salameh, (2020), proved that an 8-week medicine ball training program makes a significant contribution to the growth of physical abilities connected to muscle strength, speed, agility, and balance. However the researcher did not address the effects of medicine ball training on handball technical skills performance like shooting accuracy and speed dribbling; as a result, this study also includes hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy on female handball project trainees.

The ideas, methods, tools, and components of sports training all lead to the aims and goals of training that were best for contests and competitions and deliver the best performance. Still now

lack enough information to report on the effects of medicine ball training on hand grip strength and handball skill performance variables. Therefore, the researcher was trying to fill this gap by analyzing the relationship between the effects of medicine ball training on hand grip strength and handball skill performance variables such as shooting accuracy, speed dribbling, and throwing accuracy. Therefore, the purpose of this study was to investigate the effects of medicine ball training on hand grip strength and handball skill performance variables such as shooting accuracy, speed dribbling, and throwing accuracy variables among female under-17 handball project trainees.

1.3 Research objective

1.3.1 General objective

The general objective of this study was to examine the effects of medicine ball training on hand grip strength and some selected handball skill performance of under-17 female handball project trainees.

1.3.2 Specific objective

In line with the general objective, the specific objectives of the study were to observe:

1. The effect of medicine ball training on the hand grip strength of female under-17 project handball trainees
2. The effect of medicine ball training on the shooting accuracy performance of female under-17 project handball trainees.
3. The effect of medicine ball training on the speed dribbling performance of female under-17 project handball trainees.
4. The effect of medicine ball training on the throwing accuracy skills of female under-17 project handball trainees.

1.4 Research hypothesis

The research hypothesis is linked to two variables: an independent variable and a dependent variable, which is a prediction. In most cases, a research hypothesis needs to have at least one

independent and one dependent variable (Los, n.d.). Therefore, this thesis had the following research hypotheses:

1. H.1: medicine ball training significantly affects the hand grip strength of female u-17 handball trainees.
2. H.1: medicine ball training significantly affects the shooting accuracy of female u 17 handball trainees.
3. H.1: Medicine ball training significantly affects the speed dribbling of female u 17 handball trainees.
4. H.1: medicine ball training significantly affects the throwing accuracy of female u 17 handball trainees.

1.5 Significance of the Study

The study may provide several kinds of information to the concerned body, such as trainers, coaches, and other researchers who were motivated to look into this subject. The study's conclusions may have a significant influence by presenting concepts to aid the coach in developing a proper training program. The study may also help trainers and trainees to assess hand grip strength and skill level and whether this method of training improves or not on hand grip strength and technical skill performance. For coaches, instructors, and students, this study also offers baseline data and references on the effects of medicine ball training on hand grip strength and the technical skill performance of handball players. Furthermore, because there is a shortage of research on the effects of medicine ball training on hand grip strength and handball skill performance sports overseas, the findings of this study would be reference materials for future researchers on the same title from different perspectives.

1.6 Delimitations of the Study

This study was delimited in the following areas.

This study was delimited to the effects of 8-week medicine ball training on hand grip strength and handball technical skill performance of female u-17 handball project trainees at Bahir Dar University Sports Academy. Handball has a variety of technical skills that were important for success in handball competitions. This includes passing, shooting, feinting, goalkeeping, dribbling, and catching. But this study was delimited to the effects of medicine ball training on hand grip strength and shooting accuracy, speed dribbling, and throwing accuracy of female u-17 handball project trainees. Tests were taken from 9m front jump shot for shooting accuracy, 16 m

distance agility dribbling for speed dribbling, and overhead throw from 7m and 10m for throwing accuracy. This research was also considering training season 2022/23 G.C.

1.7 Limitations of the Study

Despite the attempts made to ensure the reliability and validity of the data, this research is comprehensive, and the following points might be considered limitations of the study**:**

- The absence of sufficient kinds of literature related to the selected issue in our country
- On the other hand, the sample players were taken regardless of players' position, so the different responsibilities of the players may have an impact on the results of this study.
- In addition to this, unable to control the training modality for instance weather conditions/atmosphere pressure during the testing period.

1.8 Organization of the Study

This experimental research was organized into five chapters, chapter one includes the background, problem, hypotheses, objectives, delimitation, limitations, and organization of the study. Chapter two focuses on a survey of related literature. The problem, the study's conclusions, and the gap that needs to be filled were all supported by this section's in-depth assessment of relevant research works involving conceptual and empirical analysis. Chapter Three research methods include research approach, design, population, sampling techniques, criteria, data collection instrument, training protocol, method of data analysis, and ethical considerations.

In chapter four the results obtained in the study and analysis were presented, which investigates the nature of the medicine ball training, hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy of u-17 female handball trainees. In addition, this chapter portrays a discussion of the results with the existing and past research works scrutinized in line with the present findings. Finally, in chapter five summaries of the study presented, based on the findings, conclusions, recommendations, and directions for intervention affirmed possible improvement for future research.

1.9 Definitions of key terms

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

Dribbling is moving on the field while maintaining ball possession.

Dynamometer is an electronic device for measuring force, a moment of force, or power

Handball is a team sport in which two teams of seven players each pass a ball using their hands to throw it into the goal of the other team.

Handgrip is a handle or similar part of an object affording a grip by the hand, for lifting or press

Hand grip strength is the maximum force/tension generated by one's forearm muscles

Medicine ball is a weighted ball whose diameter is about shoulder-width, often used for rehabilitation and strength training

Shooting is the final part of the action and it aims at scoring a goal. Technically it is similar to passing, but the action is much more forceful and fast.

Shooting accuracy is the ability to control one's movement and shot the ball as hard as possible a player can to a specific target in which the goalkeeper and defenders cannot easily reach the ball and defend or block it.

Speed dribbling is the skill of moving as fast as possible by bouncing the ball with the ground towards the opponent goal

Sports performance is highly dependent on the health- and skill-related components of fitness.

Strength is the property of being physically strong

Technical Skill performance: an ability that an athlete has to perform different techniques and tactical activities by showing certain qualities

Throwing involves propelling a ball away from the body and is a target skill

Training is a process of preparation for a sports performance

Throwing accuracy is the ability to throw the ball as much as possible to the target area

CHAPTER TWO

REVIEW OF RELATED LITERATURE

In this chapter, different reviews of related literature were included. Nature of the handball game, and fundamental technical skills of handball such as hand grip strength, shooting accuracy, dribbling, and throwing accuracy are included. In addition to these, medicine ball training, and its importance for handball sports, medicine ball training design recommendations, safety considerations of medicine ball training, and its effect on the technical skill performance of handball players were clearly stated in this chapter.

2.1 Short Description of Handball Sport

Handball is a fast team sport that was popularized by Scandinavia and Germany at the end of the 19th century. The Field Handball World Championships were held in Germany in 1938 after being introduced at the 1936 Berlin Olympics courtesy of the creation of the International Amateur Handball Federation (IAHF) in 1928 at the Olympic Games in Amsterdam. In the team sport of handball, a ball is passed from player to player to direct it to the other team's goal. The team with the most goals at the end of two 30-minute halves typically wins a game.

Modern handballs are played on courts that are 40 by 20 meters (131 by 66 feet) and include goals in the middle of each end (Sutarman, 1938). 183 nations now play handball. There are 31 million athletes, coaches, and officials in the world. Other names for handball include "team handball," "field handball," "European handball," and "Olympic handball." The object of the game is to kick the ball into the goal of the other team by passing and bouncing it between two teams of seven players each (six players plus a goalkeeper) (I.E., 1936).

The sport of handball is one of the team sports that is undergoing rapid growth in international, continental, Arab, and small local championships because the execution of fundamental defensive and offensive skills necessitates using all the coach's training resources to develop players' aspects (physical, skill, kinetic, tactical, functional, and psychological) through unique exercises and by the unique requirements of each playing center, the front line, and the back line (Ali Naser & Darwash Rashid, 2022).

2.3 Nature of Strength in Handball

Strength refers to the capacity to tolerate a considerable amount of force or pressure. Possessing a strong physique would let you perform demanding activities without getting exhausted (Suchomel et al., 2018). The ability of a muscle or a collection of muscles to generate force against external resistance is known as muscular strength. In most athletic scenarios, the external resistance is provided by the mass of a body, either the performer's or an object's mass (Spiering et al., 2022). According to (Mascarin et al., 2017) Young female handball players who conducted strength training with elastic bands over six weeks showed improvements in their ball speed and muscle power.

Muscular strength is measured by the amount of force that can be generated during a certain movement task. The force produced when muscles contract is converted into moments acting at the joints, and these moments are further converted into an external force that alters how the athlete's body moves or the motion of an object they are in touch with. Because all sports require the use of force, having strong muscles is crucial for all players (Gavin L Moir, 2015). The performance of an athlete may be influenced by a variety of basic factors. While sports scientists and practitioners cannot manipulate an athlete’s genetic characteristics, an athlete’s absolute and relative muscular strength can be enhanced with regular strength training (Suchomel et al., 2016).

Strength and conditioning coaches are looking for measures that may be used to objectively track development and direct programming for strengthening the hand, forearm, and surrounding musculature. The hand is a sophisticated anatomical structure with 27 bones, 15 joints, and roughly 308 degrees of rotational and translational mobility that is used to grasp and exert force on objects of different sizes and shapes as well as to carry out a variety of complex, precisely timed actions (Zealand et al., 2017). The hand is a highly developed musculoskeletal organ that is capable of a wide range of accurate and powerful movements. It is hard to measure all functional aspects of the hand, although hand grip strength (HGS) is a widely used objective measure that provides quantitative evidence of the hand's functions and its integrity as a whole (Massy-Westropp et al., 2011).

The human hand is an essential and unavoidable organ. It can be used for both fine and large motor tasks. High-hand activity is required for numerous daily tasks and sporting activities. Forearm and hand muscles are crucial for grip strength. Some degree of grip strength is required for success in daily tasks like carrying, turning a doorknob, and vacuuming, as well as in sports like cricket, hockey, tennis, football, basketball, handball, and baseball (Manoharan et al., 2015).

2.4 Hand Grip Strength in Handball

Handgrip strength is the maximum force that all fingers can voluntarily flex at once under normal bio-kinetic circumstances (Fallahi & Jadidian, 2011) and also ball game requires a variety of handgrip actions, including catching, holding, shooting, and throwing the ball, which all require frequent use of the wrist and digit flexors (Gerodimos, 2012). The hand grip strength has been identified to involve in overhead throw since the player needs to hold the ball throughout the throwing phase. Since the hand grip strength was reported to have a high correlation with throwing ball velocity.

Most daily and athletic activities require a firm handgrip. In many sports, such as rock climbing, wrestling, judo, weight lifting, basketball, baseball, martial arts, and racket sports, grip strength, and endurance—the hand's capacity to produce and maintain muscle force—play a crucial role (Moezy et al., 2021). Hand grip strength is a simple and economical evaluation that gives practical information about muscle, nerve, bone, or joint disorders (Liao, 2016). When evaluating hand function, grip strength—the ability to control fingers to hold objects—is crucial. It does a decent job of analyzing functional decline and impairment. Shoulder stability plays a significant role in grip strength since it increases with shoulder stability (Kobesova et al., 2015).

2.5 Fundamental Skills in Handball

We may see an energetic style of play in current handball. One of the new elements in team handball at the moment is tactical evolution and technical executions (Alexandru et al., 2022). The physical activities of motor skills, sprinting, jumping, flexibility, and throwing velocity are essential for team handball. A handball player must simultaneously jump, toss, and race and they must do so swiftly and precisely. They commonly use their upper bodies to dribble, pass, and shoot (Karadenizli, 2015). The fundamentals of handball include passing, dribbling by bouncing to the ground (dribble), receiving the ball after it is caught, shooting by hurling the ball towards

the goal, and defending against an opponent's attack by blocking the opponent's shot with your hand and obstructing their movement (block) (Sadullah et al., 2019).

The fundamental skills of handball are essential for carrying out strategies and winning games (Ismael & Ismail, 2020). Even when a team's plan is subpar, having a high degree of technical talent and a solid foundation in physical fitness typically leads to success. Good foundational abilities are essential to handball success, as they are in many other sports. The measuring and assessment of fundamental technical abilities and particular physical fitness are attracting a lot of attention in nations with developed sports industries. This is done not just to help with sport selection but also with the planning, management, and evaluation of training.

2.5.1 Shooting

One of the key components of handball is shooting. They are crucial factors that affect the scores. The muscles in the trunk, pelvis, and upper and lower limbs are all heavily used while shooting. Shooting is presumably accomplished similarly to passing but with a stronger trunk and upper limb action. The shot distance and hand action time on the ball are two factors that affect shot power. The strength of the shot would increase with the amount of space the ball-holding hand travels over in a certain amount of time (the ball will reach a higher velocity). The movement of the players on the court and how close to the ground their bodies were placed led to the creation of the names of various shots. There are a few different shots in handball: (Remarks & Feints, 1997).

There are various techniques for shooting at the goal, like the vertical jump shot, the stride jump shot, and the shot with a twist, which are frequently used by players who play at various posts. Let's examine the two most common shooting techniques: both a vertical jump shot and a stride jump shot (Juhász et al., 2015). The jump shot from a straight-on approach unquestionably belongs to the most fundamental technical aspects of handball, is taught to the youngest players, and is frequently observed in every elite handball tournament (Pori et al., 2005). A crucial tactic to help you increase your chances of scoring a goal is the shooting technique of a handball. Shooting styles include flying, ripe, leap, and straight shots. The following shooting methods are also used: center, jump, dive, fall, side, flying, and reserve shots. To win the game, each team attempts to score more goals (Pujianto et al., 2020). Excellent arm muscle performance is necessary for good shooting technique. As a result, the throw's strength will depend on how well

the arm muscles execute, making this a potentially game-changing move to advance and score a goal (Pujianto et al., 2020).

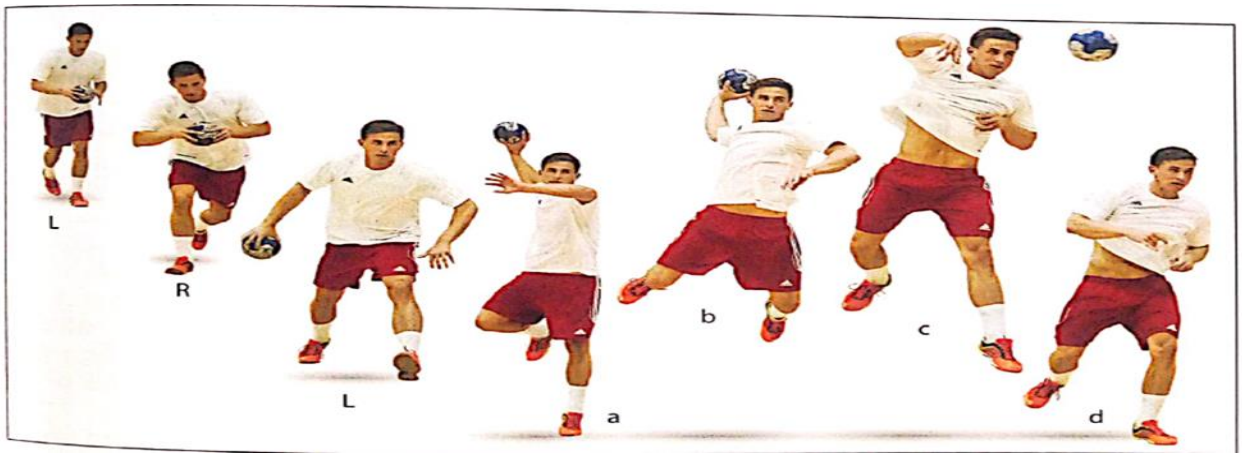

Figure 2.1 Basic position of handball Jump Shot

2.5.1.1 Shooting accuracy

In handball, the shooting technique is one of the most important aspects of the game because it is used to score goals and complete the game's primary aim (Marković, 2020). Any handball player needs to master shooting as their most important talent. Shooting entails aiming directly at the goal of the opposition, which determines the winner. To enter the opponent's goal, a precise assessment of throwing speed is required. It has been investigated in the past how to shoot effectively in a handball game (Nopianto et al., 2021).

