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Effects of Core Strength Training on Passing Technical Skills and Selected Physical Fitness Qualities of Male Junior Volleyball Trainees

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DEPARTMENT OF SPORT SCIENCE

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A THESIS SUBMMITED TO SPORT ACADEMY, BAHIR DAR UNIVERSITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN VOLLEYBALL COACHING

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Approval of Thesis for Defense

I hereby certify that I have supervised, read, and evaluated this thesis titled **"Effects Of Core Strength Training on Passing Technical Skills and Selected Physical Fitness Qualities of Male Junior Volleyball Trainees "** by **Seid Teshome** prepared under my guidance. I recommend the thesis be submitted for oral defense.

Advisor's name	**Signature**	**Date**

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Approval of Thesis for defense result

We hereby certify that we have examined this thesis entitled **"Effects of Core Strength Training on Passing Technical Skills and Selected Physical Fitness Qualities of Male Junior Volleyball Trainees" by Seid Teshome.** We recommend that the thesis is approved for the degree of "Masters of Science in Volleyball Coaching".

Board of Examiners

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DECLARATION

I, **Seid Teshome,** hereby declare that the material contained within this research now submitted to the Sport Academy of Bahir Dar University in partial fulfillment for the award of Degree of **Master of Science in Volleyball Coaching** is entirely my own work. I have followed all ethical principles of scholar in the preparation, data collection, data analysis and completion of this thesis. Any materials accessed and utilized and ideas acquired in the process of conducting this research have been cited and acknowledged. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every serious effort has been made to avoid any plagiarism in the preparation of this thesis.

Student's Name…….

Signature…….

Date……

DEDICATION

This thesis is dedicated to my mother Mulunesh Asfaw and my father Teshome worku

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I would like to express my deepest gratitude to Mr. Chalachew Chekol for his constructive comments and encouragements throughout this study. It would have been impossible to complete this study without his unreserved support and guidance. Had it not been his whole follow patience and cooperation this research would have been much more difficult.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANRS	Amhara National Regional State
BDU	Bahir Dar University
BL	Bottom left
BR	Bottom right
CG	Control Group
DHHS	Department of Health and Human Service
EG	Experimental Group
MD	Mean Difference
N	Number
POT	Post Test
PT	Pre Test
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
TL	Top left
TR	Top right
USDHHS	United States Department of Health and Human service

ABSTRACT

Strengthening the core muscles is a significant component in minimizing sports injuries, speeding up rehabilitation, and boosting application of technical skills and physical abilities. The purpose of this study was to investigate the effect of core strength training on passing technical skills and selected physical fitness qualities. The study employed an experimental research design. The target population of this study were male volleyball trainees of Bahir Dar University (N=22) with the age of (EG=14.82±0.751, CG =15.00±0.775) were participated by using comprehensive sampling technique and randomly assigned into two equal groups. Both the experimental group (EG, n = 11) and control group (CG, n = 11) participated in the regular volleyball training, but only EG performed additional core strength training for 10 weeks, with 3 sessions per week, each lasting 40 to 60 minutes. Subjects were measured on forearm passing accuracy, overhead passing skill, muscular endurance, explosive power and flexibility on two occasions, first before administration of core strength training as pre-test and after 10 weeks of the training as post-test. The data collected from the study subject was analyzed using SPSS version 26 software by ANCOVA to compare between groups post tests and to observe the effect sizes of core strength training on passing performance and physical fitness qualities at 0.05 level of significant. The results showed that core strength training had large effect size and significantly improved forearm passing accuracy, overhead passing skill, muscular endurance, explosive power and flexibility in EG at (P<0.05). However, no significant improvements were found in all the variables in CG (P>0.05). Based on this finding, it can be concluded that core strength training has significant effect on improvement of passing performance and physical fitness qualities of volleyball players. Therefore, this type of training method is suggested to volleyball players and coaches to include in their training sessions for improvement of passing technical skills and physical fitness qualities.

Key words: core strength training, volleyball, physical fitness

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Volleyball is one of the most popular ball games in the world which is played by hitting an inflated ball with hands, forearms, head, or any part of the body. It is a team sport, which is played by two teams, on playing court divided by a net (Povovas et al., 2012). In addition it is a sport that is widely used in society for educational, recreational, and competitive purposes. It is a team sport supported by physical, technical, tactical, and mental elements that show in the form of an attack by dropping the ball into the opponent's territory (Klob, 2016). Volleyball players with excellent technique, tactic and physical condition can achieve success if they systematically develop their basic motoric features like strength (Turna, 2020).

Accordingly, Strength is a bio-motor ability determining effectiveness in sports branches. It is generally described as the ability to withstand resistance or the ability to endure against resistance at a certain level (Boyle, 2004). Increasing muscular strength provides a significant advantage to athletes in all sport branches. Developing groups of the most commonly used muscles in a certain sports branch is the further specialization of strength. Various training methods were developed as a result of scientific research on increasing muscular strength. One of these methods is core strength training method (McGill, 2010).

As Shinkle et al, (2012) definition, the core is considered a box with the abdominals and gluteal in back the diaphragms the roof, oblique's, as the side and the pelvic girdle and hip girdle musculature serving as the bottom. Also core can be defined as a part of body providing adequate support for lower and upper extremity movements during an athletic performance (Dendas, 2010). In other words, the core concept can have described as the combination of muscle groups "forming the body, supporting and surrounding the spin, having an active role in the integrity of the muscle groups in the upper and lower limb power switch" of volleyball players (Boyacı et al., 2018). Moreover, strengthening the core muscles is an important factor for avoiding sport injuries and speeding up the returns to the field for rehabilitation along with improving the physical performance. So that core concepts in the field of volleyball has been identified as an important component for "functional athletic performance" (Hibbs et al, 2008; Dendas, 2010).

Furthermore, core training is a kind of exercises done with the individual's own body weight and aiming to strengthen the lumbo-pelvic muscles and deep muscles that keep the spine balanced (Atan, 2013). A well-trained core region is required for high-end fitness, optimal performance, and injury prevention. Likewise, the development of the core region muscles means the stabilization of the body's balance mechanism and the provision of a proportional force development in the body. Force training without giving importance to the core area will create risks of injury for the athletes and limit their technical skills (Mcgill, 2010). Additionally, A good core zone will allow the athlete to load more and at the same time ensure that technical movements are displayed more efficiently and well. Along with core strength training the game of volleyball requires a well-developed physical fitness quality and technical skills (Povovas et al., 2012).

Physical fitness is the ability of players to play the game without undue fatigue, with the ability of players to jump vertically high and the ability of players to move joints fully Haskell & Kiernan, (2000) and Kwong, and Oil, (2010). According to (Perumal, 2016; Tanwar, 2013). Volleyball players need physical fitness qualities including muscular endurance, explosive power, and flexibility. To perform jumping efficiently, leg power and core strength should be developed (Manshouri, et al., 2014). Diving and lateral movements also require flexibility (Billot, 2010). Muscular endurance should be developed to play in long duration (Clanton, 1997). Hence, volleyball players should develop specific physical fitness qualities via different trainings including core strength so as to effective and for acquiring an excellent volleyball performance. Moreover Volleyball players are expected to improve their entire volleyball technical skills level in addition to their physical fitness. (Chittibabu, 2014).

According to Willardson, (2013) Volleyball is a highly explosive sport, volleyball players generate high levels of force when spiking or approach jumping and absorb high forces when diving, landing, or blocking, due to this strengthen the core which is power generating center of the body is vital for developing physical fitness qualities and technical skills. Since the core region is strong, it prevents other muscles from being damaged. Proportionally improving the body strength of the player will make it easier to learn and apply technical skills (Mcgill, 2010).

Technical skills are the mastery of volleyball's certain basic aspects, such as serving, passing and setting, spiking, blocking, and digging. A technique is a method of accomplishing a goal that

requires the application of specific skills or expertise. The strategy of a volleyball offense has been to receive the ball from the opponents and return it with an attack play. The attack play developed from three main skills, the forearm pass to receive the ball and pass it to the setter; the overhead pass to set the ball to a spiker; and the spike to hit the ball forcibly into the opponent's court. Czerwinsk & Taborsky, (1947).

Finally, Volleyball players throughout practice and matches are in defensive and passing posture for prolonged periods of time. Unfortunately, passing and defensive posture causes a lot of strain on their lower back and also causes their hips to be very tight and injury potential is high. As a result, strengthen the core area is vital not only necessity to play volleyball at highest level, but of critical importance to protecting the all-important spine (Reid, 2019).