Because it refers to shooting without error, shot accuracy is regarded as a crucial performance characteristic for athletic success. In handball, shot precision is crucial because the team with the most goals always wins. For a successful shot, the ball must be thrown quickly and accurately (Metan & Küçük, 2022). The ability to shoot at the goalpost is the most important talent in the game of handball. Through rigorous analysis, a coach and players could improve this fundamental method and use the most efficient tactic to score the most goals (Pujianto et al., 2020).

Likewise, shooting efficiency is a very important technique for handball players. Rathod (2018) showed that the effects of 6-week medicine ball training on Nagpur district 30 national handball players' medicine ball exercises showed an improvement in shooting performance. Also, Pujianto et al. (2020) show that the effects of medicine ball training on the handball athletes of the

Indonesian Handball Association improve handball shooting skill performance. Moreover, results of previous research also indicate that Zaid et al. (2023) stated that after eight weeks of skillful force training with various medicine balls, there was a significant improvement in shooting scores.

2.5.2 Dribbling/bouncing

Handball dribbling skills are significant because players who are proficient in dribbling have one way to attack their opponents and maintain the position of the ball to prevent being caught by their opponents (Ruslan & Hamdiana, 2019).

Attackers employ medium-high dribbling more frequently than low- or high-dribbling in handball. In this way, the ball is guided alongside the body to prevent kicking and shield it from an opponent. The arm, forearm, and wrist are moved toward the ground as the ball is pushed down (not hit!) Dribbling is used so that a player can move around the court while still in possession of the ball after taking three steps. To avoid breaking the double-start rule, though, caution must be exercised. It's crucial for the athlete to feel the ball rather than watch it while dribbling. He is thus able to fake without having to glance at the ball and move in any direction. Low and deep dribbling occurs at a distance from the ground. The best approach to keep the ball is to keep it away from the defender, hence handball players need to be able to dribble with either hand (Juhász et al., 2015).

The ball is held by a player with both hands after receiving it and before dribbling. The elbow and wrist joints work together to produce the bounce that is felt on the ground. Depending on how fast the player is traveling, the ball will bounce at a certain angle. The angle gets increasingly obtuse the faster the run is. A player must reduce both his position and the dribble when an opponent approaches to prevent the opponent from stealing the ball (Remarks & Feints, 1997). To attack the goal or set up a potential scoring play, the ball is moved forward using the dribble. Three circumstances necessitate the use of the dribble: (1) an open goal dribble on a fast break; (2) the player has moved forward three feet; and (3) the player is unable to pass or shoot.

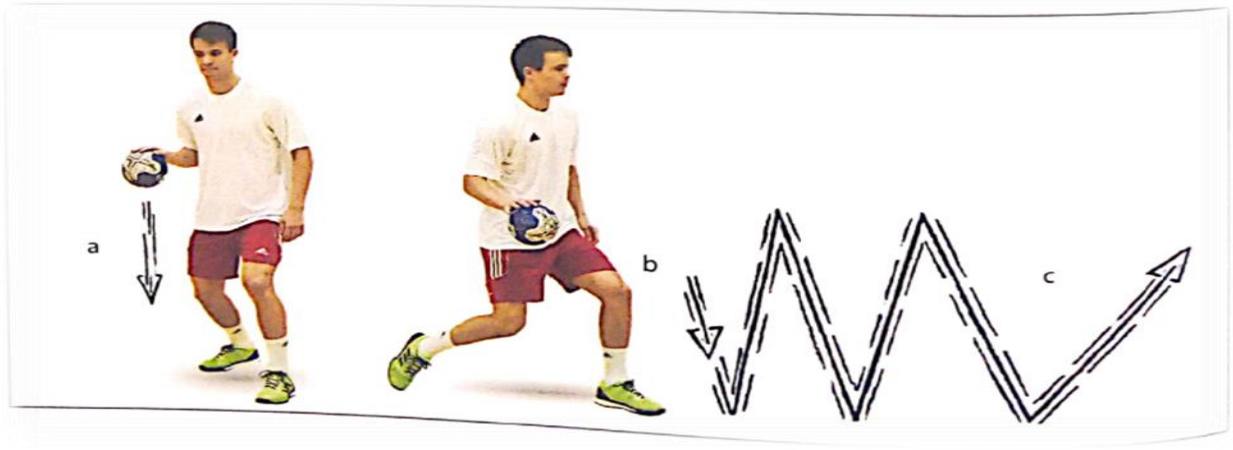

Figure 2.2 Basic handball bouncing/ dribbling position at different angles

2.5.2.1 Speed dribbling

Players that are adept at dribbling in handball have one option to attack their opponents and maintain the location of the ball to avoid getting caught by their opponents, which makes handball dribbling important (Ruslan & Hamdiana, 2019). Therefore, the outcome of a handball game is greatly influenced by the opponent team by dribbling abilities (Qowiyyuridho et al., 2021). To play handball, students must master several essential abilities, including passing, catching, dribbling, and shooting. Dribbling is one of the key abilities in the game of handball, and students learn it as a way to attack the opponent and hold the ball in place to keep the opponent from taking it (Ruslan & Hamdiana, 2019).

Also, Vk & Balamurugan (2021) conducted a study showing that the effect of six weeks of medicine ball training was significant in improving the passing and dribbling abilities of male basketball players aged 18–23. Additionally, Nidzam et al. (2022) conclude that the effects of 8-week medicine ball training on physical performance among basketball players significantly improved control dribbling (CD), defensive movement (DM), passing (PASS), and speed spot shooting (SSS).

2.5.3 Throwing the Ball

In many sports, overarm throwing is regarded as the most crucial element, and according to several researchers, overarm throwing is one of the crucial abilities required for success in team handball (Mastergradsoppgave, 2009). In handball, throwing is regarded as one of the most

important technical talents because it greatly influences all of the players' activities (Karadenizli, 2016). Ball throwing velocity is the primary performance aspect influencing the throwing movement in handball because throwing refers to movements in which strength from the body is transferred to the hands during movements of body segments and ball receiving and releasing (Karadenizli, 2016).

The throwing action completes the attacking activity in team handball competitions. A team handball player must maximize both the throw's accuracy and the ball's velocity to succeed in trying to score a goal. Team handball players are well-known for using various throwing methods depending on their playing position, which is determined by the movements of the opposing defensive players. Jump throws account for 73–75% of all throws made in a competitive game, withstanding throws with run-ups coming in at 14–18%, penalty throws at 6-9%, diving throws at 2-4%, and direct free throws at 0% (Isbs2009_resubmission_60, n.d.).

As a result, the ball, which players pass to one another or shoot at the goal, serves as the game's central element. The throw is one of the most common and distinctive aspects that can be employed for passing or goal-scoring, depending only on the amount and direction of the power surge. A fundamental and sophisticated motor skill, throwing. One of the most challenging fundamental motor skills for both children and adults, it demands whole-body coordination to learn. According to the game implicit learning model, this motor ability is a crucial component of the integrative (non-specific) idea of team-ball sports. According to this idea, sports contests are categorized as rebound, goal-scoring, and throwing contests (invasion games). The technically sound throwing motion applies to and is comparable to various athletic disciplines, such as tossing a ball, in throwing games (Gokulakrishnan & Monisha, 2021).

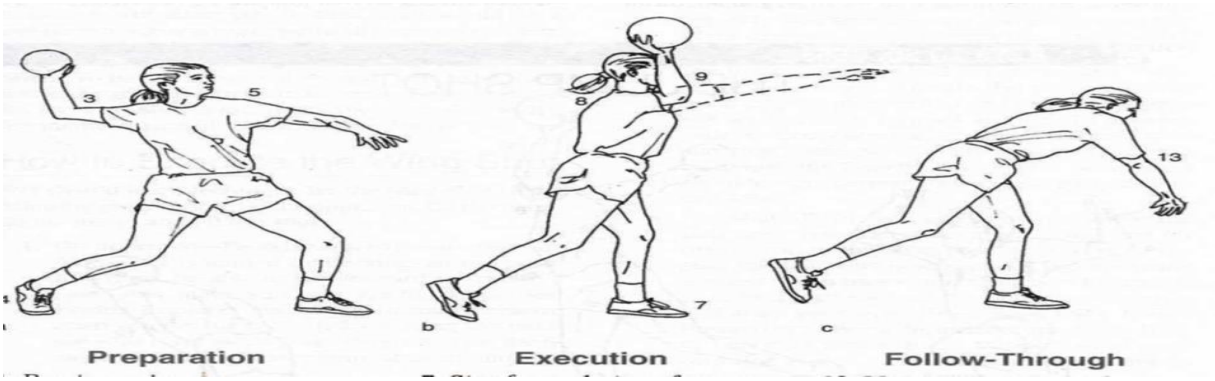

Figure2.3 Basic handball throwing position

2.5.3.1 Throwing accuracy

Throwing performance depends on the player's body being precisely synchronized. When getting ready to throw, the player must use every joint from their ankle to their wrist. Reveal that 53.1% of the throwing velocity is derived from arm movement, while 49.9% of it is reliant on stepping and body rotation. The speed of the ball and the accuracy of the throw are both important factors in handball scoring. When playing handball, throwing velocity and accuracy are the primary indicators of handball skill (Çetin & Balcı, 2015). The handball throw is described by both external and interior shoulder movements (Nopianto et al., 2021).

In handball, throwing is a vital ability. Shot efficiency is largely influenced by accuracy and ball-throwing velocity. The fewer times defenders and/or the goalkeeper has to block the shot, the faster the ball is thrown. The timing of movement in successive body segments, the technique employed, and the strength and power of both the upper and lower limbs appear to be the primary factors of ball velocity, according to coaches and scientists (Luigi Bragazzi et al., 2020).

To score more goals than the opposition is the ultimate goal of a handball game, in light of this, the handball throw is a fundamental movement skill that must have been mastered in the beginning phases of long-term athlete development. The throwing of a handball is a quick, complex action that incorporates a distinct whole-body, kinetic-chain proximal to distal motion, just like other overhead throws (like baseball pitching or tennis serving) (Fernandez-Fernandez et al., 2022). The study focused on throwing accuracy. For instance, when comparing the mean value of accurate throwing in team handball, it was found that the effects of isokinetic performance on accurate throwing are such that throwing velocity and accuracy are considered to be the main performance parameters during the game, and that high throwing velocity is associated with lower accuracy, indicating a negative significant relationship. The main factor influencing throwing accuracy is experience, as elite athletes prefer to throw accurately rather than quickly like their non-elite counterparts (Çetin & Balcı, 2015)

2.6 An Overview of Medicine Ball Training

Medicine ball training has been a cornerstone of American physical culture since its prehistoric beginnings, serving both the healthy and the ill. The four hand tools employed by early physical trainers were quite prevalent. Photographs show them with Aaron Molyneaux Hewlett, who

oversaw the Harvard College Gym in the middle of the nineteenth century. Strength and stamina are increased by using dumbbells. To be flexible, use the wand. The medicine ball stimulates the deep core muscles, arms, and legs, and Indian clubs offer joint mobility and neurological conditioning (Molyneaux, 2002).

The recent researcher, (Pramod & Divya, 2019) the advantage of medicine ball exercises is that they can target the entire body or just particular areas, enhancing both overall conditioning and core stability. In young sports training facilities and schools, medicine balls are growing in popularity. Medicine balls are now utilized to enhance health-related fitness, performance-related fitness, and participative self-efficiency in school-age children and were originally employed in the rehabilitation of muscle function in all patients. According to, (Dinata, 2021) developing unique movement patterns required building arm power; therefore, medicine ball training is one type of exercise to develop power, especially for handballers.

The Medicine Ball for All training program was chosen because it is progressive, simple to use, and created for students with little prior expertise with medicine ball exercises. But, medicine balls are weighted balls that can be purchased for a reasonable price and come in a range of colors, forms, and sizes (ranging from the size of a baseball to larger than a basketball (Siegel, 2008). The medicine ball has been a staple of physical conditioning training since its inception. Workouts involving medicine balls have the great advantage of being able to target either the entire body or just particular areas, which improves both overall conditioning and core stability (Research Scholar & Pramod Research Scholar, 2019)

Until recently, the only uses for medicine balls were to increase core (abdominal) strength and for therapeutic purposes. Medicine balls, which come in a range of sizes, forms, and colors, have just entered the sports world. They might be vibrant, air-filled polyester balls with different colors that can "float" and "bounce," offering a range of workout benefits. They also come in various sizes to resemble sports like baseball, basketball, and volleyball. There are several weights and simulations available for every medicine ball. In some medical balls, for instance, air can be added, allowing for higher weights and more bounce than medicine balls without air. The goal of the medicine ball is to serve as a multipurpose training tool that may be used by one person or two people to improve overall strength and flexibility as well as core strength, functional motions, muscular coordination, and response time (Armstrong, 2002).

Likewise, training with a medicine ball is an effective approach to getting ready for rotational power sports. Medicine balls have been used in athletic training as a unique form of power training for many years. Similar to rotational power sports, the goal of medicine ball motions is to transmit the greatest amount of angular velocity to an external object while using simple, basic body movements. Throwing a ball at a medium distance allows you to use more force and move more swiftly than you would in a regular sporting event, making it a terrific resistance training exercise (Nopianto et al., 2021).

Although, medicine ball training is safer to perform and results in fewer injuries when compared to other forms of resistance training like free weights and plyometric, it is initially frequently advised as a form of resistance training for children because it develops the neuromuscular structure for more advanced training in free weights and plyometric. Medicine ball training is an efficient form of exercise for boosting power development since many of the concentric movements in medicine ball workouts don't have a period of deceleration at the conclusion, which is common in many sporting movements like striking (Kobak et al., 2018).

Utilizing a medicine ball for exercise combines ballistic and plyometric exercises to strengthen the torso's rotational muscles. Thus, it is suggested that rotating torso exercises be performed twice each week (Szymanski et al., 2007). Exercises with such a medicine ball can complement the sport-specific workouts that are a part of any program (e.g., squats, bench presses, power clean, etc.). Additional medicine ball exercises should complement the generic component, and activities should be chosen to emphasize sport-specific needs such as velocity, the plane of movement, and body alignment during the activity(Earp et al., 2010).