Based on the above explanation, the aim of this study was to determine effects of core strength training on passing technical skills and selected physical fitness qualities among Bahir Dar University junior male volleyball trainees.

1.2. Statement of the Problem

Volleyball is a team sport that necessitates a variety of skills. Physical fitness and technical skills are the most important assets in volleyball, and they are the foundations of any sport (Chittibabu, 2014). As a result, it is indisputable that these essential attributes can be developed through training. One of the key duties of the training process that leads to the growth of player performance is physically and technically preparing the players for volleyball game demands.

So that, strengthening the core muscles is a significant component in minimizing sports injuries, speeding up rehabilitation, and boosting application of technical skills and physical abilities. As the term "power region" or "power house" might be used to describe the core. And also, it is the location where the body's center of gravity is located and, more significantly, where all motions begin (Dendas, 2010).

Providentially, the researcher able to observe many parts of a training session, as the trainees were juniors there was lack of physical fitness and passing performance for BDU junior male volleyball trainees. Besides, when speaking of the core region the first thing that comes to the minds of not only athletes but also the trainers is abdominal region. However, Core region covers the part from the neck to the gluteal area, as upper and lower extremities work in harmony in our body (Otman, 2012). Furthermore, trainers have provided less attention to physical fitness & players yet not enough to fit to applying volleyball passing technical skills efficiently. The majority of their trainings were only focused on volleyball games, deprived of incorporating physical fitness activities and volleyball fundamentals. This trend may have resulted in players developing lower levels of fitness and technical skills than planned. If the training session continues in the same manner, players' physical fitness and technical skills may be hampered.

Scholars such as Tim Gabbett (2006), on the other hand, claim that only game-based training has no influence on volleyball players' physical condition. Szabo (2014) validates that developing physical fitness in order to have a positive impact on players' performance is one of the most important aspects of coaching.

Although some studies reported core strength training has significant effect on vertical jumping, upper and lower extremity strength, and balance; spiking and service performance among volleyball players (Bilici, & Selçuk, (2018), karacabey k. *et al(* 2016), , Yapıcı, (2019), and

Şahin, & Özdal, (2020)). These trials revealed that core strength training enhanced volleyball player's physical fitness qualities and technical skills. However, the existing literature does not provide strong evidence in this view, particularly on forearm passing accuracy and overhead passing skill of volleyball players and other physical demands, especially for male junior volleyball trainee's age between 14-16 years. Moreover, training like core strength has not been well emphasized by coaches of the training center when it compares to its benefit locally in Bahir Dar University male volleyball trainees. Hence, this was also the source of inspiration for the researcher which initiated him to conduct a research on the pre described issue to fill the gap.

Therefore, the purpose of this study was to determine effects of core strength training on passing technical skills and selected physical fitness qualities of Bahir Dar University junior male volleyball trainees.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of the study was to investigate the effects of core strength training on passing technical skills and selected physical fitness qualities among Bahir Dar University junior male volleyball trainees.

1.3.2. Specific Objectives

In addition to the general objective above, the study addressed the following specific objectives:

1. To measure the effect of core strength training on forearm passing accuracy of junior volleyball trainees.
2. To find out the effect of core strength training on overhead passing skill of junior volleyball trainees
3. To examine the effect of core strength training on explosive power of junior volleyball trainees.
4. To analyze the effect of core strength training on muscular endurance of junior volleyball trainees.
5. To determine the effect of core strength training on flexibility of junior volleyball trainees.

1.4. Hypotheses

The study has attempted to test the following hypotheses.

1. H_0 1: Core strength training may not have significant effect on forearm passing accuracy of junior volleyball trainees.
2. H_0 2: Core strength training may not have significant effect on overhead passing skill of junior volleyball trainees.
3. H_0 3: Core strength training may not have significant effect on muscular endurance of junior volleyball trainees.
4. H_0 4: Core strength training may not have significant effect on explosive power of junior volleyball trainees.
5. H_0 5: Core strength training may not have significant effect on flexibility of junior volleyball trainees.

1.5. Significance of the Study

The study intends to signify the following importance:-

- The study may increase the awareness of volleyball trainees to engage in core strength training to boost their physical fitness and volleyball passing technical skills level.
- It may provide a suitable ground for volleyball coaches to have core strength training program for their players throughout their training plan.
- It may help physical education teachers, coaches and sport science experts to know further about the effect of core strength training on physical fitness and technical skills.
- It could serve as an important resource for those who want to pursue similar studies.
- It may also help other researchers as a spring board to conduct further researches

1.6. Delimitation of the Study

This study was delimited in the following areas

- The study was delimited to Bahir Dar University male volleyball trainees, aged between 14 to 16 years.
- Selected dependent variables were volleyball passing performance, explosive power, muscular endurance and flexibility. Whereas independent variable was delimited to core strength training.
- Type of core strength training was confined to anterior and posterior core muscles using trainees own body weight.
- The duration of the training period was three days per week and 40 up to 60 minutes per sessions for 10 weeks.
- The study was conducted in the year of 2014 E.C.

1.7. Limitations of the Study

The following limitations have been confronted in the time of study.

- Since the test items were many, tests were limited to specific tests that are easily monitored and administered.
- Subjects included in the study could not be controlled with regard to their life style, diet and habits which may have influenced their performance.
- Environmental factors which may influence the results of this study could not be controlled.

1.8. Operational Definitions of Key Terms

Core strength training: is simply performing specific exercise to strengthen the abdomen, lower back, and hips usually using free weight, or individuals own body weight.

Junior volleyball trainees: Subordinate volleyball players their age between 14 to 16 years.

Physical fitness qualities: The ability of players to play the game without undue fatigue (muscular endurance), with the ability of players to jump vertically high (explosive power) and the ability of players to move joints fully for diving and lateral movements referred to as flexibility.

Project: is a long term development of players, which is carefully planned and structured in order to improve volleyball trainee's performance.

Technical skills: The excellence of fundamental elements to play volleyball, (passing the ball to their teammates either by their forearm or overhead).

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Theoretical Framework of Strength Training

Strength training is a process of preparing sportspersons to develop strength or other aspects in sport (Gorden, 2009). Also strength training is any physical activity that causes the muscles to work against an additional force or weight (this concept is called resistance). That is why strength training sometimes called resistance training or weight training (Hongu, Michael & Patrick, 2015). In addition, it can be defined as the stimulus imposed by external resistance, which has the aim to develop strength and related aspects, usually using free weight, machines or own body weight (Mosby's Medical Dictionary, 2009). There are different factors besides the training itself, that affect the outcome of maximal power as morphological features including fiber type contribution to whole muscle areas, muscle architectural features and tendon properties as well as neural factors including motor unit recruitment, firing frequency synchronization and inter-muscular coordination (Cormie, Guigan & Newton, 2011). Accordingly, the definitions given by Mosby's Medical Dictionary (2009) is directly related to this study, strength training refers to performing exercises by using free weight, machines and by using own body weight. Strength training has significant benefit for athletes in terms of increasing muscle mass and decreasing risk of injury. Strength training has been growing in popularity in recent years. Extensive research reveals that not only is resistance training an effective method for improving muscular strength, endurance and power, but it is also effective for improving the health status of most individuals-not only competitive athletes. Moreover, strength training provides various benefits (Hongo et al, 2015). Moreover, upper, middle and lower body muscle strength is required to perform jump serve, passing, dig and spike and to demonstrate aggressive blocking in volleyball (Zhang, 2010). Abdominal, back and hip muscle strength played an important role for explosive jumping and powerful hitting, diving and digging in volleyball. It provides the muscular link between the upper and lower body and by this means assists force summation (Hughes, 2014).

2.2. The Concept of Core

The “core” is comprised of several groups of muscles including the transversus abdominus, multifidus, diaphragm and pelvic floor muscles. These muscles work together to produce maximum stability in the abdominal and lumbar (lower) back region, as well as coordinate the movement of the arms, legs, and spine. Likewise, engaging these muscles is not something that most people do consciously, therefore it is important to learn how to effectively co-contract these muscles while performing these rehabilitation exercises (Dasteridis, 2011). Similarly, the core is the foundation for your movements, enabling mobility in the upper and lower body, directing power efficiently to your limbs, and stabilizing your spine, ribcage, and pelvis against the stress of those movements, or of external forces exerted upon them Thurgood, G., & Paternoster, M. (2013).

2.3. The Core Muscles

2.3.1 The Anterior Core Muscles: are the muscles to the front and sides of your abdomen which drive core movement while supporting your spine by maintaining pressure inside the abdomen and the chest. The muscles of the hips and abdomen are the anterior core muscles work with those of the back and buttocks in supporting and stabilizing the spine, and are important in driving rotational movement and hip flexion. Together with the lumbar region of the back, these muscles play a vital role in building core strength, Thurgood, & Paternoster, (2013). This includes:

2.3.2 The Posterior Core Muscle: are the core muscles of the back (posterior core muscles) are built up in layers around the skeleton. These muscles provide strength, support, and stability to your spine, and drive hip movement. That includes the muscles of the back and buttocks. The posterior core muscles work with those of the abdomen and hips in supporting and stabilizing the spine against external movements, and controlling most of the movements of the hip joint Thurgood, & Paternoster, (2013).

2.4. Developing a Core Exercise Program

Exercise of the core musculature is more than trunk strengthening. Lack of sufficient coordination in core musculature can lead to decreased efficiency of movement and compensatory patterns, causing strain and overuse injuries. This motor relearning of inhibited

muscles may be more important than strengthening in patients with low back pain and other musculoskeletal injuries. A core exercise program should be done in stages with gradual progression. It should start with restoration of normal muscle length and mobility to correct any existing muscle imbalances. Adequate muscle length and flexibility are necessary for proper joint function and efficiency of movement. Muscle imbalances can occur where agonist muscles become dominant and short while antagonists would become inhibited and weak. One example of a muscle imbalance pattern includes tightness and over-activity of the primary hip flexor (iliopsoas), which in turn causes reciprocal inhibition of the primary hip extensor (Aurora, 1985).

2.5. Core Strength Training

All powerful movements originate from the center of the body out, and never from the limbs alone. Before any powerful, rapid muscle contractions can occur in the limbs, the spine must be solid and stable and the more stable the core, the most powerful the extremities can contract. Training the muscles of the core also corrects postural imbalances that can lead to injuries. The biggest benefit of core training is to develop functional fitness that is essential to both daily living and regular activities. Core strengthening exercises are most effective when the torso works as a solid unit and both front and back muscles contract at the same time, multi joint movements are performed and stabilization of the spine is monitored (Akuthota et al,2008). People seem to think core training is synonymous with abdominal training, which explains why various websites, blogs, infomercials, and trainers use the phrase to attract misinformed readers desperate for a six-pack. In truth, the core is much more than a six-pack, and it needs to be treated as such. And it’s time to destroy misconceptions about core training and restore its true meaning (Akuthota et al, 2008). Endless sets of sit-ups and leg raises will only take your core so far. Eventually, your core will need to support heavy weight under serious stress when you squat, dead lift, or press. Purposeful core action requires understanding its function. The core stabilizes and protects the spine by creating stiffness that limits excessive movement in any direction most notably extension, flexion, lateral flexion, and rotation. In lifting terms, the core's responsibility is to limit movement (Afyon. 2014). Think about the core through the scope of strength exercises like the squat, dead lift, bench press, and overhead press. These movements require the spine to hold a rigid position so the hip and shoulder joints can move with force. The core muscles create the rigid spine position. To make the core stronger, you only need to let it do its job and protect

the spine when you put heavy loads in your hands or on your shoulders. From this perspective, every exercise is a core exercise. Complete an exercise with good form and you trained the core to do its job. Consistently increase the load of an exercise using good form and you make the core stronger (Akuthota et al, 2008).

2.6. Basic Principles of Training

The basic principles of sports training are the guidelines for coaches, teachers and sportspersons for the formulation, implementation and control of sports training. These principles are valid for all aspects and elements of training.

2.6.1. Overload

A trainer has to be exposed to an overload stimulus at regular intervals for the induction of training adaptations. Overload stimulus can be manipulated by changing the mode of exercise, duration, frequency, intensity, and recovery period between training sessions (Bompa, 1999). Similarly, an overload training stimulus can also be imposed by altering nutrition and influencing the intracellular milieu before the training session. Exercise over loads must be increased gradually and they must also allow the body to adapt to avoid injury. In addition, varying the type, volume, and intensity of training load allows the body an opportunity to over compensate and recover. Therefore, loading should continue to increase gradually as adaption occurs. Moreover, when more is demanded, within reason, the body adapts to the increased demand.

2.6.2. Progression

To sustain increases in muscle development and performance, one constantly needs to progress the program by gradually increasing the demands placed on the body (Pearson et al. 2000). Gradual increase can be incorporated into a training program by manipulating any of the following training variables appropriately: increasing the number of exercises; increasing the frequency of training; increasing the repetitions in each set; decreasing the rest periods between sets and/or exercises; increasing the load utilized; or changing the speed of movement.

2.6.3. Specificity

This principle asserts that the best way to develop physical fitness is to train the energy systems and muscles as closely as possible to the way that they are used in a particular sport. The principle implies that to become better at a particular exercise or technical skill, it must be

performed. For example, to improve the core muscle of an athlete, an athlete must participate specifically in core muscle exercise. In particular, the principle of specificity states that adaptations are specific to the type of training stress. Also, it follows the success of the plan can also be tested regularly to confirm that specific goals have been met in preparation for the main competition (Lambert, 2006). Training for a sport result in physiological adaptations that are specific to the activity's movement pattern, metabolic demand, force generation pattern, contraction type, and muscle recruitment pattern.

2.6.4. Individualism

Every trainer's response to training is different and brings to sports activities based on their own capabilities and capacities. An appropriate training program should be modified to take individual differences into account. Young athletes are not physiologically or psychologically able to tolerate programs created for advanced athletes (Rhea et al., 2003). An individual's training capacity can be determined by biological and chronological age, training age, training history, stress, health status, and recovery rate.

2.6.5. Variation

To achieve the goals and objectives of individual training cycles, it is necessary to change the nature of exercise, the environment, the time of day of the session, and the training group. Variation has a great role in varying the training content to maintain the athlete's interest and motivation. Variation states that exercises should be changed regularly; therefore, players do not overstress a certain part of the body (Vincent et al., 2013). In addition, this principle implies that we should consistently change aspects of the workouts for the players. Nonetheless, training variations should always take place within ranges that are consistent with your training directions and goals.

2.6.6. Recovery

Players must get adequate rest between workouts in order to recover and be well prepared for the next training. The following are factors that need to be considered during the recovery process after a training session: 1. an athlete aged older than 25 years needs longer recovery periods than younger athletes (Bompa 1999). 2. Environmental conditions training and competing in the heat imposes more physiologic stress on the athlete and requires a longer recovery period (Noakes,

2001). 3. The type of training and competition that induces muscle damage requires longer recovery periods than activities that cause fatigue but no muscle damage or soreness.

2.7. Benefit of Strength Training for Volleyball Players

Strength training has enormous benefit. According to (William & Rately, 2014; Hongu, Micheal & Patrick, 2015, strength training has the following advantages.

- To improve strength and endurance, resistance training can be effective in the development of muscular strength, muscular endurance, power and flexibility and muscular mass in abroad range of people.
- To increase bone mass and density. Weight-bearing and resistance exercises can help protect against osteoporosis.
- To improve joint stability and balance, reducing the risk of falls.
- To prevent muscle mass by slowing down the loss of muscle mass by continually rebuilding muscles. Adults lose between five and seven pounds of muscle every decade after age 20. Only strength training prevents muscle loss.
- To reduce resting blood pressure, low back pain and the pain of osteoarthritis; improved energy level and increased confidence;
- To reduce symptoms of other chronic disease. Strength training can help to reduce the symptoms of depression, heart disease, type 2 diabetes and sleep disorders.
- To better concentration and sound sleep
- Enhances the immune system
- Lessons future tear of your body
- Increased muscle mass and decreased fat mass
- To facilitate metabolism
- Improve ability and perform everyday tasks
- Increase energy level
- Decrease the risk of injury

2.8. Theoretical Framework of Physical Fitness

Physical fitness has been defined by many scholars in different ways even though ―there is no universally agreed up on the definition of fitness and its' components (Abiyu, 2014). Baltimore et al., (2017) described physical fitness as the ability of the body to perform moderate to

vigorous levels of physical activity without undue fatigue and capability of maintaining such abilities throughout the life. Haskell & Kiernan (2000) physical fitness is defined as ―the ability of players to carry out games with vigor and alertness, without undue fatigue and with ample energy.

Garzon (2009) defined that physical fitness is the ability of a person to perform daily activities effectively with vigor and by traits and capacities that are associated with a low risk for the development of chronic disease and premature death. Wuest & Bucher (1995) described physical fitness as a set of physical attributes that allows the body to respond or adapt to the demands and stress of physical effort. As cited by Tim, Kwong, Russia & Oil (2010) defined physical fitness as the ability of players in relation to game, such as muscular endurance, vertical jumps, flexibility etc.