Handball players are among the athletes that need to have a strong core (midsection), keep their upper bodies at a higher degree of strength, and keep their entire bodies flexible to play effective defense. Attributes when practicing for "game-like" situations, a medicine ball can facilitate the precise training required to "improve the strength of the body as a whole." Increased functional movement, reaction time, movement speed, neuromuscular coordination, core strength, general strength, and flexibility are also possible with the medicine ball (Armstrong, 2002). Recent researcher, (Szymanski et al., 2007) conducted that baseball players' torso rotational and sequential hip-torso-arm rotational strength improved more with a 12-week medicine ball

training program than with a stepwise periodized resistance training program with bat swings, according to a study.

2.7 Basic training principle

Training is described as engaging in an activity to increase performance and/or fitness. It is necessary to understand the general sports training principles listed below to achieve this goal (Kasper, 2019). The right program design is essential for effective resistance training at any age or level of fitness. The program design includes goal setting (so the program can target specific areas of interest), a method of evaluating training progress toward training goals, the proper prescription of the acute program variables, and the inclusion of specific methods of progression targeting specific training areas (Kraemer & Ratamess, 2004).

2.7.1 Overload

When you don't get adequate rest during your training schedule, overtraining, a fairly prevalent issue develops. Overload, which is the deliberate exposure to more work with the appropriate amount of downtime in between sessions, should not be mistaken for this. Overload training adaptations require the body's systems to experience stress over what is considered normal. As long as these additional demands are put on the system, it will eventually respond and this will become the new normal. To prepare for the next session, the body's systems overcompensate during this adaptation phase. Overcompensation will be possible with this kind of exercise and sufficient recovery, which will boost fitness levels overall (Theory et al., 2002).

2.7.2 Specificity

Our bodies adjust to physical strain or exercise in direct proportion to the demands placed upon them. The term "specific adaptation to imposed demands" (SAID) refers to this phenomenon; hence, event-specific training needs to be provided. Athletes need to practice the technique or strategy they'll use in competition. Jumpers must practice timing and explosiveness, 400-meter runners must practice lactate tolerance, and distance runners must exercise to increase their aerobic thresholds. In addition to fitness, athletes must prepare physically and emotionally for competition. A certain amount of training must mimic the specific nature of the competition. As a result, a training program that is founded on science and is methodical may be referred to as

specific fitness training. It gives athletes the tools they need to adjust to the unique demands of a sport (Thor et al., 2014).

2.7.3 Progression

The need to progressively raise the burden you subject your body to is at the center of this. It is crucial to balance relaxation and exercise while also increasing the amount of stress placed on the body. This so-called "stress" is a result of the workout's frequency, length, and intensity. For the systems being taught to keep growing, expanding, and improving, they must gradually be overwhelmed. Gains start at their highest level and then drop off over time. However, progression might help shock the body back into adaption by changing the training method (Kasper, 2019). Any resistance training program, whether it is intended to increase muscular size, strength, or power, must include progressive overload (Lambert et al., 2005). During resistance training, there should be a progression that takes individual training status and goals into account. This article will also highlight some key progression ideas recently advised by the American College of Sports Medicine (Medicine, 2009).

2.7.4 Individualization

The basic truth is that each person is unique! Every person reacts differently to training. Don't worry if one of you grows fitter faster than the other if you are walking or cycling with a friend and putting in the same amount of exercise; this is what individualization is all about. Each person has their special talents, skills, capacities, and training reactions. Physically, as one develops and adjusts. That illustrates the individualistic concept in action. People have varying levels of maturity, capacity, skill sets, and openness when they first enroll in training programs. They also leave training programs in the same manner. The same goes for group training; cookie-cutter methods are rarely successful (Byorum et al., 2015).

2.7.5 The Principle of Variety

The same load and recovery being repeated over time might get boring for both the athlete and the coach because sport training is a lengthy procedure. Because of this, the coach should mix up the training program to keep the trainees interested and motivated. Cross-training, or engaging in other sports, as well as altering the type of exercise, the setting, the time of day that sessions take

place and the training group can all help to provide variety in training. The coach's ingenuity would be more of a factor in this principle (Al-Shaarani & Al-Wazir, 2006).

2.7.6 Reversibility

Fitness levels are irreversibly lost when you quit working out. Gains from training are lost more quickly than they are gained, and it might take up to three times as long as the training hiatus to get back to where you were in terms of fitness. The most typical way for reversibility to happen is when you have an injury that prevents you from training (Mclean, 2003). According to the reversibility principle, the body readjusts to the decreased physiological demand, and the advantageous adaptations may be lost (Baar, 2006)

2.7.7 Recovery

Consider recovery to be the capacity to perform at or above one's previous level in a specific activity. For instance, after a strenuous distance running session, a person's capacity to run a personal best 10-kilometer distance will be temporarily lowered. Although that runner will eventually recover, no runner can expect to perform at their peak during the first 3–4 hours following a workout. Others have employed this idea of recuperation (Ishop et al., 2008).

For best performance and ongoing improvement, post-exercise recovery is a crucial element of the overall exercise training paradigm. Higher training volumes and intensities are feasible without suffering the negative consequences of overtraining if the rate of recovery is appropriate. Choosing the best training and recovery program for a client requires deliberate trial and error, and this is where health and fitness professionals come in (Bird, 2011).

’Training recovering is the period of rest in between sessions or events. The time between workouts is considered recovery for athletes who occasionally train twice a day, such as football players, swimmers, and runners. Similar to this, in some competitive sports with heats and finals held on the same day, training recovery would also include the time necessary to recuperate between subsequent contests held on the same day. The time between one session and the next is known as recovering for the majority of athletes who only perform one workout each day. (Gómez et al., 2002)

2.7.8 Variables of training

The focus of the training program should be on training variables in proportion to the needs of the athlete. If the training variables need to be adjusted further, the coach must continuously assess how the athlete is responding to the training program. It is possible to gain insight into the efficacy of training variable modifications by critically examining the annual training schedules employed throughout the athlete's career (Bompa & Haff, 2009).

Two fundamental training principles are progression and overload. To increase fitness, the body must be subjected to greater stress or load than it is accustomed to, which is known as overload. A person should progress through the burden in this manner. Either in frequency, intensity, time, or a combination of all three, it is a progressive increase. The FITT Principle explains how to safely implement the overload and progression principles (N. A. for S. and P. Education et al., 2010).

Intensity is the amount of force applied during resistance exercise or the rate at which energy is used to complete the activity to attain the target function (aerobic activity) (Riebe, 2013). The amount of activity completed overall during a training session is the most basic definition of volume. The amount of work completed during a training phase or session is sometimes referred to as volume. It is necessary to measure and keep track of the complete amount of training

Frequency is commonly expressed in sessions, episodes, or bouts per day or week.

Duration is the length of time for each bout of any specific activity

2.8 Medicine Ball Training Consideration

2.8.1 Safety precautions

- Always check with your doctor before starting any exercise routine or program.
- Make sure you choose the correct amount of weight for the exercise being performed. The correct amount of weight helps prevent:
    - ✓ Loss of control of the medicine ball
    - ✓ Limited range of motion.
    - ✓ Compromised accuracy.

2.8.2 General Medicine Ball Training Guidelines

- The exercise environment should be safe and free of hazards.
- Begin each class with dynamic warm-up activities.
- Start with one set of 7 to 10 repetitions with a lightweight ball (1 to 3 kg).
- Begin with simple exercises and gradually progress to more challenging exercises over time.
- Gradually increase the number of sets, exercises, and weights of the ball.

Although there is no set age requirement for joining a medicine ball training program, kids should be emotionally mature enough to accept and follow instructions as well as understand the advantages and risks of this type of exercise. The majority of kids over seven are capable and ready to engage in some kind of resistance exercise Children should undertake a variety of exercises that target the main muscle groups twice or three times each week on days other than consecutive ones, according to recommendations. However, starting with simple activities and advancing to more difficult ones over time will not only allow for good changes in fitness performance but will also give participants a chance to boost their confidence before moving on to more difficult levels (Faigenbaum & Mediate, 2008).

2.8.3 What Medicine Ball Should You Use?

This depends on your gender, age, level of strength and fitness right now, type of exercise, and other factors. Sizes of medicine balls range from one pound to more than thirty pounds. The American College of Sports Medicine claims that a lot of people utilize a heavier ball than is necessary. As a general rule, the medicine ball should be heavy enough to delay the action but not so heavy that it compromises the exercise's control, accuracy, or range of motion. Exercises involving tossing can be done with lighter weights, such as 4 to 10 pounds. Abdominal workouts can be performed with medium weights, such as 8 to 15 pounds. For lower body exercises, heavier weights might be employed (Song et al., 2015).

2.9 The Benefit of Medicine Balls for Handball Players

Young female handball players can benefit greatly from medicine ball workouts as a kind of strength training since they can more effectively mimic the strong movements required to succeed in the sport. The benefits of medicine ball training on kids and young athletes have been studied in the past. There doesn't seem to be any published research on how medicine ball

exercises affect the muscular fitness of young female participants, even though other types of resistance training programs have been investigated in connection to young women (Ignjatovic et al., 2012). The medicine ball training regimen strengthened the handball players' muscle power and significantly enhanced their fitness performance (Actor et al., 2021). Arm strength and shooting technique are improved with the use of medicine balls. Muscle growth based on the used energy system for action should be included (Pujianto et al., 2020).

2.10 Important Upper Body Medicine Ball Training for Handball

Both the upper body and lower body may be more important for some functional tasks older people must accomplish, such as lifting a load, getting back on their feet after falling, opening doors, and rising from a chair. It is impossible to overestimate the importance of this area of fitness because it is necessary for many daily activities, such as carrying groceries, bringing out the trash, and lifting children. There has been evidence of a high correlation between upper-body strength and lower-body strength (CHAD HARRIS CHAD HARRIS & WATTLES, 2011).

When studying the effects of 12-week medicine ball training on young female handball players' muscle strength and power, the researcher concentrated on the throwing motion. This result shows how the side medicine ball throw contributes significantly to the peak power of young female handball players (Gnjatovic et al., 2012). The use of medicine balls in pushing, throwing, and passing exercises that can be performed individually, in pairs, or collectively, as well as in other different situations and forms, such as standing, kneeling, sitting, lying, or hanging, is one of the modern, unconventional training methods that emerged as a direct result of the scientific renaissance in the sports field to bring players to the top of sports achievement (Salameh, 2020).

2.11 Types of medicine ball

While most medicine balls are round, they are also available in other shapes, such as footballs, for sports-specific training and with built-in handles for improving your grip. Additionally, they are available with single or double handles or with an attached rope. The type of medicine ball you should use depends on the type of exercise and the levels of the exerciser.

Figure2.4 Types' of medicine ball

For instance, if you plan to perform a throwing or catching exercise like the chest pass, you might opt for a ball made of leather or nylon to make it more pleasant on your hands. Rubber is another material used to make medical balls, making it a great option for exercises that call for bouncing the medicine ball (Song et al., 2015).

2.11.1 Selecting a Medicine Ball

The diameter and weight of medicine balls can vary, often from a few inches (baseball size) to larger than a basketball and from 1 to 30 pounds (1/2 kg to 14 kg). They are also made of various materials and have diverse shapes. The majority of medicine balls are spherical, but they can also be found with integrated handles for a better grip and in the shape of footballs for training specialized to a particular activity. Additionally, several medicine balls have been created with single, double, or rope handles or ropes to maximize training specificity (Armstrong, 2002). Moreover, some medicine balls feature a gripping or based on the aforementioned for better grip, while others are inflatable and bounce. Adolescents start with 2- or 3-kg medicine balls to acquire the correct form and technique for each exercise. Leather balls do not bounce but can be used as a basis to stand on for balance training. (Faigenbaum & Mediate, 2008). For this reason,

the researcher started with a 3 kg medicine ball for the training program of under-17 female handball project trainees and through the process increased it to 5kg, and 6kg due to the accessibility of materials.

2.12 Physical Demands in Team Handball

Usually, in an exciting sport, team handball, Players need to be physically prepared for a match's worth of constant sprinting, jumping, direction changes, and powerful ball tossing. As a result, team handball players need to build strength so they can use their talents and muscular endurance so they can keep up high levels of application during the entire game (Cardoso Marques, 2010). The physical preparation of elite team handball players has become an indispensable part of contemporary professional team handball due to the high fitness level required to cope with the ever-increasing demands of match play (Iacono & Karcher, 2018).

Handball is a physically demanding team activity involving body contact that heavily emphasizes sprinting, jumping, running speed, and throwing and necessitates high levels of strength to hit, block, push, and hold during game activities (Leyk et al., 2007). One key element in the success or failure of sporting events is the physical conditioning of ball players, which has been built over many years (Duthie, 2006).

During team handball games, players frequently accelerate, sprint, jump, change directions quickly, and make a lot of physical contact with one another. Regular player actions, like tackles, feints, and shots, must be executed with the highest level of intensity to succeed against opponents. The muscles involved in all of these movements are highly taxed (Ronglan et al., 2006). Consequently, one essential component in the success or failure of sporting achievements is the physical preparation of ball players acquired over many years (Farley et al., 2020). An extended competition period lasting 9 to 10 months per year has resulted from the growth in the number of matches and national and international tournaments. As a result, top-tier TH players' bodies have a determining impact on their playing ability not just during each game but also throughout the entire regular season (Michalsik & Aagaard, 2015).

2.13 Mental Requirements of Handball

Modern athletes are becoming physically stronger, which shows that at the greatest levels of competition, psychological factors might occasionally choose a winner and a loser. The following distinguishing characteristics were found in Olympic medal winners who were elite athletes in a variety of sports: psychological abilities or states (self-confidence, concentration, an ideal level of arousal, etc.); personal dispositions (such as optimism, adaptive perfectionism, sports intelligence, etc.); and cognitive and behavioral techniques that athletes use to achieve these desired psychological states (goal setting, self-talk, imagination, etc.) (Jakšić et al., 2022). All of this necessitates athletes to a high degree of psychological stability, which would ensure their application in various game situations, in addition to good technical and tactical readiness (Ibragimov, 2021). Therefore, every sport's athletes employ psychological training as a tool to improve their performance. The many forms of psychological preparation are directly tied to individual preference. Therefore, successful athletes need to prepare mentally (Shahbazi et al., 2011).

Young athletes can become top athletes by specializing in their sport with the aid of psychological skills. To increase the athletic abilities of children and adolescent athletes, coaches should prioritize research on reducing anxiety and promoting self-efficacy. As a result, psychological skill development based on self-efficacy beliefs would help adolescent athletes develop their psychological skills and improve their sporting performance by affecting their self-efficacy beliefs and shot accuracy capacities (Metan & Küçük, 2022).