The definitions given by Tim, Kwong, Russia & Oil (2010); Haskell & Kiernan (2000) are directly related to this study. According to them, physical fitness qualities refers to the ability of players to play the game without undue fatigue (muscular endurance), the ability of players to jump vertically high (explosive power) and the ability of players to move joints fully for diving and lateral movements referred to as flexibility.

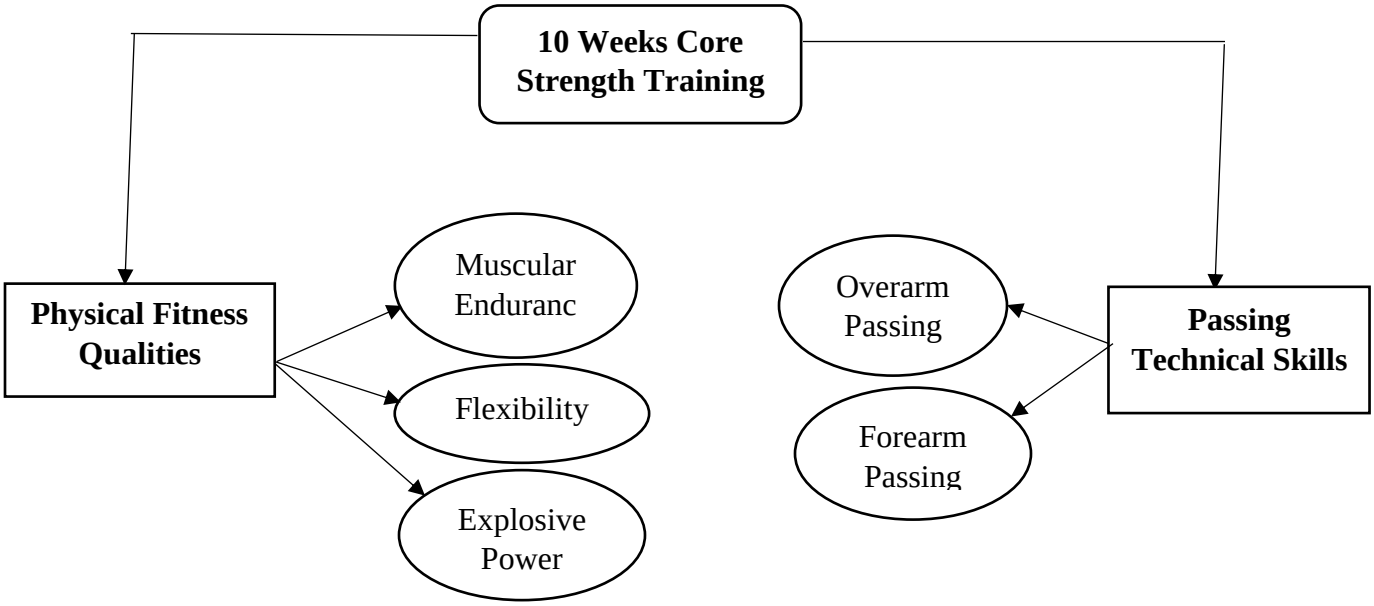

Figure 1: Conceptual Model of the Study

2.9. Physical Fitness Qualities of Volleyball Player's

Physical fitness has health related component and skill related components. Health related physical fitness components are components which are associated with the health of individuals which include; aerobic fitness, muscular strength, muscular endurance, flexibility and body composition (Olaitan, 2005). Besides, health related physical fitness includes those components of physical fitness that have shown to be more clearly related to health status and it could also relate to well-being and happiness (Garzon, 2009)

Furthermore, health related fitness: increases muscle tone and strength, decreases injuries and illness, improves bone mineral density, reduce risk of osteoporosis, improves posture, increases efficiency of the respiratory and circulatory systems, decrease risk of diabetes and some Physical fitness qualities Explosive Flexibility power Muscular endurance 20 cancers, improves self-esteem and self-confidence, decrease body fat and facilitate metabolism, increase energy level and academic achievement (Virginia, department of education, 2006).

Additionally, skill related components are physical fitness components which are associated with the performance of individuals and includes agility, balance, coordination, speed, power and reaction time (Wilmore & Costill, 2002).

However, physical fitness qualities such as muscular strength, muscular endurance and power and flexibility are important factors for success in competitive volleyball. Therefore, these capacities are discussed as follows.

2.9.1. Muscular Endurance

Muscular Endurance: - is a health-related component of physical fitness that relates to the muscle's ability to continue to perform without fatigue (USDHHS, 1996). For true assessment of muscular endurance it would be necessary to test each major muscle group of the body. Lab and field tests of muscular endurance are similar and based on the number of repetitions that can be performed by the specific muscle group being tested (example: repetitions of push-ups or abdominal curls). Muscular endurance can be measured isometric ally (static contractions) or isotonic ally (dynamic contractions) (USDHHS, 1996).

It has been shown by Corbin et al. (2003) that athletes and people interested in jobs requiring high-level performance such as curl-ups and sitting tuck are, likely to benefit from good muscular endurance fitness. According to Baumgartner and Jackson (1991), research people who train for strength gain as much endurance as those who train for endurance and vice versa. As female students, there is the vital need for muscular endurance development throughout life. Miller (1994) has postulated that muscular endurance is important in our daily activities such as walking, working, and playing which involves muscular contraction and relaxation, and that people who possess good muscular endurance are said to have a greater working capacity. Volleyball requires endurance capacity as the game lasts for long duration. Therefore, endurance capacities are very important to exhibit volleyball performance (Clanton & Dawigh, 1997).

2.9.2. Power

According to Sharkey, (1990) power is the ability to transfer energy swiftly in to force. And also, it is an explosive strength, is the ability to effectively integrate strength and speed to produce maximum muscular force at a maximum speed. Power is the rate at which energy is expended or work is done, and it is work divide by time, or the rate of doing work if one can perform the same work better than the other with in the same time interval, then we have got a better power. It combines strength (force) and velocity or speed (Distance/time). Moreover, Explosive power is the most essential part of most players' skills and enables players' activities during the games to be not only the required height and with the necessary power but also at the right moment. The standing long jump is a test for lower body power. This is a non-resistant exercise used to measure jumping ability. This test is very important because the ability to jump is a measure of power. In many sports such as volleyball, football and basketball, power is very important component for players. Power cleans and jerks are exercises that can be used to measure total body power. Power is important in vigorous performance because it determines how hard a person can hit, jump, and spike (Gordon, 2009).

2.9.3. Flexibility

Flexibility: -is a health-related component of physical fitness that relates to the range of motion available at a joint. Some experts specify that flexibility requires range of motion without discomfort or pain (Howley & Franks, 1997). And also, he stated that flexibility is specific to each joint of the body, thus there is no general measurement of flexibility as there is for

cardiovascular fitness. Flexibility is typically measured in the lab using measurement devices such as a goniometric, flex meter and in the field with test exercises such as the sit and reach, and the zipper. Miller (1994), suggest that active peoples are more flexible than inactive individuals. Since all the subjects were in their youthful ages and active in a wide range of movements, their loss of extensibility might be minimal. Another fact was that, the subjects were youths and their muscles were capable of stretching far enough forward due to the soft tissues (ligaments, tendons) of the joints, as well as the muscles. The inability to stretch far forward indicates tightness in the low back and hamstrings due to inactivity. Flexibility is important for volleyball players in diving to defend the hit ball and in lateral movements to receive the ball coming at the right and/or left sides (Billot, 2010).

2.10. General Directions for Fitness Program

Many different agencies and organizations have distributed guidelines for various types of physical activity in recent years; the general public may be confused concerning which activity guidelines to follow. The best of guide lines are well supported by scientific evidence and endorsed by respected experts. However, as the (ACSM, 2000), indicates physical activity prescription is both an art and a science. It is important that all people who apply physical activity guidelines understand the scientific reasons for the guidelines and use them artfully with consideration for those to whom the guidelines are being applied (Carbin et al.., 2000).

According to the New Jersey fire department, (2007), the fitness program is divided into the following sections: warm-up, strength and muscular endurance exercises weight training and calisthenics, Aerobic Training Exercises, and cool-down. The strength and muscular endurance exercises do not have to be done on the same day or during the same exercise sessions as aerobics program. In other words, they may be done on separate days or at different times on the same day. However, every exercise session should be preceded by a warm-up period and followed by a cool-down period. The warm-up exercises are designed not only to get a person physically and mentally ready for the muscular and or aerobic exercise sessions, but also to help develop flexibility in various joints.