Mental preparation is confidence derived from a feeling of being physically and mentally prepared with an optimal focus on performance. Therefore, mental preparation is necessary for athletes to succeed (Shahbazi et al., 2011). Sometimes the difference between victory and defeat depends on the psychological factors of the players. e.g., shooting the seven-meter throw and regulating emotions under pressure, enduring to the end in a physically demanding match, and taking responsibility for their actions and decisions (Jakšić et al., 2022). Along with the physical, technical, and tactical aspects of athlete training, it's important to remember the psychological aspect as well. It is understood from the practice of sporting activities that an athlete's performance is influenced by their emotional and nervous-psychic stability, anxiety, aggressiveness, and other personal attributes (Achmad Ali Fikri, Syamsul Arifin, 2022).

2.14 Technical & Tactical Requirements of Handball

During the game's current development phase, the character of the competition was realized in probabilistic game situations of the character, which significantly increased the scope and intensity of motion activity. As a result, stricter physical, technical-tactical, and overall fitness requirements are placed on prospective players. They must be able to demonstrate that they possess the conditional and coordination abilities required to carry out technical-tactical acts with accuracy in space and time, in addition to the bio-mechanical justification for doing so. The combined effect of physical and technical-tactic fitness on players is a promising direction in the improvement of the system of handball players' training because it would ensure coordination, quickness, and variety of technical-tactic potential as well as ensure that competition movements are carried out effectively and logically under the influence of various disruptive factors (A.A., 2014).

To be able to display conditional and coordinating skills in space-time accuracy of technical-tactical acts and their bio-mechanical rationale, potential players must achieve greater requirements for physical, technical-tactical, and overall integral fitness. Also, despite the empty net, field player techniques generated positive results and no significant negative returns (Gümüş et al., 2020). At all levels of performance, technical training in handball allows players to make the best use of opportunities that drive them to play the game and resolves tactical game scenarios while facing adversity and conserving energy.

CHAPTER THREE

RESEARCH METHODS

3.1 Geographical Location of the Study Area

The study was conducted at Bahir Dar University, which is located between latitudes of 11° 34´ 20" N and a longitude of 37° 24´ 10" E 1800 m. The altitude on the campus is 2830 meters above sea level with a mean annual temperature of 14.84°C (FAO, 2006).

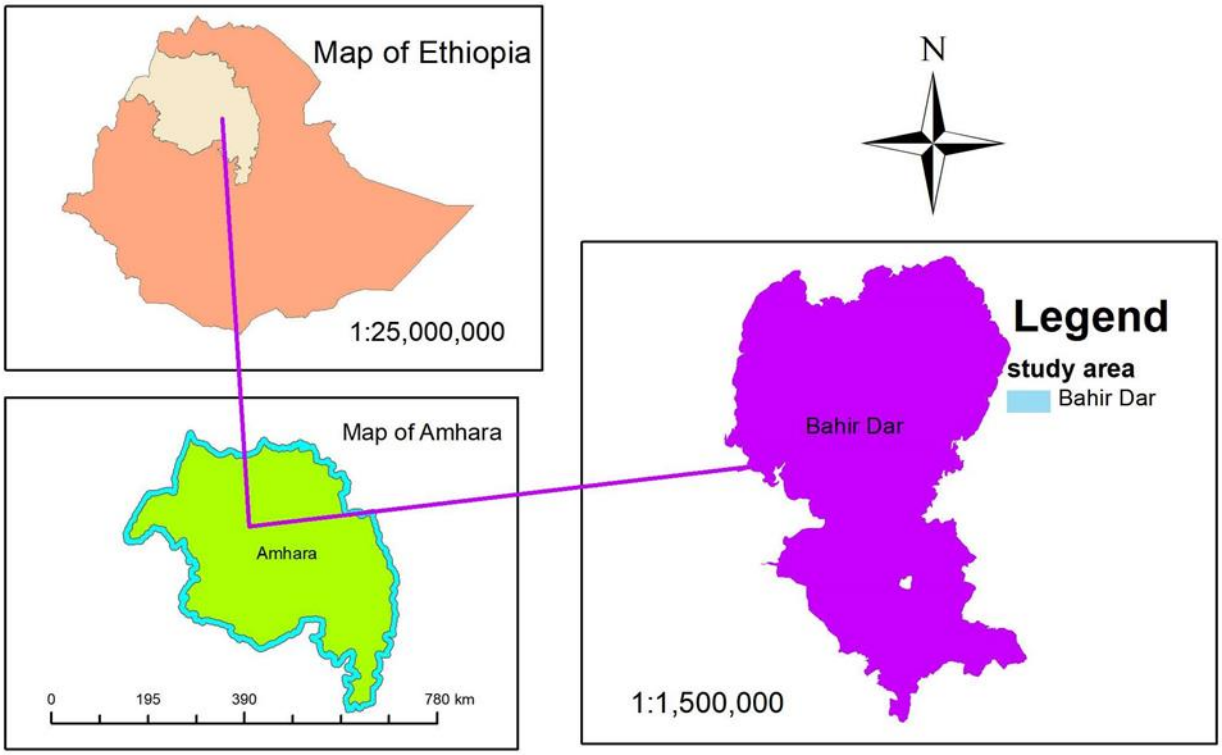

Figure 3.1 Map of Ethiopia and Amhara Reign to Bahir Dar City

3.2 Research design

The research design in this study used an experimental design depending on the kind and suitability of the pretest and posttest data. The experimental design was better for studying cause-and-effect relations among variables. Throughout the late 19th and early 20th centuries, psychological tests served as the foundation for experimental study (Moshinsky, 1959). Every relevant condition that affects the events under investigation was an attempt to be isolated and controlled in experimental research, and the results of controlling the conditions are then observed. In its most basic form, cause and effect occur when the independent variable changes

and the results are seen in the dependent variable. Although experiments can be performed to investigate a specific event, they typically call for the formulation of a hypothesis (prediction) first to identify the variables that would be evaluated as well as how they can be controlled and quantified since it helps to measure, assess, evaluate, and analyze the influence of an independent variable on the dependent variables.

3.3 Research approach

Research approaches are strategies and guidelines for conducting studies that cover anything from general hypotheses to specific techniques for gathering, analyzing, and interpreting data. This strategy contains a number of choices, and they don't all have to be made in the order that makes sense to me. Therefore this study would be used a quantitative research approach to examining the relationships between variables was a method used in quantitative research to test objective theories. To use statistical techniques to analyze numbered data, these variables can be measured, typically using instruments. The final written report has a set structure consisting of an introduction, literature and theory, methods, results, and discussion(Creswell, 2014).

3.4 Population, sample, and sampling techniques

At Bahir Dar University there were two handball projects, the male and female handball projects. But, the researcher purposively selects the female handball project. The total numbers of trainees found in this project were 20. All trainees were taken as a sample by utilizing a comprehensive sampling technique. In this research, participants were assigned randomly to the control group (CG; n = 10) and experimental group (EG; n = 10)

3.5 Inclusion and Exclusion Criteria

The qualities participants must possess to be included in the study were known as inclusion criteria. Exclusion criteria are those traits that prevent subjects or participants from being included in the study. We selected a sample of research participants who actively contributed to the team, had no history of health issues, and consented to provide informed consent. However, those who were unable to give informed consent had a prior health issue or were unable to handle the training sessions were not used as a sample in this study.

3.6 Source of Data

The pre-and post-test findings of the experimental and control groups serve as the basis for the data collection. To conduct this study, the researcher solely used primary data sources to obtain sufficient information about the effect of medicine ball training on hand grip strength and on the handball skill performance such as shooting, dribbling, and throwing abilities of female handball project trainees.

3.7 Research variables

Research variables can be defined in terms of measurable factors through a process of operationalization. Depending on what they are used for, variables can be categorized in many ways. There are three categories: intervening variables, response variables, and stimulus variables. Therefore, classifying a variable in a research study as independent or dependent is the most popular scheme, which is inspired by mathematics and science. The condition that is altered in an experiment is referred to as an "independent variable" in strict meaning (Hatfield, Larry L., Ed.; Bradbard, David A., 1978).

3.7.1. Independent variable

It serves as "the variable we utilize to measure the effect on the dependent variable." The values of the variables that are associated with it change as a result of changes in this variable's values”(Gould, 2001). Therefore in this research independent variable is medicine ball training.

3.7.2 Dependent variable

It is defined as the variable that changes as a result of the independent variable's effect, or it is the variable for which we want to know the effect of the independent variable on it. In this research dependent variables were hand grip strength and handball technical skills such as

- Hand grip strength
- shooting accuracy,
- speed dribbling,
- throwing accuracy

3.8 Data collection instruments

The research design was experimental; therefore data was collected through strength tests and field skill tests of study participants. For instance, the data was collected through hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy, and in the Bair Dar University Sports Academy's female u-17 handball project training

3.9 Data collection procedure

Under the direct supervision of the subjects, the investigator follows a standard procedure for testing the selected variables and also records the score on the test record sheet. To investigate the effect of medicine ball training on hand grip strength and some selected handball skill variables, all pretest measurements would be done within the first week before the application of the 8-week medicine ball training program, while post-testing would be performed within the first week following the completion of the program. Participants begin by doing enough warm-ups and stretching exercises to prepare for all tests. The testing period included a warm-up, a test, and breaks. Every test was described and shown in action. Before testing, subjects go through practice trials to get comfortable with the testing process. As part of the pretest procedure, the subjects complete each test, and the results from the best trials were used in this study.

3.9.1 Test: Handgrip strength test

Objective: The purpose of this test was to measure grip or forearm muscle strength. Handgrip strength was important for any sport in which the hands are used for catching, throwing, or lifting. Also, as a general rule, people with strong hands tend to be strong elsewhere

Equipment: Handgrip Dynamometer, Pencil, Score sheet**.**

Procedure: The subject holds the dynamometer in the hand that would be tested, holding the elbow close to the body and the arm at a straight angle. The dynamometer's handle was adjusted as necessary; the handle should sit on the middle of the four fingers and the base should rest on the first metacarpal (heel of the palm). When ready, the individual squeezes the dynamometer as hard as they can while maintaining that effort for roughly five seconds. Other forms of movement are not permitted. The subject needs to be pushed hard to put out their best effort.

Scoring: The best result from several trials for each hand was recorded, with at least 15 seconds of recovery between each effort. The values listed below (in kilograms) give a guide to expected scores for adults**.**

Suggestions: Check if the subject was swinging or folding the arm. See that the grip dynamometer was adjusted at zero at every grip. It can also be used to determine the dominant/strong hand of the subject

.

Figure 3.2 Electronic device of Handgrips Dynamometer

3.9.2 Jump Shoot Testing

Purpose: To measure the shooting accuracy of handball project trainees.

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

Procedure: A total of three parts 40 cm on either side and in the center, made up the goal post. The difficulty of shooting the ball into each region was represented by the number of points that were given to each component. As the person in charge stands in the center of the goalpost and

the player primarily shoots at the ends, 5 points were granted for either of the two parts of either side and 0 points are given for the remainder of the goalpost. Players typically attempt the jump shot from the left in, center back, and right in throughout a game. Players were instructed to attempt 3 jump shots from the left and right and 4 jump shots from the center back out of a possible 10. All shots must be made from inside nine meters of the free throw line. No points were awarded if the ball touches the court before it reaches the goal shooting from the outside counts as an attempt and the maximum possible point each player scored was 50 points

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

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

No Points would be given if

I. An Athlete touches/cuts the free throw line before the release of the ball
II. the ball hits the court surface before it reaches the goal
III. An Athlete loses control of the ball
IV. The ball shoots outside the goalpost

Note: The athlete has to shoot again if the ball hits on the string which divides the goal post

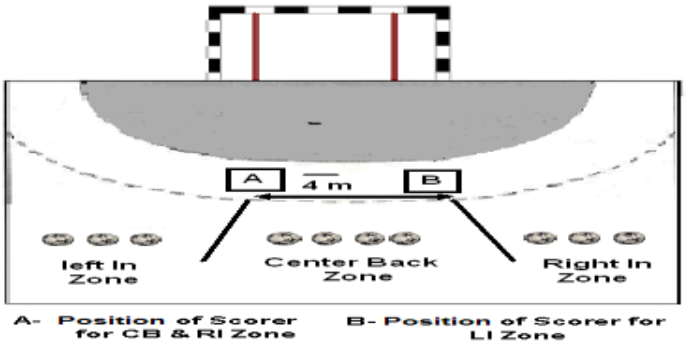

Figure 3.3 Jump Shoot Test (Final) Adopt from (Westoff, 2016)

3.9.3 Agility/Obstacle Dribble Test

Purpose: To measure the speed with which trainees can dribble a handball around obstacles.

Equipment: A level floor or smooth surface ground, a stopwatch, 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. The distance between Start & Finish lines was 16 meters. The first and last Obstacle was 4 meters away from Start Line & Finish line. The distance between the second to last obstacle was 3 m, 2m, and 3 m respectively.

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

Retrial if: I. An Athlete loses control of the ball

II. An Athlete fell due to imbalance.

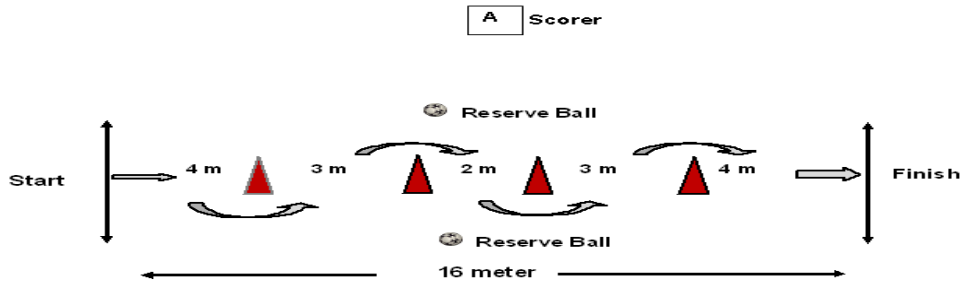

Figure 3.4 Obstacle dribbling Adopt from Westoff (2016)

3.9.4 Throwing accuracy testing

Purpose: To measure the accuracy of short & long passes 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 a pencil/pen would be needed.

Procedure: Two circles were marked on the wall. The innermost circle has a radius of 0.15 m and was 1.5 m above the ground, while the outermost circle has a radius of 0.25 m and was also 1.5 m above the ground. Two boxes (1 x 1 m) would be marked on the floor at a distance of 7 m and 10 m from the wall. In handball, during the match, players perform a variety of passes accurately, mainly in two forms: short passes and long passes.

Short Pass: The player, with a handball, stands behind a line on the floor marking 7 meters from the smooth wall. On the signal "go," the player throws the ball at the target using a one-arm

throw (overhead pass). Five throws were compulsory, and all would be executed from behind the restraining line (7 m).

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

Scoring: Five points are scored for each throw that hits the center circle and three points for hitting the outer circle. A ball hitting on a line would be counted as hitting in the area of the higher score. The score was the total for ten throws (five throws for the short and long passes, respectively). A maximum of fifty points are possible.

No Points would be given if

I. An Athlete touch/ cut the restraining line before the release of the ball
II. An Athlete loses control of the ball
III. The ball shoots outside the target (Westoff, 2016).