2.11. Benefits of Physical Fitness for Volleyball Players

As Bucher (1993) physical development objective help build big muscles and develop the human organic system (organic refers to the digestive, circulatory, excretory, heart regulatory, respiratory and other systems of the human body). He stated in his book, it results in the ability to sustain adaptive efforts and recover. The short term and long term physiological and psychological benefits of physical fitness and exercise are well documented. The Governor's council on physical fitness and nutrition believes that regular physical training is one of the most important things humans can do for their health. It can help:

- Control weight
- Reduce the risk of cardiovascular disease
- Improve core strength
- Contribute to productivity in the game and worksite
- Reduce the risk for type two diabetes and some cancers
- Improve bone and muscle strength

2.12. Factors Which May Affect Fitness Tests

According to Michael (N.D) Fitness tests are subject to a large number of internal and external variables which may affect the outcome of the test. When performing a repeat test, it is important to try to limit as many variables as possible by ensuring the conditions/circumstances are exactly the same as during the previous test.

- Time of the day
- Time since the athlete's last meal
- Weather conditions
- Athlete's emotions
- Environment (surface/noise)
- Athlete's state of hydration
- Presence of other people
- Test protocol not followed as before
- Different assessor colds/illness
- Athlete's health recent
- Accuracy of measurements
- Medication the athlete may be taking

2.13. Technical Skills of Volleyball

There are several offensive skills that all volleyball players must perfect to play at their best. The serve may be the most crucial component of the offence than others. Therefore, both ―effective serving and the passing of an opponent's tough, controlled serve are vital skills necessary to score points. In addition, players must have the ability to consistently transition from any kind of pass to an offensive strategy (Miller, 2005). To be successful, players must understand their role in the framework of court coverage and team flow. The game requires court coverage on and off the net; for this to be done successfully players must understand how to develop court awareness. They must learn how to position themselves on the court and move to the ball during play (Miller, 2005). In common with other team games volleyball consists of two elements, attack and defense, but unlike other games every player is required to master all the skills in both elements. Because every player will rotate on each position and may serve, receive, set, spike and block a ball (Smith, 2003)

2.13.1. Serving in Volleyball

A serve is a way of starting the game volleyball; it used to gain a point in the rally. Concerning to this, Palao (2013) expressed the serve must not only be legal but, put the opponents under pressure. To clarify, the serve should never be received with a volley. Serving is the only skill in volleyball where the individual player is in complete control of the ball. Although there are many different types of serves, common guiding principles should be applied to every serve. The objective of the serve is, minimally, to put the ball in play and, maximally, to score a point. The easiest way to score a point is to make the serve difficult to pass. Being able to serve different types of serves will keep the opposing team off balance with their passing. Any type of serve with good speed will give the opponents less time to react to the ball coming over the net. This, in turn, gives them less time to get in a good position to pass the ball properly or communicate with a teammate if the ball is served to a seam between two players. An aggressive serve is a way of keeping the opponents ―out of their offensive system‖ and out of rhythm. Other variables to consider in serving include the velocity of the serve, where the server is located along the end line as well as the distance behind the end line, and the target or zone where the ball is served into the opposing team's court. Obviously players will miss serves periodically. Remember, it is better to miss the serve long or wide than to serve it into the net and not give the

opponents an opportunity to decide whether or not to play the ball. There are several guiding principles that you and your players must be aware of when serving:

- There is a point scored on every serve.
- The serve is the only skill in volleyball where the player has control over all factors, such as location, velocity, and trajectory.
- If there is a serving error, the other team scores.
- An aggressive serve has a better chance of taking the opponents out of their offensive system or rhythm.
- There should be more aces than errors.
- Players should use the same routine each serve, which includes taking a deep breath, selecting a target, and serving.
- Simple, efficient mechanics lead to repeatability and more success.
- Always practice serves in game like situations (Palao, 2013)

2.13.2. Passing in Volleyball

Passing is used in its many variations to receive serves, free balls, down balls, or even tips or attacks. The forearm pass is the most common form and is usually used for any ball coming over the net that is too low to play using an overhead pass. Passing is one of the most important skills in volleyball and is a key to whether a team is successful. Being able to receive a serve and accurately pass it to the setter, whether using a forearm or an overhead pass, will determine the offense the team will be able to use. Poor passing will limit the team's options in setting the attackers. Successful passers have good vision, movement, and eye–hand coordination. They are confident and communicate quickly and effectively with teammates before and during the play. Two techniques for passing are discussed here, with forearm passing being the most popular and overhead passing being for more advanced players (Reynaud, 2011). Passing can be seen in two main categories- receiving with forearm pass, and receiving with overhead pass.

Dig/Forearm is an individual defensive skill performed by players to deflect the ball up off their forearms. The defensive player will read the play as it develops position themselves around the blockers, and prepare to keep a ball hit by an attacker off the floor. If the blockers and the back-row defenders work together to cover the court, it can make very exciting action (Reynaud,

2011). It is used to receive the serve safely and play the ball to the setter in the front court. It is also the main technique used to play the opponents' smash. Harries, (1992) concluded as: in volleyball game, forearm pass is better to receive the ball coming directly from opponents serve and to handle the ball which is hardly hit by the opponent spiker/smasher. Due to the smashed or the served ball may be too fast and hardly heavy. Dig pass is better to receive the serve and the ball being hit by the spiker without or with less injury.

According to Reynaud (2011), there are several guiding principles that you and your players must be aware of when passing:

- Angle of arms at contact is the key— knows the coming ball angles.
- Keep the head in front of the feet.
- Arms and body act independently.
- Arms move faster than the body to pass from outside the midline.
- One motion to the ball.
- Less movement means more repeatability.
- Passing needs to be consistent under pressure.

2.13.3. Setting / Overhead Pass in Volleyball

Setting is one of the basic skills in volleyball and is preparing the ball for the attack**,** which varies not only in their position along the net, but also in their height above the net (Baxter, et al., 2003). The volley pass sometimes referred to as the overhead pass (over arm pass), is the most accurate method of passing the ball during a rally (Benedict, 2009). However, it is the most difficult of all the techniques to learn and master. Setting skills classified as front set, back set, jump set, quick set, play set and back row set, and declared that back set and play set were better to fake opponent players than others (Neville, 1994). There are number of different sets in volleyball game during attacking: high sets, shoot sets and short sets. Variety of setting enables a team to make it more difficult for the opposition to anticipate where the attack is coming from (Nichillis, 1995). The significant of shoot set as; the shoot or fast set to the side of the court is difficult not only to play, but also to hit. Its main advantage is in speeding up the attack so that the opposition does not have time to get a good block in position (Thomas, 2017). In addition, overhead pass is essential to receive the ball served with underarm serve (soft), and the ball

coming from the opponent player hit by finger (setting). It is better to set the ball for spike accurately than forearm pass (Harries, 1992).

2.13.4. Spike/Smash/ Attack in Volleyball

Smash involves the players jumping to gain as much height as possible and then hitting the ball with the hands, down across the net in to the opponents' court (Blatter, et al., 1979). Hence it is obvious that leg power is required to climb over explosively. Players like to jump up and hit the ball hard in to their opponents' court and quite roughly so. However, the smash or spike is very difficult, and does not always score, and it is the most exciting part of volleyball game‖ for most players. The spike/smash in three perspectives – the dump, the tactile ball, and the off-speed attack (Nambaka, 2011).

According to Reynaud (2011), the attack, also called a spike or a hit, is the most popular and exciting skill in the sport of volleyball. Most players want to work on the technique for their attack as much as possible. It is a very difficult skill in which the player jumps in the air to hit a moving ball over the net while avoiding the opposing blockers. The attacker's goal is to direct the ball around, over, or off the blockers' hands or to hit the ball down into the opposing team's court away from the defenders. The attacker can hit sets from her on-hand or off-hand side. On-hand refers to a ball that comes from the right side of the court to a right-handed hitter. This is the easiest ball to hit since an attacker can contact it before it travels across her body. Off-hand refers to a ball that comes from the left side of a right-handed hitter. These balls are more difficult to hit because they must travel across the attacker's body and drop in front of her right shoulder before she can hit it. For a player to hit any ball she is set, she must have her body in the correct position every time. She can do this using efficient footwork and by getting the hitting arm fully extended, with the ball slightly in front of her hitting shoulder. There are several guiding principles you and your players must be aware of when attacking:

- Attackers should be able to put the ball away.
- Attackers should be able to keep the ball in play.
- Attackers should make as few unforced errors as possible (Reynaud, 2011).

2.13.5. Blocking in Volleyball

Blocking is the first line of defense in volleyball is the act of jumping up and placing the hands above and over the net to keep the ball on the opposing team's side of the court. This can be done by positioning your blockers so they essentially eliminate a part of the court from the opponent, forcing the attacker to hit the ball into the block or to hit the ball in a different direction toward the back-row defenders or with different speed than she wanted to. Blockers may deflect the attack attempt back into the opposing team's court or back and up into their own court for a teammate to play the ball or may force the attacker to tip or hit the ball off-speed. A well-positioned block may never touch the ball, but it can channel the spike toward the defenders placed in the court around the blockers. The best blockers are players who understand the game and have good timing on their jump to get their hands across the net at the correct time. Good core strength will help blockers stabilize their bodies 30 in the air while keeping their shoulders, arms, and hands in place when an attacker hits the ball into them (Reynaud, 2011).

2.14. Effects of Core Strength Training on Physical Fitness Qualities and Technical Skills of Volleyball players

Power, muscular endurance and flexibility are needed to block, dive, set, serve and passing. Strength to the development of these specific skills through the use of strength training enables volleyball players to reach their full potential. Volleyball players can mimic the exact movements needed during a game while performing strength training to build quick and strong muscles fibers that contract quickly and explosively for greater flexibility, mobility and power in the execution of those targeted game time skills. Although volleyball is considered a non-contact sport, injury often occurs because of the act of continuous jumping, diving, and high volume of movements. Therefore, volleyball players must develop their strength properly to protect the lower back, pelvis, legs and knees. Strength training helps players protect their joints and reduce the risk of injury as they build explosive power, endurance, move more freely, and achieve a greater range of motion (Widmer, 2020).

Passing is difficult skills to master. It takes speed, direction, position, technique, flexibility, endurance, and much more to dominate the competition. Performing volleyball techniques with strength training has advantage to control the game (Widmer, 2020). The volleyball sport

demands repetitive movements of the upper, middle and lower muscle groups. Body muscle strength training is required to perform jump serve, passing and spike and to demonstrate aggressive blocking in volleyball. Strength training is important in offensive, defensive and in minimizing mistakes in basic techniques of volleyball (Zhang, Y., 2010).

Any training has positive or negative, direct or indirect effect on certain variables. So core strength training has an effect on physical fitness variables and volleyball technical qualities. It has an effect on different aspects, for instance, it has an effect on some physical fitness components such as muscular strength, muscular endurance, power, flexibility and volleyball techniques such passing technical skills.

2.14.1. Effects of Core Strength Training on Muscular Endurance

Different researchers have been reported that core strength training has significant effect to muscular endurance quality, for instance Research conducted by Gaganpreet & Jogiswar (2019) on effect of core specific fitness training program on muscular endurance of school going children. The researcher has selected a total of 40 participants whose age ranged between 15 to 18 years. The participants were divided on control and experimental group having 20 members each. All the participants were school going children and regularly participated in physical activity classes. The experimental group has received the planned training program whereas the control group did not get any training program. The results of the study have shown positive and significant impact of core specific training program on muscular endurance of school going children.

Correspondingly, the study was conducted by Boyaci, & Tutar, (2018) on effects of the quad-core training on muscular endurance. The research was applied in the age range between 13-15 school's football team. Core exercise program for young athlete’s muscular endurance was applied for 10 weeks, 3 days a week, 20-25 minutes (warming) in addition to the school team soccer practice. As a result, the 10-week Core training athlete’s muscular endurance has been developing in a positive direction. In this regard the researcher wants to investigate effects of core strength training specific to volleyball players age ranges between 14 to 16 years.

2.14.2. Effects of Core Strength Training on Explosive Power

Different researchers have been reported that core strength training has significant effect on explosive quality of athletes, for instance research was conducted by Dinç, N., & Ergin, E. (2019) on Effects of 8-Week Core Training on Explosive Force Performance. 28 athletes volunteered in the study. The athletes were separated into two groups: the experimental group (n=15) with the average of age and weight of 19.5 ± 1.2 years and 64 ± 8.9 kg, respectively and the control group (n=13) with average age and weight of 19.4 ± 1.5 years and 67.4 ± 10.3 kg respectively. During the intervention, both groups continued their normal training sessions for 8 weeks. The experimental group performed thirteen core movements 3 times a week for 8 weeks, while control group did not. The experimental group performed each movement with 20 repetitions of 3 sets and a 1-minute rest between sets. As a result, 8-week core strength training intervention showed positive effect on long jump were observed. Similarly the findings of Şahin, & Özdal, (2020) conducted on effect of core exercises on vertical jump of volleyball players. This confirmed that the core training program has positive effects on vertical jump when applied with volleyball training. The researcher desires to investigate similar study particularly in volleyball players the age ranges 14 to 16.

2.14.3. Effect of Core Strength Training on Flexibility

Different researchers have been reported that core strength training has significant effect on flexibility, for instance research was conducted by Gaganpreet & Jogiswar (2019) on effect of core specific fitness training program on flexibility of school going children. To get the answers to the questions, the researcher has planned a very scientific core specific fitness training program for the implementation. The researcher has selected a total of 40 participants whose age ranged between 15 to 18 years. The participants were divided on control and experimental group having 20 members each. All the participants were school going children and regularly participated in physical activity classes. The training of the participants was conducted for 12 weeks for 4 days a week. The results of the study have shown positive and significant impact of core specific training program on flexibility of school going children. In addition to the above the researcher desires to identify the effect of core strength training specifically on teenage of volleyball players for ten weeks of training.

2.14.4. Effects of Core Strength Training on Passing Technical Skills

Volleyball passing is the first volleyball hit in the three-step process. Volleyball passers are the players in the back row, prepped and ready with quick feet to move forward, backward, or laterally around the court at any and all necessary times. When the volleyball is served deep, a volleyball passer is able to use their forearms to pass the ball with great timing and accuracy. If the volleyball is served short, a front row player has the ability to pass the volleyball overhand. No matter which way a volleyball player passes the ball, the passer must maintain a balanced athletic position that allows for multi-directional movement. A passer must squire up the hips, feet, knees, and shoulders in order to remain balanced and in control to make a great passes (Widmer, 2020).

Moreover, different researchers have been reported that strength training has significant effect on passing skill level of volleyball players, for instance research was conducted by Selvakumar & Palanisamy (2017) on effects of strength and polymeric training on passing skill performance of male volleyball players. The result of 12 weeks strength training has significant effect on passing performance of experimental group compare to control group. However, the existing literature does not provide strong evidence, particularly effects of core strength training on technical qualities of volleyball players. Accordingly, the researcher needs to determine the effects of core strength training on forearm passing accuracy and overhead passing skill of volleyball trainees.

2.15. Factors that Affect Physical Fitness Qualities and Technical Skills Level of Volleyball Players

Training: It is perhaps not surprising that high levels of training or practice are required to attain performance of volleyball players. Skill development clearly supports the relationship between training practice and skill acquisition. Vigorous physical fitness training will be conducted 3-5 times per week. For optimal results players must strive to conduct 5 days of physical training per week (headquarters of US army, 1998). Training improves the function and capacity of the body such as respiratory system, cardiovascular system, etc. for instance, strength training improves muscle's ability to produce energy via facilitating the muscle fiber (Sharkey, 1990).

Heredity: genetically we inherit have factors that contribute to our fitness and skills. for instance, in aerobic fitness, including the maximal capacity of the respiratory and cardiovascular systems, a large heart, more red blood cells and hemoglobin and a high percentage of slow oxidative and fast oxidative- glycolytic muscle fibers, mitochondria, the energy producing units of muscle and other cells, are inherited from the maternal side (Sharkey, 1990).

Talent identification: Talent identification is big business. From sports, through art, to education in all domains are attempting to find a way to identify the best in their field. However, finding the most effective and most efficient talent identification method is a 42 complex. Players who can identify their talent can be effective in volleyball sport. Talent identification is important to reach high performance in a short period of time (Bompa, 1994).

Players' diet: The importance of players' diet cannot be underestimated when planning the path to increase performance. If a player does not have a healthy diet, they will not be able to train as hard, will struggle to improve their competition and be more susceptible to tiredness (Stewart, 2001).

Facilities and equipment's: Availability of volleyball sport facilities and equipment's has tremendous effect on the development and popularity of players. If the facilities are comfortable to conduct the training program, it is easy to produce a number of outstanding top performer volleyball players. Well-developed volleyball sport specific facilities and equipment's, which allow players to train and improve in volleyball sport are important (David, 2005).