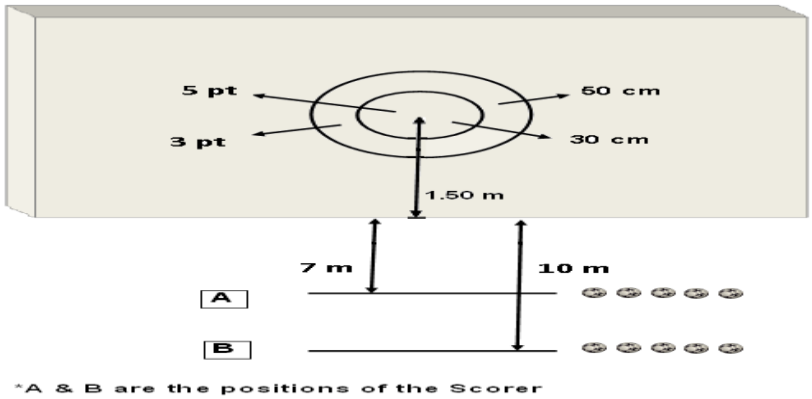

Figure3.5 Throwing accuracy Adopt from Westoff (2016)

3.10 Training protocol

The present study conducts on 6 weeks of MBT has significant improvements in functional performance (i.e., throwing velocity) in female handball players (R et al., 2010). The resistance training sessions have been recommended that children engage in resistance training activities 2 or 3 days per week on nonconsecutive days and perform a variety of exercises that focus on the major muscle groups (Faigenbaum & Mediate, 2008). In line with the above literature, the

study's topic would be split into two groups: experimental and control. While the control group engages in regular handball drills without any specific training, the experimental group engages in additional medicine ball training for two days per week, lasting approximately 60 minutes each, including warming up and the training section. I would give it over two months for a total of 8 weeks and 16 days, and I would also exercise, performing 8–10 repetitions with 2-3 sets. The training program concentrated on medicine ball training using movements like the overhead, left, and right side movements, and pushing and throwing with medicine ball. (See the training program in appendix C)

3.11 Method of data analysis

For this study, the researcher would be used mean and standard deviation statistical data analysis tools. Coupled with, paired Samples t-Test data analysis method would be used to compare the pre-test before the intervention of medicine ball training and the post-test after the intervention of training of fitness level, and technical skill performance of female handball project trainees of both groups and an independent t-test would be used to compare the pretest and posttest mean value of experimental group with the mean value of control group. The data was collected through field tests and it was analyzed by using the computerized Statistical Package for Social Sciences software (SPSS) version 26 used.

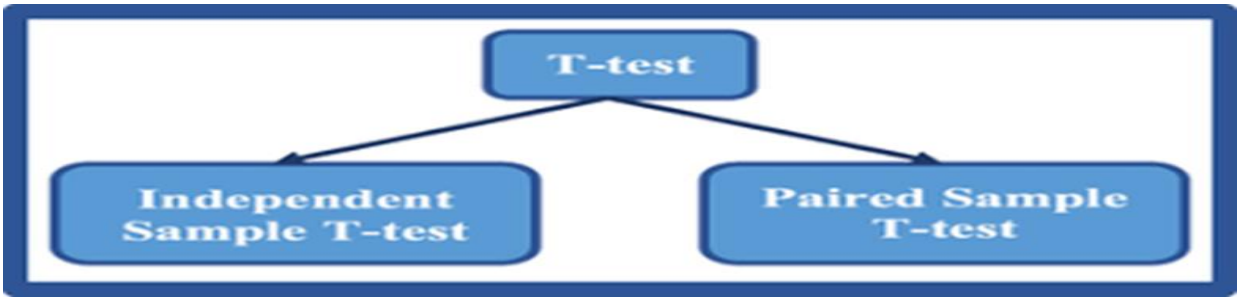

Figure3.6 T-test

For data processing, the researcher used the SPSS program through the use of the following statistical treatments:

1. The independent-samples t-test (or independent t-test, for short) compares the means between two unrelated groups on the same continuous, dependent variable and for the Levene's Test for Equality of Variances of the two groups

2. The dependent t-test (called the paired-samples t-test in SPSS Statistics) compares the means between two related groups on the same continuous, dependent variable.

3.12 Ethical considerations

This study would be concerned with the ethical issues and code of conduct related to the investigation. Ethical standards require that researchers not put participants in situations where they might be at risk of harm as a result of their participation. In this study, the following ethical considerations were considered: These include research participants, who should not be subjected to harm; respect for the dignity of research participants should be prioritized; and full consent should have been obtained from the participants' parents before the study. The protection of the privacy of research participants had to be ensured. Besides, the secrecy of individuals participating in the research had to be ensured. Similarly, any deception or exaggeration about the research's aims and objectives was avoided, and all affiliations, funding sources, and potential conflicts of interest were declared. Furthermore, any type of communication about the research should be done with honesty and transparency; any type of misleading information, as well as the representation of primary data findings in a biased way, should be avoided.

CHAPTER FOUR

RESULTS AND DISCUSSION

In this chapter, pre-and post-test data from the experimental (n = 10) and control (n = 10) groups that were the subject of the study and discussion were analyzed. Pre-test and post-test results of hand grip strength shooting accuracy, speed dribbling, and throwing accuracy for both groups were examined using a paired sample t-test for pre and post-test results of the control and experimental groups were compared using an independent t-test. The goal of this study was to look into how the U-17 female handball project trainees performed on a set of hand grip strength and technical skills after 8 weeks of medicine ball training. The researcher provided a summary of the respondents' demographic details under this chapter, including their age, height, and weight, as well as their training age.

4.1. Result of Data Analyzed

4.1.1 Demographic Characteristics of the study participants

Table 0.1 Descriptive Data of Demographic Characteristics of study participants

Variables	Experimental Group					Control Group				
	N	**Mean**	**Std**	**Max**	**Min**	**N**	**Mean**	**Std**	**Max**	**Min**
Age in (year)	10	14.60	1.265	16	13	10	14.50	1.080	16	13
Weight in(kg)	10	42.40	6.53537	50	33	10	42.20	6.14275	50	32
Height in (m)	10	1.4050	0. 09466	1.5	1.25	10	1.410	0.09843	1.5	1.24
Training year	10	2.00	0.00	2	2	10	2.00	0.00	2	2

As the above table 4.1 the descriptive characteristics of 20 study participants' u-17 female handball project trainees indicate, the average age of the experimental group players was 14.60 ±1.265years, max 16, and min, was13, years, the average height was 1.4050±.09466m, and max, 1.5, and 1.25m, the average weight was 42.4000±6.53537kg, and max 50, and min was 33kg, the average training age was 2.64±1.03 years and max 2 and min was 2 respectively. On the other

hand, the control group trainee's average age was 14.50±1.080 years, max was 16, and min was 13 years, the average height1.4100±.09843m, and max was 1.5 and min was 1.24m, the average weight was 42.2000 ±6.14275kg, and max 50 and min was 32kg, and the average training age was 2.00 ±.000years max 2 and min was 2. In addition, the researcher utilized independent sample t-test comparisons between the group pretest outcomes of each variable to check the simple randomization equivalent.

4.1.2 To check the homogeneity level b/n experimental and control group by independent sample t-test

To compare the experimental and control group independent t-test pre-test results of hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy to show the homogeneity of variances using Levene's test

Table 0.2 Pretest result of independent sample t-test

Performance variable	Group Statistics				t-test for Equality of Means			
	Groups	N	Mean	Std. Deviation	MD	T	DF	Sig. (2-tailed)
Pretest of handgrip strength	Control	10	26.3000	1.94651	.70000	.814	18	.426
	Experimental	10	25.6000	1.89737				
pretest of shooting accuracy	Control	10	24.0000	3.16228	.50000	.342	18	.736
	Experimental	10	23.5000	3.37474				
pretest of speed dribbling	Control	10	5.6280	.14351	01900	.234	18	.818
	Experimental	10	5.6090	.21325				
pretest of throwing accuracy	Control	10	9.7000	2.54078	.40000	.404	18	.691
	Experimental	10	9.3000	1.82878				

*Degree of freedom =18, (n-2), *t-statistic value, and significance value of the test (p-value) =0.05

Key:-N = Number of participants

Based on the results above, suggested that the mean values of the hand grip strength pretest about the experimental and control groups were25.60 and 26.30kg, and the standard deviation was 1.89 and 1.94kg respectively, t (18) = 0.814, p=0.426, in shooting accuracy the mean values of the experimental and control group were 23.50 and 24.00 and the standard deviation was 3.37 and

3.16 respectively, t (18) =0.342, p= 0.736. On the other side, in the case of speed dribbling the mean values of the experimental and control group were 5.60 and 5.62sec and the standard deviation was 0.21 and 0.14sec respectively, t (18) =0,234, p= 0.818. And also the mean value of throwing accuracy in experimental and control groups were 9.30 and 9.70 and the standard deviation was 1.82 and 2.54 respectively, (18) =0.404, p= 0.691. The p-value of hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy was (P > 0.05). The funding implies that there is no discernible difference between the experimental and the control group in hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy observed through the independent sample pre-test (table 4.2). Therefore, the randomized groups' pretest findings for the control and experimental groups were most likely equivalent, or the groups were homogeneous.

4.1.4 Paired sample t-test result of the experimental group

To compare the pre-test and post-test results of the experimental group of hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy by using paired sample t-test.

Table 0.3 Paired sample t-test results of the experimental groups

performance variable	Paired Samples Statistics			Paired Differences		T	Df	Sig.(2-tailed)
	N	Mean	Std. Deviation	**Mean Difference**	**Std. deviation**			
Pre and post-test of hand grip strength	10	25.6000	1.89737	-3.80000	1.75119	-6.862	9	.000
	10	29.4000	.6999					
Pre and post-test of shooting accuracy	10	23.5000	3.37474	-6.00000	3.94405	-4.811	9	.001
	10	29.5000	4.97214					
Pre and post-test of speed dribbling	10	5.6090	.21325	.45600	.11702	12.323	9	.000
	10	5.1530	.16720					
Pre and post-test of throwing accuracy	10	9.3000	1.82878	-.50000	1.58114	-1.000	9	.343
	10	9.8000	1.54919					

*The mean difference is significant at the 0.05 level (p-value). DF= degree of freedom=9, (n-1)

Key; N=number of participant

Based on the results above pre-and post-test results of the experimental group showed a statistically significant improvement in hand grip strength following the 8-week medicine ball training program, with a mean value and standard deviation of 25.60±1.89 kg to 29.40±0.699 kg respectively, ($p< 0.0005$); an improvement of the paired difference of -3.80 ±1.75 kg. The second performance variable, shooting accuracy, showed a statistically significant improvement in the pre-and post-test results of the experimental group following 8 weeks of medicine ball training. The mean value and standard deviation went from 23.50±3.37 to 29.50±4.97 respectively, (p, 0.001); an improvement of the paired difference of -6.00±3.94.

The third performance variable, speed dribbling, showed a statistically significant improvement in the pre and post-test results of the experimental group following 8 weeks of medicine ball training. The mean value and standard deviation went from 5.60±0.21 sec to 5.15±0.16 sec respectively, ($p<.0005$); an improvement of the paired difference of 0.45±0.11 sec. Finally, the fourth performance variable, throwing accuracy, showed no statistically significant improvement

in the pre and post-test results of the experimental group following 8 weeks of medicine ball training. The mean value and standard deviation went from 9.30±1.82 to 9.80±1.54 respectively, (p, 0.343); an improvement paired difference of -0.500±1.581. Generally in (table 4.3) the result suggests that the pre-and post-test result of experimental groups' hand grip strength, shooting accuracy, and speed dribbling were significantly improved (p, < 0.05) when exposed to 8-week medicine training. But no significant improvement in throwing accuracy was observed between pre- and post-testing (P > 0.05).

4.1.3 Paired sample t-test result of the control group

To compare the pre-test and post-test results of the control group in hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy by using a paired sample t-test

Table 0.4 Paired sample t-test results of the control groups

Performance variable	Paired Samples Statistics			Paired differences		T	Df	Sig.(2-tailed)
	N	Mean	Std. Deviation	Mean difference	Std. deviation			
Pre and post-test of hand grip strength	10	26.3000	1.94651	-.30000	1.05935	-.896	9	.394
	10	26.60	2.221					
Pre and post-test of shooting accuracy	10	24.0000	3.16228	-.50000	4.37798	-.361	9	.726
	10	24.5000	4.37798					
Pre and post-test of speed dribbling	10	5.6280	.14351	-.00100	.02885	-.110	9	.915
	10	5.6290	.14433					
Pre and post-test of throwing accuracy	10	9.7000	2.54078	-.20000	1.03280	-.612	9	.555
	10	9.9000	2.33095					

Key; N= Number of participant

Based on the results above the pre and post-test results of hand grip strength in the control group suggested no statistically significant improvement, with a mean value and standard deviation of 26.30 ±1.94kg to 26.60 ±2.22 kg, respectively (p, 0.394), an improvement of the paired difference of -0.30±1.05 kg. The shooting performance variable of the pre-and post-test results of

the control group showed no statistically significant improvement, with a mean value and standard deviation of 24.00±3.16 to 24.50±4.37, respectively (P, 0.726), an improvement of the paired difference of -0.50±4.37.

The second performance variable, speed dribbling, showed no statistically significant improvement in the pre-and post-test results of the control group, with a mean value and standard deviation of 5.62±0.14 sec to 5.62±0.14 sec, respectively (p, 0.915), an improvement of the paired difference of -0.001±0.028 sec. Finally, the third performance variable throwing accuracy showed no statistically significant improvement in the pre-and post-test results of the control group, the mean value and standard deviation of 9.70±2.54 to 9.90±2.33, respectively (p .555) and a paired difference of -0.200±1.032. In (table 4.4) result suggests that the pre-and post-test result of the hand grip, shooting accuracy, and throwing accuracy of control groups have slightly improved but not speed dribbling. However, there is an improvement but not statistically significantly improved hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy ($p > 0.05$).

4.1.5 Posttest independent t-test result

To compare the experimental and control groups' post-results of hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy by using an independent t-test.

Table 0.5 Independent sample t-test in Posttest result difference

Strength and skill performance variable	Group Statistics			t-test for Equality of Means			
	GP	Mean	Std.Deviation	Mean Difference	T	DF	Sig.(2-tailed)
Posttest of hand grip strength	CG	26.60	2.221	-2.800	-3.803	18	.001
	EG	29.40	.699				
Posttest of shooting accuracy	CG	24.5000	4.37798	-5.00000	-2.387	18	.028
	EG	29.5000	4.97214				
Posttest of speed dribbling	CG	5.6290	.14433	.47600	6.815	18	.000
	EG	5.1530	.16720				
Posttest of throwing accuracy	CG	9.9000	2.33095	.10000	.113	18	.911
	EG	9.8000	1.54919				

Key: GP=Group of Participation, EG=Experimental Group, CG=Control Group

Based on the results above suggested that the experimental group of hand grip strength had a statistically significant (29.40±0.699 kg) mean and standard deviation at the end of an 8-week medicine ball training program compared to the posttest of the control group (26.60±2.221 kg),and the mean difference was -2.800kg, t (18) = -3.803, p = 0.001. In shooting accuracy performance hand statistically significant in the experimental group (29.50±4.97) mean and standard deviation respectively at the end of the 8-week medicine ball training program compared to the posttest of the control group (24.50±4.37), and the mean difference was -5.00000, t (18) =-2.387, p = 0.028.