Finance: The role of finance in modern athletes now a day's become a huge factor in the players' performance. In order to be effective and successful within the growing sports industry, sport organizations must be very competitive on both a sport and financial level (Syzmanki, 1998).

Rest and recovery: It is not secret the body needs rest in order to function at its highest level. Players tend to be especially limited on rest time due to competition schedules, prolonged training days and work demands. During the period of rest that the body discards unnecessary information from the brain, heals and gains energy for the next day's activities (Fischer, 2008).

Anthropometrics: affect volleyball players' performance and it is possible that such characteristics differentiate players of a different competitive level. More successful teams are

taller and have lower body fat than less successful teams (Hasan et al., 2007). Therefore, players with a higher skill level are taller and have a higher fat free mass and players with larger hand can execute volleyball techniques easily.

CHAPTER THREE

RESEARCH METHODS

3.1. Description of the Study Area

The study was conducted in Amhara region, capital city of Bahir Dar located in West Gojjam Zone Ethiopia. Bahir Dar city is located in south west part of Ethiopia, about 565 Km North West of Addis Ababa. The town has a latitude and longitude of 11°36′N 37°23′E respectively and an elevation of 1,800 meters.

The study was conducted at Bahir Dar University, one of the pioneer universities found in the west part of Amhara regional state. Particularly, conducted at Bahir Dar University peda campus, the altitude of the campus is 2830 meter above sea level with a mean annual temperature of 14.84°C (FAO, 2006).

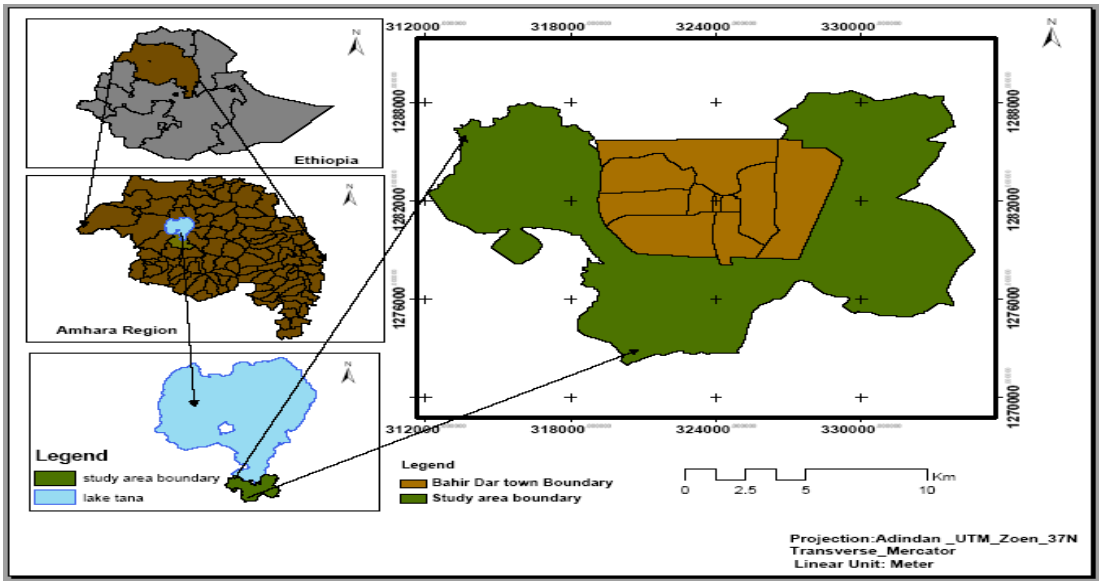

Figure 2: Map of Bahir Dar city and Bahir Dar University

3.2. Research Approach

As the study focused on the cause and effect phenomenon, the quantitative approach was used for its potential to provide with a lot of information. It is used to describe current conditions, investigate relationships, and cause and effect phenomenon (Mills, 2006).

3.3. Research Design

The research design applied for this study was true experimental research design. Because it helps to analyze the effect of core strength training (the independent variable) on passing technical skills level and selected physical fitness qualities of junior volleyball players (the dependent variable). In line with this view, Kothari (2004) stated that true experimental research is the means of research that can reliably test hypothesis and show cause and effect relation. The layout for this study is described as follows:

Treatment	Core strength training
Frequency	Three days per week
Total duration	10 weeks
Duration of training per session	40-60 minutes
Exercise day	Tuesday, Thursday, and Saturday
Time of training	Morning and afternoon

Table 1`: The Study Design Layout

3.4. Population, Sampling and Sampling Technique

The target population of this study were male volleyball trainees of Bahir Dar University (N=22), and have been trained for one year. To achieve the objective of the study, all project trainees were taken as a sample through comprehensive sampling method and randomly assigned in to two groups: the experimental group, EG (n=11), who were exposed to continuous periodical core strength training for 10 weeks, with 3 sessions per week, each lasting 40-60 minutes and the control group, CG (n=11), who underwent only regular volleyball training sessions.

3.5. Source of Data

To get adequate amount of information for this study, primary sources of data were used. The primary data were obtained from the results of field tests conducted from pre to post tests of both experimental and control group. Quantitative data were gathered through the appropriate volleyball passing technical skills tests and physical fitness test measures.

3.6. Study Variables

In this study, core strength training were considered as independent variable, whereas passing technical skills (forearm and overhead passing) and physical fitness qualities (muscular endurance, explosive power and flexibility) were considered as dependent variables.

3.7 Instruments of Data Collection

So as to collect the necessary data, tests (volleyball passing skill tests and physical fitness tests) of data collection tools were used. The aforementioned instruments or tests were used because the investigator believed that they are effective to collect in depth quantitative data. That is why (Dornyei, 2007) state that the most common and effective instrument to collect quantitative data in quantitative research approach such as experimental studies are tests. Instruments for the present study were adopted from scholars. The researcher has collected quantitative data through the appropriate volleyball passing skill tests and physical fitness test measures such as: wall volley test for overhead passing and passing to target test for forearm passing accuracy, sit up test for muscular endurance, vertical jump for explosive power and sit and reach test for flexibility. Before the experimental group going to core strength training, the pre-tests were taken from both control and experimental groups. Post-test was also taken from both groups after 10 weeks core strength training intervention completed for experimental groups.

3.8. Training Protocol

The trainees were divided in to two groups: experimental and control group. Experimental group was subjected to additional core strength training and control group followed standard volleyball training. Experimental group performed additional units of core strength training lasting about 40-60 minutes each session three times per week for 10 weeks. The training protocol focused on core strength training based on such exercises as free weight (body weight) exercises. The training load increased progressively throughout the experiment, changing the number of sets

and repetitions in accordance with standard training procedures. The training program has given based on recommendations of volume. Therefore, the researcher had prepared training session plan for experimental trainees. Which included warm-up, selected core strength exercise and few minutes of cool down. Indeed, all training sessions had been applied on the principles of physical exercise. The following components were studied in the study: passing technical skills namely: forearm passing accuracy and overhead passing, and physical fitness qualities specifically: muscular endurance, power and flexibility were measured. The data were collected on two days during pre-test and after 10 weeks of core strength training again had taken two days and collected the post test result. On the first day sit up, vertical jump (using wall and chalk), sit and reach test were measured whereas forearm passing accuracy and wall volley passing technical skill test were measured on the second day.

3.9. Procedures for Administration of Tests

The researcher followed standard procedures for testing the selected variables and register on the record sheet in the direct supervision of subjects. In order to determine effects of core strength training on selected variables, all pre-test measurements were done within the first week prior to the beginning of the 10 weeks training program, while post-tests were performed within the first week following the completion of the training program. The participants were performed enough warming up and stretching exercise to all tests at the beginning. The testing sessions were consisted of tests interspersed with rest. All tests were explained and demonstrated. Before testing, subjects were given practice trails to become familiar with the testing procedures. Subjects were performed each test as per test procedure. Moreover, detail descriptions of each test that were conduct for this study followed the following procedures.

3.9.1. Volleyball Passing Technical Skills Tests

I. Forearm Passing Accuracy Test

Objective: To measure forearm passing accuracy

Equipment: Cone or chalk, one meter height box

Procedures: The passing ability of the players is evaluated by determining their ability to return a pass to a target positioned at the net 2 m from the right-hand sideline. The target dimensions were 1.6 m long and 2.3 m wide. This target was chosen because it was located at the approximate position at which the setter would stand during a match. A coach-positioned in the service position, approximately 1 m above the ground and 10 m from the receiving player-threw an overhead pass to the receiving player. The coach assumed the position above the ground to ensure that the ball took the trajectory that might be expected from a ball that was served or spiked by an opponent. Players are required to forearm pass (dig) the ball to another player standing with arms extended above the head in the target area. A second target area is created for passes that did not make the main target area but would be likely to reach another player in a match situation. The second target extended from the right-hand sideline and is 3 m long and 4.1 m wide.