And also, speed dribbling performance was statistically significant in the experimental group (5.15±0.16 sec) mean and standard deviation, respectively, at the end of an 8-week medicine ball training program compared to the posttest of the control group (5.62±0.14 sec),and the mean difference was 0.47600, t (18) =6.815, p <0.0005. On the other side, in the case of throwing accuracy performance, there was no statistically significant difference in the experimental group's (9.80±1.54) mean and standard deviation, respectively, at the end of the 8-week medicine ball training program compared to the control group (9.90±2.33), and the mean difference was 0.88506, t (18) =0.113, p = 0.911. The findings of the study in (table 4.5) suggested that EG statistically significantly improved hand grip strength, shooting accuracy, and speed dribbling compared to CG in post-testing (p< 0.05). But no statistically significant improvement in throwing accuracy was observed between EG and CG in the post-test result (P > 0.05).

4.2. Discussions

This study looked at how training with a medicine ball for eight weeks affected the hand grip strength and technical skill performance of participants in a handball project. The findings show that an eight-week medicine ball training program considerably increased the hand grip strength, shooting accuracy, and speed dribbling of handball project participants but did not increase their throwing accuracy. It is seen that the EG made significantly greater improvements than the CG in the hand grip strength, shooting accuracy, and speed dribbling performances following the 8-week medicine ball training in u-17female handball project training($p<0.05$), but not in throwing accuracy ($p>0.05$).

When papers in the literature were carefully searched, it became clear that some of the results were in line with my finding, and some results contradict the findings of this paper.

4.2.1 The first objective of this study was to examine the effect of medicine ball training on the hand grip strength

To do this, paired sample t-test and independent sample t-test were computed and the results of paired sample t-test demonstrated that EG significantly improved in hand grip strength (p= 0.000, P<0.05), but in the CG indicated that no statistically significant improvement in hand grip strength observed in between pre-and post-testing(p=0.394, p>0.05). As a result of the independent sample t-test indicated that EG significantly improved than CG as observed in post-testing (p = 0.001, P<0.05). This result shows that EG u-17 female handball project trainees' hand grip strength was improved in the experiment. Hence the researcher accepted H. 1 hypothesis at a 0.05 level of confidence.

Handgrip strength in court sports (such as tennis, squash, and badminton), handball, volleyball, basketball, netball, and box lacrosse is important for hand function. High torque and rotational velocities of the shoulder, arm, and wrist during overarm movements are desired characteristics and are necessary for producing higher ball release velocities in the majority of court sports (Zealand et al., 2017). This data, which has been found from the present study, is compatible with research findings; therefore, handgrip strength is important for catching and throwing the ball in different sports games. According to Nida Sha and Rehana Mushtaq (2021), the effects of seated medicine ball throw training significantly improved the hand grip strength of female and male undergraduate physiotherapy students ages 18–24 from the Shalamar Medical and dental college.

Likewise, Rahmawati et al. (2021) hand exercises using a rubber ball increased hand grip strength in patients with non-hemorrhagic stroke, and Gnjatovic et al. (2012) suggested that a 12-week resistance training program with medicine balls can significantly improve throwing distances and shoulder press power for young female handball athletes. Therefore, my finding was in line with other researchers the objective would be to conclude that handgrip strength is important for court sports such as racket sports, handball, volleyball, basketball, netball, and box lacrosse. Research has shown that seated medicine ball throw training can improve hand grip strength, while hand exercises using a rubber ball can increase hand grip strength.

4.2.2 The second objective of this study was to examine the effect of medicine ball training on shooting accuracy

To do this, paired sample t-test and independent sample t-test were computed and the results of paired sample t-test presented that EG statistically significantly improved shooting accuracy ($p=0.001$, $P<0.05$), but in the CG indicated that no significantly improved in shooting accuracy was observed in between pre-and post-testing($p=0.726$, $p>0.05$). As a result of the independent sample t-test indicated that EG significantly improved than CG as observed in post-testing ($p = 0.040$, $P<0.05$). This result shows that EG u-17 female handball project trainees' shooting accuracy was improved in the experiment. So the researcher accepted H.1 hypothesis, on a 0.05 level of confidence.

In this regard, the information obtained from the study aligns with research findings (Rathod, 2018), showing that the effects of 6-week medicine ball training on Nagpur district 30 national handball players' medicine ball exercises showed an improvement in shooting efficiency among handball players. Likewise, Pujianto et al. (2020) show that the effects of medicine ball training on the handball athletes of the Indonesian Handball Association improve handball shooting skill performance.

Moreover, results of previous research also indicate that Zaid et al. (2023) stated that after eight weeks of skillful force training with various medicine balls, there was a significant improvement in shooting scores. It also discussed how these balls affected the development of specific physical skills and the accuracy of long-range shooting in handball. According to the discussion, my finding was in line with other researchers finding therefore, medicine ball training has been shown to improve handball shooting efficiency, accuracy, and shooting scores with various medicine balls.

4.2.3 The third objective of this study was to examine the effect of medicine ball training on speed dribbling

To do this, paired sample t-test and independent sample t-test were computed, and the results of paired sample t-test presented that EG and CG had EG statistically significantly improved speed dribbling($p=0.000$, $P<0.05$), but the CG indicated that no significantly improved in speed dribbling was observed in between pre-and post-testing ($p=0.915$, $p>0.05$). As a result of the

independent sample t-test indicated that EG significantly improved than CG as observed in post-testing (p = 0.000, P<0.05). This result shows that EG u-17 female handball project trainees' speed dribbling was improved in the experimental group. So the researcher accepted H.1 hypothesis, on a 0.05 level of confidence.

The finding of this study is supported by the finding (Vk & Balamurugan, 2021) that the effect of six weeks of medicine ball training was significant in improving the passing and dribbling abilities of male basketball players aged 18–23. Similar to Nidzam et al. (2022) the study concludes that the effects of 8-week medicine ball training on physical performance among basketball players significantly improved the control dribble (CD), defensive movement (DM), passing (PASS), and speed spot shooting (SSS). To finalize the above discussion, the effects of six weeks of medicine ball training and the effects of eight-week medicine ball training improved the dribbling ability and control dribble of basketball players. But most researchers investigate basketball players rather than handball players and trainees.

4.2.4 The fourth objective of this study was to examine the effect of medicine ball training on throwing accuracy

To do this, paired sample t-test and independent sample t-test were computed and the results of paired sample t-test presented that EG and CG had no significantly improved throwing accuracy observed in between pre-and post-testing (EG, p= 0.343and CG, P=0.555, p>0.05) and the result of the independent sample t-test showed that there is no significant difference in EG and CG observed in post-testing (p= 0.911, p>0.05). This result shows that the EG of u-17 female handball project trainees in throwing accuracy was not significantly improved. So the H.1 hypothesis was rejected, on 0.05 level of confidence.

The finding of this study is supported by the research findings of R et al. (2010), who stated that female handball players did not significantly increase their throwing accuracy after six weeks of medicine ball training. Similarly, Melugin et al. (2021) suggested that baseball pitchers' velocity was greatly increased by weighted ball training. Given that high throwing velocity is linked to lower accuracy, this indicates there was little improvement in the baseball pitchers' throwing accuracy (Etin & Balc, 2015). Related to this, Eler & Eler (2017) concluded that the effect of strength training programs has no significant value on the throwing accuracy of female handball players. On the contrary, Di Ardian Fufu et al. (2021) conducted a study on the effects of throw

and catch exercises and the accuracy and speed of softball throws to target. As a result, the effect of throw and catch exercises on accuracy and speed when throwing the ball in softball games was greatly improved.

To conclude this objective, my finding was in line with other researchers. Therefore, medicine ball training, weighted ball training, and strength training programs had no significant effect on the throwing accuracy of female handball players. However, a study conducted by Dwi Ardian Fufu et al. (2021) showed that throw and catch exercises significantly improved accuracy and speed when throwing the ball in softball.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATION

In this chapter, the main points of the study are summarized, conclusions are given based on the results of the study, and recommendations for researchers, coaches, and concerned bodies are given based on the results of the study.

5.1. Summary of the study

The purpose of this study was to investigate the effect of 8 weeks of medicine ball training on hand grip strength and some selected handball skill performance of u-17 female handball project trainees. There are different types of handball technical skills, including shooting, dribbling, throwing, blocking, goalkeeping, etc., but this investigation was focused on the effects of medicine ball training on hand grip strength and shooting accuracy, speed dribbling, and throwing accuracy performance of under-17 female handball project trainees. Different kinds of literature were included in the area of handball games, hand grip strength, and fundamental skills of handball such as shooting accuracy, speed dribbling, and throwing accuracy.

The research design in this study was a true experimental design with a quantitative research approach. The participants of this study were 20 u-17 female handball project trainees, and all were taken as samples by using a comprehensive sampling technique. Through randomization, the participants were grouped into control and experimental groups. The data was collected through a hand grip strength test and shooting accuracy, speed dribbling, and throwing accuracy through a skill test; therefore, the data in this study was the primary source of data. The data were analyzed through paired sample t-tests and independent sample t-tests. Based on this, the data analysis and the result indicate that medicine ball training had a significant effect on hand grip strength, shooting accuracy, and speed dribbling, but it did not significantly improve the throwing accuracy of u-17 female handball project trainees.

5.2. Conclusions of the study

The purpose of the present study was to examine the effect of 8-week medicine ball training on the hand grip strength and some selected handball skill performance of female u-17 handball project trainees. An adequate amount of data was collected from the target group through fitness

and skill field tests. Therefore, within the limitations and delimitations of the study the following conclusions have been drawn:

- ✓ The effects of 8 weeks of medicine ball training on the hand grip strength of female u-17 handball project trainees had a positive significant improvement. Therefore, the research has concluded that medicine ball training is very important for the hand grip strength of female u-17 handball project trainees.
- ✓ The effects of 8 weeks of medicine ball training on the shooting accuracy skill performance of female u-17 handball project trainees had a positive significant improvement. Therefore, the researcher has been concluded that medicine ball training is very important for the shooting accuracy skill performance of female u-17 handball project trainees.
- ✓ The effects of 8 weeks of medicine ball training on the speed dribbling skill performance of female u-17 handball project trainees had a positive significant improvement. Therefore, the researcher has been concluded that medicine ball training is very important for the speed dribbling skill performance of female u-17 handball project trainees.
- ✓ The effects of 8 weeks of medicine ball training on the throwing accuracy skill performance of female u-17 handball project trainees had no positive significant improvement. Therefore, the researcher has been concluded that medicine ball training is not important for the throwing accuracy skill performance of female u-17 handball project trainees.

In general, the main finding of this study was strength and handball technical skill performances such as hand grip strength, shooting accuracy, speed dribbling, and throwing accuracy. Hand grip strength and all selected skills except throwing accuracy performance showed significant improvement in u-17 female handball project trainees after the intervention of the medicine ball training program.

5.3 Recommendations

The purpose of the current study was to examine the effects of medicine ball training on hand grip strength and some selected technical skill performance of u-17 female handball project trainees. Based on the conclusions drawn in light of the research findings, the following recommendations have to be forwarded.

5.3.1 Recommendations for Practices

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

- The medicine ball training method should not be used more than three days per week. When applying the medicine ball training method, the training loads would be based on the players' physical fitness level, training age, and gender.
- The medicine ball training program should be a part of the physical preparation of handball players, and it is necessary to raise the awareness of the trainers about the importance of medicine ball training in the direction of skill because of their significant influence on raising the level of the player physically and skillfully.
- In addition to the technical training, hand grip strength training is important to improve overall performance related to handball games. So, for better improvement, handball players should participate in programmed strength training.

5.3.2Recommendations for further study

- Other researchers should conduct this research on female and male handball project trainees by increasing or decreasing training weeks.
- Other researchers should conduct these training effects by incorporating other strengths and technical skills of handball rather than shooting accuracy, throwing accuracy, and speed dribbling
- Another researcher should conduct in the same area on various age categories
- Researchers should conduct this research by considering the playing position of handball project trainees.
- Researcher who have an interest on the area should do research within the comparison effects of medicine ball training other training methods on hand grip strength and technical skill performance of handball players.

REFERENCE

A.A., P. (2014). Structure and Physical Technical and Tactical Training Handball Players Aged 10-11 Years. *Pedagogics, Psycology, Medical-Biological Problems of Physical Training and Sports*, *10*, 35–40. https://doi.org/10.5281/zenodo.10488

Achmad Ali Fikri, Syamsul Arifin, M. F. F. (2022). No Titleלנגד שבאמת מה את לראות קשה הכי העינים. *הארץ*, *2*(8.5.2017), 2003–2005.

Actor, I. M. F., Alue, I. C. V, Alue, I. S. I. V, Kumar, A. S. S., & Rahul, R. (2021). *Online Copy Available : www.ijmer.in EFFECT OF MEDICINE BALL TRAINING ON STRENGTH RELATED PARAMETERS AND PLAYING ABILITY OF SCHOOL LEVEL HANDBALL PLAYERS*. *514*(1), 95–98.

Alexandru, A., Eftene, A., & M, C. L. (2022). *Power and Strength Training in Team Handball*. *September*.

Armstrong, T. E. (2002). Specific medicine ball training for the soccer goalkeeper. *Theses Digitization Project*. https://scholarworks.lib.csusb.edu/etd-project/2075

Baar, K. (2006). Adaptation to Resistance Exercise. *Medicine and Science in Sports and Exercise*, *38*(11), 1939–1944. https://doi.org/10.1249/01

Bird, S. (2011). Post-Exercise Recovery. *Australian Orienteer*, *161*, 10–14. http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=59968051&lang=es&site=ehost-live

Bompa, T. O., & Haff, G. G. (2009). Periodization: theory and methodology for training. In *Fifth Edition.United States of America: Human Kinetics*.

Byorum, B. S., Real, N., & Tax, E. (2015). *Training Principles Part 3 : Individualism & Involvement*. *August 2011*, 25–26.

Cardoso Marques, M. (2010). In-season strength and power training for professional male team handball players. *Strength and Conditioning Journal*, *32*(6), 74–81. https://doi.org/10.1519/SSC.0b013e3181fbec32

Çetin, E., & Balcı, N. (2015). The Effects of Isokinetic Performance on Accurate Throwing in Team Handball. *Procedia - Social and Behavioral Sciences*, *174*, 1872–1877. https://doi.org/10.1016/j.sbspro.2015.01.850

CHAD HARRIS CHAD HARRIS, 1, & WATTLES, A. P. (2011). T s m b t u b p o a. *Strength And Conditioning*, 2344–2348.

Creswell, J. W. (2014). The Selection of a Research Approach. *Research Design*, 3–23. https://doi.org/45593:01

Duthie, G. M. (2006). A framework for the physical development of elite rugby union players. *International Journal of Sports Physiology and Performance*, *1*(1), 2–13. https://doi.org/10.1123/ijspp.1.1.2

Earp, J. E., Kraemer, W. J., & Sciences, H. (2010). *Medicine Ball Training Implications for Rotational Power Sports*. *32*(4), 20–25.

Faigenbaum, A. D., & Mediate, P. (2008). Medicine Ball Training for Kids. *ACSM'S Health & Fitness Journal*, *12*(3), 7–12. https://doi.org/10.1249/fit.0b013e31817047a2

Fallahi, A. A., & Jadidian, A. A. (2011). *The Effect of Hand Dimensions , Hand Shape and Some Anthropometric Characteristics on Handgrip Strength in Male Grip Athletes and Non-Athletes*. *29*, 151–159. https://doi.org/10.2478/v10078-011-0049-2

Farley, J. B., Barrett, L. M., Keogh, J. W. L., Woods, C. T., & Milne, N. (2020). The relationship between physical fitness attributes and sports injury in female, team ball sport players: a systematic review. *Sports Medicine - Open*, *6*(1). https://doi.org/10.1186/s40798-020-00264-9

Fernandez-Fernandez, J., Granacher, U., Martinez-Martin, I., Garcia-Tormo, V., Herrero-Molleda, A., Barbado, D., & Garcia-Lopez, J. (2022). Physical fitness and throwing speed in U13 versus U15 male handball players. *BMC Sports Science, Medicine and Rehabilitation*, *14*(1), 1–13. https://doi.org/10.1186/s13102-022-00507-0

Gavin L Moir. (2015). *Muscular strength and power* (Issue JANUARY 2015).

Gerodimos, V. (2012). *Reliability of Handgrip Strength Test in Basketball Players by*. *31*(March), 25–36. https://doi.org/10.2478/v10078-012-0003-y

Gnjatovic, A. L. M. I., Arkovic, Z. I. M. M., & Adovanovic, D. R. S. R. (2012). *E 12- m b t m s p y f h p*. *28*.

Gokulakrishnan, J., & Monisha, C. (2021). *" EFFECTIVENESS OF MEDICINE BALL TRAINING PROGRAMME IN FEMALE THROWBALL PLAYERS ."* *9*(8), 217–223.

Gómez, A. L., Radzwich, R. J., Denegar, C. R., Volek, J. S., Rubin, M. R., Bush, J. A., Doan, B. K., Wickham, R. B., Mazzetti, S. A., Newton, R. U., French, D. N., Häkkinen, K., Ratamess, N. A., & Kraemer, W. J. (2002). The effects of a 10-kilometer run on muscle strength and power. *Journal of Strength and Conditioning Research*, *16*(2), 184–191.

https://doi.org/10.1519/1533-4287(2002)016<0184:TEOAKR>2.0.CO;2

Gould, J. (2001). Variables in Research Designs. *Concise Handbook of Experimental Methods for the Behavioral and Biological Sciences*, *3*(4), 75–110. https://doi.org/10.1201/9781420040869.ch4

Gümüş, H., Şahin, T., & Gençoğlu, C. (2020). Additional Field Player Tactics' Effects to Match Performance During the Numerical Asymmetric Situations In Female Handball. *Turkish Journal of Sport and Exercise*, *22*(2), 305–310. https://doi.org/10.15314/tsed.753048

Hatfield, Larry L., Ed.; Bradbard, David A., E. (1978). *ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, Columbus, Ohio.; Georgia Univ., Athens. Seorgia Center for*.

Iacono, A. Dello, & Karcher, C. (2018). Handball Sports Medicine. *Handball Sports Medicine*, *May*. https://doi.org/10.1007/978-3-662-55892-8

Ibragimov, A. K. (2021). Individualization of Psychological Training of Qualified Handball Players. *... Research Journal*, *2*(4), 234–241. https://wos.academiascience.org/index.php/wos/article/view/68

Ignjatovic, A. M., Markovic, Z. M., & Radovanovic, D. S. (2012). Effects of 12-week medicine ball training on muscle strength and power in young female handball players. *Journal of Strength and Conditioning Research*, *26*(8), 2166–2173. https://doi.org/10.1519/JSC.0b013e31823c477e

isbs2009_resubmission_60. (n.d.).

Ishop, P. H. A. B., Ones, E. R. I. C. J., & Oods, A. K. R. W. (2008). *R f t a b r*. *22*(3), 1015–1024.

Jakšić, D., Trbojević Jocić, J., Maričić, S., Miçooğullari, B. O., Sekulić, D., Foretić, N., Bianco, A., & Drid, P. (2022). Mental skills in Serbian handball players: In relation to the position and gender of players. *Frontiers in Psychology*, *13*(August), 1–11. https://doi.org/10.3389/fpsyg.2022.960201

Juhász, I., Melinda, B., Juhász, I., Váczi, P., Vincze, T., & Hajdú, P. (2015). *Handball Ball Games*. http://oszkdk.oszk.hu/beszolgaltatas/index.php

Karadenizli, Z. I. (2015). The effects of plyometrıc educatıon traınıngs on balance and some psychomotor characteristics of school handball team. *Turkish Online Journal of Educational Technology*, *2015*(10), 612–618. https://doi.org/10.13189/ujer.2016.041007

Karadenizli, Z. I. (2016). The Relationships between Ball Throwing Velocity and Physical-psychomotor Features for Talent Identification in Physical Education. *Universal Journal of Educational Research*, *4*(11), 2509–2515. https://doi.org/10.13189/ujer.2016.041103

Kasper, K. (2019). Sports Training Principles. *Current Sports Medicine Reports*, *18*(4), 95–96. https://doi.org/10.1249/JSR.0000000000000576

Kobak, M., Rebold, M., Buser, S., Kappler, R., & Otterstetter, R. (2018). The Effects of Medicine Ball Training on Bat Swing Velocity in Prepubescent Softball Players. *International Journal of Exercise Science*, *11*(4), 75.

Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of Resistance Training: Progression and Exercise Prescription. *Medicine and Science in Sports and Exercise*, *36*(4), 674–688. https://doi.org/10.1249/01.MSS.0000121945.36635.61

Leyk, D., Gorges, W., Ridder, D., Wunderlich, M., Rüther, T., Sievert, A., & Essfeld, D. (2007). Hand-grip strength of young men, women and highly trained female athletes. *European Journal of Applied Physiology*, *99*(4), 415–421. https://doi.org/10.1007/s00421-006-0351-1

Luigi Bragazzi, N., Rouissi, M., Hermassi, S., & Chamari, K. (2020). Resistance training and handball players' isokinetic, isometric and maximal strength, muscle power and throwing ball velocity: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, *17*(8). https://doi.org/10.3390/ijerph17082663

Manoharan, V. S., Ganesh, S., & Isaac, J. (2015). *FACTORS AFFECTING HAND GRIP STRENGTH AND ITS EVALUATION : A SYSTEMIC REVIEW*. *3*(6), 1288–1293. https://doi.org/10.16965/ijpr.2015.193

Mastergradsoppgave. (2009). *June*.

Mclean, A. (2003). *The Principles of Training*. 66–78.

Medicine, A. C. of S. (2009). American College of Sports Medicine position stand. In *Med Sci Sports Exerc* (Issue 41, pp. 687–708).

Metan, H., & Küçük, V. (2022). The Effect of Psychological Skill Training Program and Positive Feedback on Handball Player's Self-Efficacy Beliefs and their Shot Accuracy. *Annals of Applied Sport Science*, *10*(3), 0–0. https://doi.org/10.52547/aassjournal.1060

Michalsik, L. B., & Aagaard, P. (2015). Physical demands in elite team handball: Comparisons between male and female players. *Journal of Sports Medicine and Physical Fitness*, *55*(9), 878–891.

Molyneaux, A. (2002). *Salute Animae*. *November*, 44–50.

Moshinsky, M. (1959). No Titleيب ل يد. In *Nucl. Phys.* (Vol. 13, Issue 1).

Neu, C. M., Rauch, F., Rittweger, J., Manz, F., & Schoenau, E. (2023). *Influence of puberty on muscle development at the forearm*. 103–107.

Nopianto, W., Setiakarnawijaya, Y., Widiastuti, Daryono, & Lanos, M. E. C. (2021). Shooting skills training needs analysis in handball game for young athlete. *International Journal of Human Movement and Sports Sciences*, *9*(3), 554–559. https://doi.org/10.13189/saj.2021.090322

Pujianto, R., Soegiyanto, S., & Rahayu, S. (2020). The Influence of Shooting and Weight Training toward Handball Shooting Skills. *Journal of Physical Education and Sports*, *9*(2), 185–194. https://journal.unnes.ac.id/sju/index.php/jpes

Remarks, G., & Feints, T. (1997). *Handball SPORTS Methods*.

Research Scholar, P. R., & Pramod Research Scholar, C. R. (2019). The effect of medicine ball training on shoulder strength and abdominal strength and endurance among Sudan school boy's football players in Qatar. *~ 151 ~ International Journal of Physical Education, Sports and Health*, *6*(1), 151–154. www.kheljournal.com

Ronglan, L. T., Raastad, T., & Børgesen, A. (2006). *Neuromuscular fatigue and recovery in elite female handball players*. 267–273. https://doi.org/10.1111/j.1600-0838.2005.00474.x

Ruslan, R., & Hamdiana, H. (2019). Learning results dribbling handball through the application of methods of play. *Journal of Physics: Conference Series*, *1318*(1). https://doi.org/10.1088/1742-6596/1318/1/012013

Salameh, H. (2020). *The effect of a proposed training program using medicine balls on some physical variables and the digital achievement of throwing events in athletics for students of physical educa ... The effect of a proposed training program using medicine balls on some*. *7*(March), 80–84.

Shahbazi, M., Rahimizadeh, M., Rajabi, M. R., & Abdolmaleki, H. (2011). Mental and physical characteristics in Iranian men's handball national team, winner of silver medal in Asian games-2010. *Procedia - Social and Behavioral Sciences*, *30*, 2268–2271. https://doi.org/10.1016/j.sbspro.2011.10.443

Siegel, D. (2008). Effects of Medicine Ball Training in Fitness Performance of High School Physical Education Students. *Journal of Physical Education, Recreation & Dance*, *79*(4),

9–9. https://doi.org/10.1080/07303084.2008.10598154

Song, G. Bin, Kim, J. J., Park, E. C., Stockbrugger, B. A., Haennel, R. G., Torgerson, D. J., Miles, J. N. V., Yu, W., Cha, S., Seo, S., Stone, M., Rowlands, A., Middlebrooke, A., Jawis, M. N., Eston, R., Palao, J. M., Valdés, D., Kerr, A., Sayers, M., … McGuigan, M. R. (2015). Strength Training With Medicine Balls. *Journal of Strength and Conditioning Research*, *21*(1), 1–145. http://www.jmir.org/2012/6/e161/%0Ahttps://academic.oup.com/nutritionreviews/article-lookup/doi/10.1111/j.1753-4887.2008.00136.x%0Ahttp://www.ncbi.nlm.nih.gov/pubmed/19178654%0Apapers2://publication/uuid/3C1E6B6A-B388-4550-8926-8FF45F0CC700%0Ahttps://www.

Suchomel, T. J., Nimphius, S., & Stone, M. H. (2016). The Importance of Muscular Strength in Athletic Performance. *Sports Medicine*, *46*(10), 1419–1449. https://doi.org/10.1007/s40279-016-0486-0

Szymanski, D. J., Szymanski, J. M., Bradford, T. J., Schade, E. L., & Pascoe, D. D. (2007). Effect of twelve weeks of medicine ball training on high school baseball players. *Journal of Strength and Conditioning Research*, *21*(3), 894–901. https://doi.org/10.1519/R-18415.1

Thor, E., Nor, S. N., & Can, T. D. (2014). *Specific Fitness Training*. 63–76.

Zealand, N., Sciences, H., Performance, H., New, S., High, G., Zealand, N., Zealand, N., Zealand, N., Scholar, G., Central, P., & Central, P. (2017). *A b r h s s p*. *31*(11).

APPENDIX A-Physical readiness activity questionnaires

The first step to consider as one of the requirements for participating in regular physical activity is a physical activity readiness questionnaire. Regular physical activity has many positive effects on one's health. The purpose of the physical activity readiness questionnaire is to determine which people are suitable for medicine ball training and which ones are not. To participate in the planned training course, individuals are asked the following questions about their health status:

Direction: please read the following questions carefully and indicate your response to each question by writing on blank space by putting a tick ("x") mark under one of the two choices: "yes" or "no" which is given below

Subject's 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?		

Source: Wubliker (Science, 2020).

APPENDIX B-የአካልብቃትእንቅስቃሴዝግጁነትመጠይቆች

በመደበኛ የአካል ብቃት እንቅስቃሴ ውስጥ ለመሳተፍ ከሚያስፈልጉት መስፈርቶች እንደ አንዱ ሊታሰብበት የሚገባው የመጀመሪያው እርምጃ የአካል ብቃት እንቅስቃሴ ዝግጁነት መጠይቅ ነው። መደበኛ የአካል ብቃት እንቅስቃሴ በጤና ላይ ብዙ አዎንታዊ ተጽእኖ ይኖረዋል። የአካል ብቃት እንቅስቃሴ ዝግጁነት መጠይቅ ዓላማ የትኞቹ ሰዎች ለሚድስ ኪስ ስልጠና ተስማሚ እንደሆኑ እና የትኞቹ እንዳልሆኑ መወሰን ነው። በታቀደው የስልጠና ኮርስ ላይ ለመሳተፍ ግለሰቦች ስለ ጤና ሁኔታቸው የሚከተሉትን ጥያቄዎች ይጠየቃሉ።

አቅጣጫ፡ እባክዎ የሚከተሉትን ጥያቄዎች በጥንቃቄ ያንብቡ እና በባዶ ቦታ ላይ በመፃፍ ለእያንዳንዱ ጥያቄ ምላሽዎን ያመልክቱ ከሁለቱ አንዱን ይመርጣል፡ “አዎ” ወይም “አይደለም” የሚለውን ምልክት (“x”) ምልክት ያድርጉ።

የተሳታፊዉስም_____ፊርማ_____ቀን_____

ተ.ቁ	መጠይቆች	አዎ	አይደለም
1	በአሁኑወቅትበሳምንትቢያንስለ3ቀናትበመደበኛየአካልብቃትእንቅስቃሴውስጥይሳተፉሉ?		
2	የልብችግርአለበዎት?ካልብዎትሀከምዎየተፈቀደለዎትንየሰዉነትእንቅስቃሴብቻነዉየሚሰሩት?		
3	በአሁኑጊዜአንድሐኪምለደምግፊትዎወይምለልብዎሁኔታመድኃኒቶችንአዝዞሎዎታል?		
4	በእረፍቱወይምበአካልብቃትእንቅስቃሴበሚሰሩበትጊዜየትንፋስማጠርችግር/ስሜትያጋጥመዎታል?		
5	የአካልብቃትእንቅስቃሴበሚሰሩበትጊዜበደረትዎላይህመምይሰማዎታል?		
6	በአካልብቃትእንቅስቃሴዎላይለዉጥበመደረጉሊባባስየሚችልየመገጣጠሚያወይምየአጥንትችግርአለብዎት?		
7	የአካልብቃትእንቅስቃሴበመስራትየሚባባስየእጅናእግርህመምአለበዎት?		
8	በራስማዞርችግርየተነሳሚዛንዎንወይምንቃተህሊናዎንሥተዉያዉቃሉ?		
9	በአለፈውወርየአካልብቃትእንቅስቃሴበማይሰሩበትጊዜየደረትህመምአጋጥሞዎታል?		

APPENDIX C-Eight-week medicine ball training plan

Week	Exercise with Medicine Ball	Set	Repetition	Rest
Week 1-2-3	✓ Push the medicine ball (3 kg) from the chest with the arms from the standing position. ✓ Push the medicine ball (3 kg) from the chest with the arms from the kneeling position. ✓ Push the medicine ball (3 kg) from the chest with the arms from the sitting position. ✓ Push the medicine ball (3 kg) from the chest with the arms from the lying position and reach the sitting position. ✓ Throw the medicine ball (3 kg) from the side. ✓ Push the medicine ball (3 kg) from the standing position by jumping over a barrier with a height of (30 cm). ✓ Throw the medicine ball (3 kg) the farthest distance by the arm from above the head	2 Set	8 Nos	2Min

Week4-5	✓ Throw the medicine ball (3 kg) over the head with the arms and from the standing position. ✓ Throw the medicine ball (3 kg) from over the head with the arm and from the standing position. ✓ Throw the medicine ball (3 kg) from over the head with the arm and from the kneeling position. ✓ Throw the medicine ball (3 kg) from over the head with the arm and from the sitting position. ✓ Push the medicine ball (3 kg) from the chest with the arms from the lying position and reach the Sitting position. ✓ Push the medicine ball (3 kg) from the standing position by jumping over a barrier with a height of (30 cm). ✓ Throw the medicine ball (3 kg) from the side.	2 Set	10 Nos	2Min

Week6-7	• Push the medicine ball (5 kg) from the chest with the arms from the standing position. • Push the medicine ball (5 kg) from the chest with the arms out of the kneeling position. • Push the medicine ball (5 kg) from the chest with the arms out of the sitting position. • Push the medicine ball (6 kg) from the chest with the arms from the lying position and reach the Sitting position. • Throw the medicine ball (6 kg) over the head by the arms and from a sitting position. • Throw the medicine ball (6 kg) from the side. • Push the medicine ball (5 kg) from the standing position by jumping over a barrier above a height of (30 cm).	3 Set	10 Nos	2Min

Week-8	▪ Push the medicine ball (5 kg) from the standing position by jumping over a barrier with a height of (40 cm). ▪ Throw the medicine ball (6 kg) from the side. ▪ Throw the medicine ball (5 kg) from over the head with the arm and from kneeling. ▪ Throw the medicine ball (5 kg) over the head with the arm and from the sitting position. ▪ Push the medicine ball (6 kg) from the chest with the arms from the lying position and reach the Sitting position. ▪ Throw the medicine ball (5 kg) the farthest distance in the arm from above the head.	3 Set	12 Nos	2Min

Source: Adopt from Salameh, (2020).

APPENDIX D-Normative data for the grip strength test

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

Gender	Excellent	Above Average	Average	Below average	Poor
Male	>56	51-56	45-50	39-44	<39
female	>36	31-36	25-30	19-24	<19

Adopt from Mackenzie, (2008)

APPENDIX E-Handball skill test score sheet

Handball player

Name _____

Team _____

Fitness test 1: hand grip strength test

Trail	Trial 1	Trial 2	Trial 3	Best one
strength (kg)				

Skill test 1: jump shoot test

Three-step jump shot																
Position	Left in					Center back					Right in					Total
No of shot	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Point scored																

Skill test 2: Obstacle dribbling test

Trail	Trial 1	Trial 2	Best
Finishing time (sec)			

Skill test 3: Accuracy throw test

	Accuracy throw test										
Types of throwing	Throwing from 7m					Throwing from 10m					Total
No of throwing	1	2	3	4	5	1	2	3	4	5	10
Point scored											

APPENDIX F-Selected fitness and skill test description

No	Name of variables	Test items	Units of measurement
1	Hand grip strength	Muscular strength	In kg
2	shoot accuracy	Jump shoot	In point
3	Speed dribbling	Agility/obstacle dribbling	In second
4	Throwing accuracy	Accuracy throw	In point

APPENDIX G-Study participant's demographic characteristics

Experimental group					
No	Name	Age in years	Weight(kg)	Height(m)	Training age in the year
1	EG1	15	47	1.47	2
2	EG2	16	50	1.50	2
3	EG3	15	45	1.45	2
4	EG4	15	42	1.46	2
5	EG5	13	33	1.25	2
6	EG6	13	34	1.30	2
7	EG7	16	49	1.47	2
8	EG8	16	49	1.50	2
9	EG9	14	39	1.35	2
10	EG10	13	36	1.30	2
Control group					
No	Name	Age in years	Weight(kg)	Height(m)	Training age in the year
1	CG1	15	45	1.48	2
2	CG2	16	47	1.50	2
3	CG3	14	42	1.45	2
4	CG4	14	42	1.46	2
5	CG5	13	32	1.24	2
6	CG6	15	44	1.30	2
7	CG7	16	50	1.50	2
8	CG8	15	49	1.50	2
9	CG9	13	34	1.29	2
10	CG10	14	37	1.32	2

APPENDIX H-Experimental group pretest and posttest fitness and skill test record sheet

No	**Name**	**Pre-tests**				**Post-test**			
		Hand grip strength	Shooting Accuracy	Speed Dribbling	Throwing accuracy	Hand grip strength	Shooting Accuracy	Speed Dribbling	Throwing accuracy
1	EG1	28	25	5.40	7	30	35	5.05	8
2	EG2	29	20	5.51	9	30	30	5.15	8
3	EG3	25	25	5.62	10	29	25	5.27	11
4	EG4	27	20	5.82	13	30	30	5.20	12
5	EG5	25	20	5.90	10	28	25	5.31	9
6	EG6	25	30	5.74	8	29	40	5.10	12
7	EG7	26	25	5.25	9	29	25	5.85	10
8	EG8	24	25	5.81	11	30	30	5.44	10
9	EG9	24	20	5.63	7	30	25	5.16	8
10	EG10	23	25	5.41	9	29	30	5.00	10

APPENDIX I-Control group pre and post-fitness and skill test record sheet

No	Name	Pre-tests				Post-test			
		Hand grip strength	Shooting Accuracy	Speed Dribbling	Throwing accuracy	Hand grip strength	Shooting Accuracy	Speed Dribbling	Throwing accuracy
1	CG1	28	25	5.45	6	29	25	5.50	7
2	CG2	28	20	5.50	8	30	20	5.45	8
3	CG3	27	30	5.67	11	28	30	5.68	10
4	CG4	27	25	5.80	12	26	20	5.79	13
5	CG5	25	25	5.71	12	25	30	5.70	12
6	CG6	25	25	5.70	10	26	20	5.72	11
7	CG7	29	20	5.85	14	28	25	5.84	13
8	CG8	27	25	5.64	9	27	30	5.66	8
9	CG9	24	25	5.46	7	23	20	5.43	7
10	CG10	23	20	5.50	8	24	25	5.52	10

APPENDIX J-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 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 the 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, two days per week, and a total of 8 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 by phone: at 0925455375 or email: melkamuasres460@gmail.com.

Please indicate with your signature in 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 t

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

Name of researcher: _____Signature: _____Date: _____

APPENDIX k-Trainees skill test picture

Throwing Accuracy Test 7&10m Lines

APPENDIX L –Medicine Ball Training material

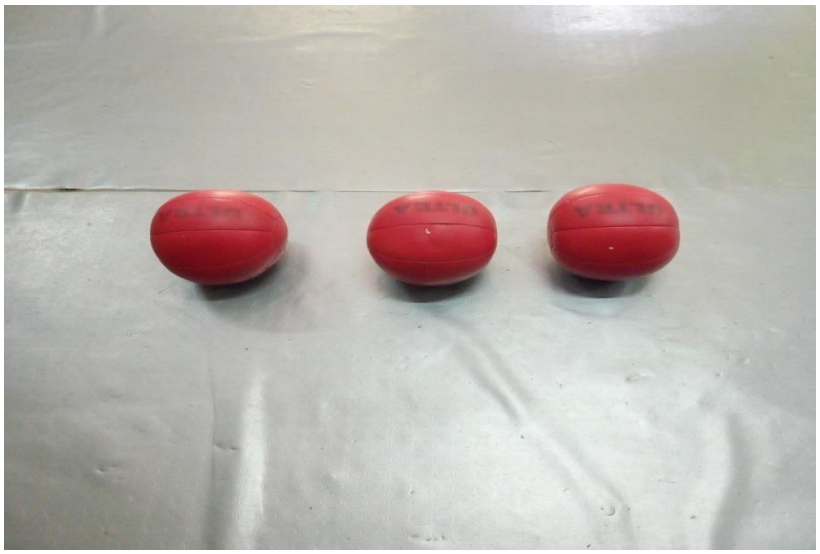

Figure of medicine ball

APPENDIX M-Independent sample test SPSS pretest result

Group Statistics

	name of respondents	N	Mean	Std. Deviation	Std. Error Mean
pretest of hand grip strength	1	10	26.3000	1.94651	.61554
	2	10	25.6000	1.89737	.60000
pretest of shooting accuracy	1	10	24.0000	3.16228	1.00000
	2	10	23.5000	3.37474	1.06719
pretest of speed dribbling	1	10	5.6280	.14351	.04538
	2	10	5.6090	.21325	.06744
pretest of throwing accuracy	1	10	9.7000	2.54078	.80346
	2	10	9.3000	1.82878	.57831

1= experimental group, 2= control group

Independent Samples Test

		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
pretest of hand grip strength	Equal variances assumed	.079	.782	.814	18	.426	.70000	.85959	-1.10592	2.50592
	Equal variances not assumed			.814	17.988	.426	.70000	.85959	-1.10601	2.50601
pretest of shooting accuracy	Equal variances assumed	.255	.620	.342	18	.736	.50000	1.46249	-2.57259	3.57259
	Equal variances not assumed			.342	17.924	.736	.50000	1.46249	-2.57351	3.57351
pretest of speed dribbling	Equal variances assumed	1.676	.212	.234	18	.818	.01900	.08128	-.15177	.18977
	Equal variances not assumed			.234	15.764	.818	.01900	.08128	-.15353	.19153
pretest of throwing accuracy	Equal variances assumed	1.925	.182	.404	18	.691	.40000	.98995	-1.67981	2.47981
	Equal variances not assumed			.404	16.352	.691	.40000	.98995	-1.69493	2.49493

APPENDIX N-Paired sample T test SPSS result of the control group

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	pretest of hand grip strength	26.3000	10	1.94651	.61554
	posttest of grip	26.60	10	2.221	.702
Pair 2	pretest of shooting	24.0000	10	3.16228	1.00000
	posttests of shooting	24.5000	10	4.37798	1.38444
Pair 3	pretest of dribbling	5.6280	10	.14351	.04538
	posttest of dribbling	5.6290	10	.14433	.04564
Pair 4	pretest of throwing	9.7000	10	2.54078	.80346
	posttest of throwing	9.9000	10	2.33095	.73711

Paired Samples Test

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest of hand grip strength and posttest of hand grip strength	-.30000	1.05935	.33500	-1.05781	.45781	-.896	9	.394
Pair 2	pretest of shooting accuracy and posttests of shooting accuracy	-.50000	4.37798	1.38444	-3.63181	2.63181	-.361	9	.726
Pair 3	pretest of speed dribbling and posttest of speed dribbling	-.00100	.02885	.00912	-.02164	.01964	-.110	9	.915
Pair 4	pretest of throwing accuracy and posttest of throwing accuracy	-.20000	1.03280	.32660	-.93882	.53882	-.612	9	.555

APPENDIX O-Paired sample T- test SPSS result of experiment group

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	pretest of hand grip strength	25.6000	10	1.89737	.60000
	posttest of hand grip strength	29.40	10	.699	.221
Pair 2	pretest of shooting accuracy	23.5000	10	3.37474	1.06719
	posttests of shooting accuracy	29.5000	10	4.97214	1.57233
Pair 3	pretest of speed dribbling	5.6090	10	.21325	.06744
	posttest of speed dribbling	5.1530	10	.16720	.05287
Pair 4	pretest of throwing accuracy	9.3000	10	1.82878	.57831
	posttest of throwing accuracy	9.8000	10	1.54919	.48990

Paired Samples Test

		Paired Differences					T	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	pretest of hand grip strength and posttest of hand grip strength	-3.80000	1.75119	.55377	-5.05273	-2.54727	-6.862	9	.000
Pair 2	pretest of shooting accuracy and posttests of shooting accuracy	-6.00000	3.94405	1.24722	-8.82141	-3.17859	-4.811	9	.001
Pair 3	pretest of speed dribbling and posttest of speed dribbling	.45600	.11702	.03700	.37229	.53971	12.323	9	.000
Pair 4	pretest of throwing accuracy and posttest of throwing accuracy	-.50000	1.58114	.50000	-1.63108	.63108	-1.000	9	.343

APPENDIX P-Independent sample test SPSS posttest result

Group Statistics

	Name of respondents	N	Mean	Std. Deviation	Std. Error Mean
posttest of hand grip strength	1	10	26.60	2.221	.702
	2	10	29.40	.699	.221
posttests of shooting accuracy	1	10	24.5000	4.37798	1.38444
	2	10	29.5000	4.97214	1.57233
posttest of speed dribbling	1	10	5.6290	.14433	.04564
	2	10	5.1530	.16720	.05287
posttest of throwing accuracy	1	10	9.9000	2.33095	.73711
	2	10	9.8000	1.54919	.48990

1= experimental group, 2= control group

Independent Samples Test

		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
posttest of hand grip strength	Equal variances assumed	10.125	.005	-3.803	18	.001	-2.800	.736	-4.347	-1.253
	Equal variances not assumed			-3.803	10.766	.003	-2.800	.736	-4.425	-1.175
posttests of shooting accuracy	Equal variances assumed	.000	1.000	-2.387	18	.028	-5.00000	2.09497	-9.40136	-.59864
	Equal variances not assumed			-2.387	17.716	.028	-5.00000	2.09497	-9.40642	-.59358
posttest of speed dribbling	Equal variances assumed	.000	.996	6.815	18	.000	.47600	.06985	.32925	.62275
	Equal variances not assumed			6.815	17.624	.000	.47600	.06985	.32903	.62297
Posttest of throwing accuracy	Equal variances assumed	2.279	.148	.113	18	.911	.10000	.88506	-1.75944	1.95944
	Equal variances not assumed			.113	15.653	.911	.10000	.88506	-1.77963	1.97963