Scoring: Players who successfully passed the ball to the player in the first target area are awarded 2 points. And also, Players who successfully passed the ball within the second target area were awarded 1 point. Finally, a pass that did not reach either of the target areas was awarded no points. The total from 6 trials was recorded as a player's accuracy score.

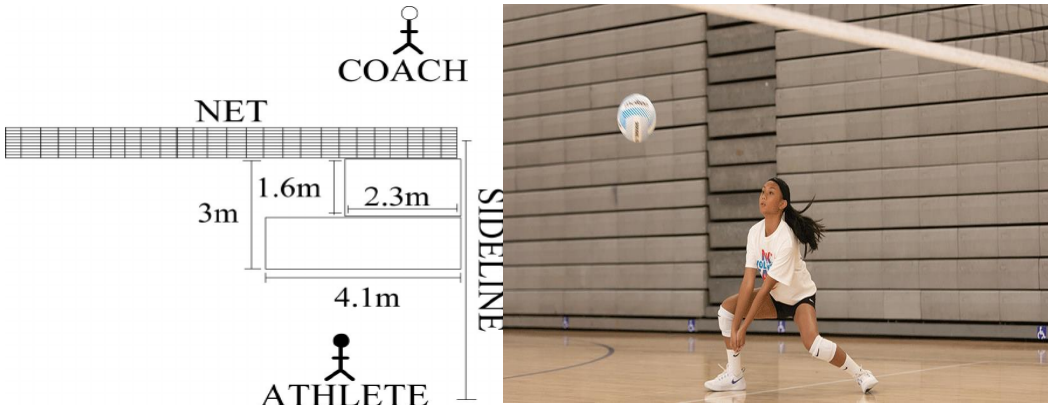

Figure 3: Forearm Passing Accuracy Test (Adopted from Gabbett, T. *et al* (2007)

II. Over Arm Passing Technical Skill (Wall Volley Passing Test)

Objective: To measure overhead (volley) passing technical skill of volleyball players.

Equipment: A solid smooth wall with one-inch-wide line marked on it which is five feet long and is 11 feet above and parallel to the floor and vertical lines extending upward from each end of the line that are three or four feet long, volleyball, stopwatch, and scoring sheet.

Procedures: The player with the volleyball in hand stands facing the wall. On signal the ball is tossed against the wall in to the area bounded by the lines. On the rebound the ball is then volleyed in to the marked area and is continued to the volleyed consecutively for one minute. The ball is held in the hands prior to the toss at start of test. The tossed ball and each volley must strike the wall above the five-foot line and between the two vertical lines. On a miss or a catch, the test continues to toss and/or volley until the expiration of one minute.

Scoring: Score is the total number of legal volleys executed with in one minute. Tosses do not count in the score.

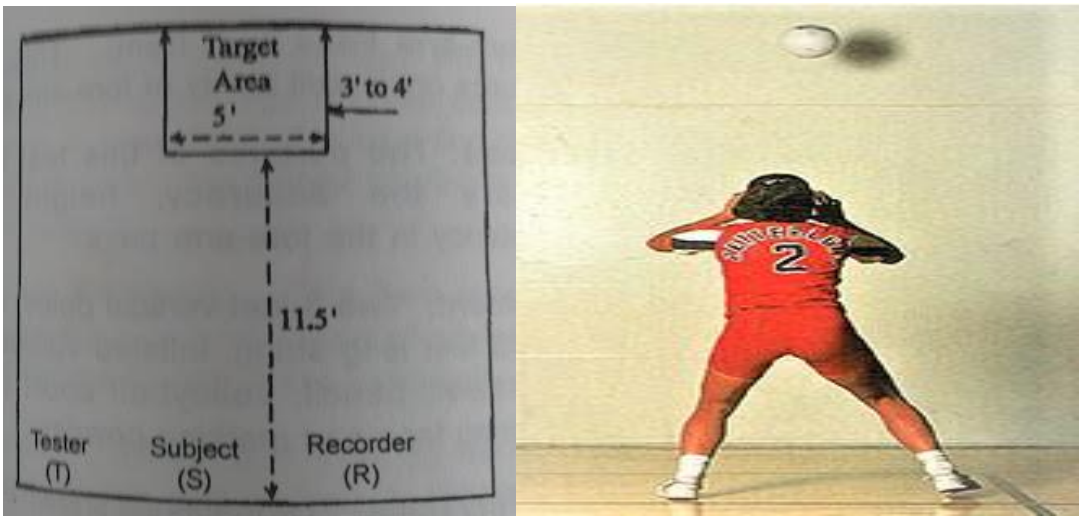

Figure 4: Wall Volley Passing Test (Adopted from Brady's Volleyball Skills Test, 2018)

3.9.2. Physical Fitness Performance Tests

In order to monitor the effectiveness of core strength training, specific fitness tests were implemented to assess each element of volleyball specific fitness variables. If technical ability is equal between players, fitness assessment may prove a valuable instrument for determining team selection and in turn may serve as an important motivation tool. The detail explanation of physical fitness tests are as follows.

I. Muscular Endurance (Sit-Up Test)

Muscular endurance would be measured using sit-up test.

Objective: to measure the endurance of the abdominals and hip-flexor muscles

Equipment: Stop watch, mat and Partner to hold the feet.

Procedure: Lie on the mat with the knees bent, feet flat on the floor and the arms folded across the chest start each sit up with back on the floor. Raise yourself to the 90 degree position and then return to the floor. The feet can be held by a partner, record the number of sits up completed in one minute.

Scoring: Count how many sit-ups the trainees can do in one minute.

Figure 5: sit up test (Adopted from Mackenzie, 2005)

II. Explosive Power (Vertical Jump Test)

Explosive Power was measured using vertical jump tests.

Objective: to measure the explosive power of the leg in vertical jump height jumped.

Equipment: measuring tape or marked wall, chalk for marking wall, score sheet, pencil **Procedure:** the player warms up for 10 minutes. The players chalk the end of their fingertips. The player stands side on to the wall, keeping both feet remaining on the ground, reaches up as high as possible with one hand and marks the wall with the tip of the fingers (M1). The player from static position jumps as high as possible and marks the wall with the chalk on his fingers (M2). The assistant measures and records the distance between M1 and M2.

Scoring: The player performed three trials, and record the highest jump from the three trials. The jump height is usually recorded as a distance score in centimeter

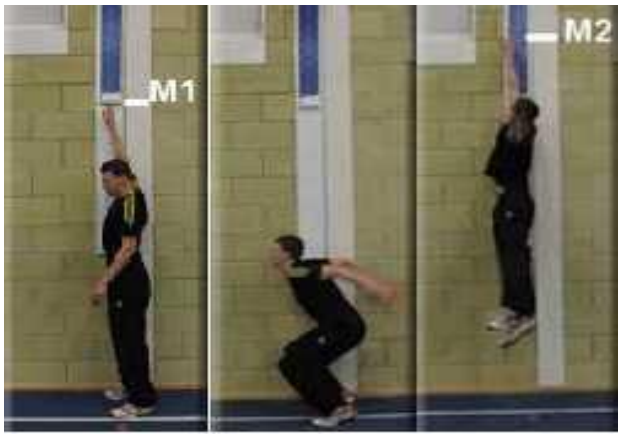

Figure 6: Vertical Jump Test (Adopted from Sergeant, 1921).

III. Flexibility (Sit and Reach Flexibility Test)

Purpose: - To measure the development of the trainees lower back and hamstring flexibility. **Equipment: -** Meter Ruler, tape, box or bench about 20cm high.

Procedure:- The trainees warms up for 10 minutes and then removes their shoes, the assistant secures the ruler to the box top with the tape so that the front edge of the box lines up with the 15cm mark on the ruler and the zero end of the ruler points towards the athlete, a person who reaches 10 cm past their toes scores 25 cm. Likewise, the athlete sits on the floor with their legs fully extended with the bottom of their bare feet against the box, the athlete places one hand on top of the other, slowly bends forward and reaches along the top of the ruler as far as possible holding the stretch for two seconds. The assistant records the distance reached by the athlete's finger tips (cm), the athlete performs the test three times.

Scoring: - Add the three trial distances and use the average for this value to assess the athlete's performance.

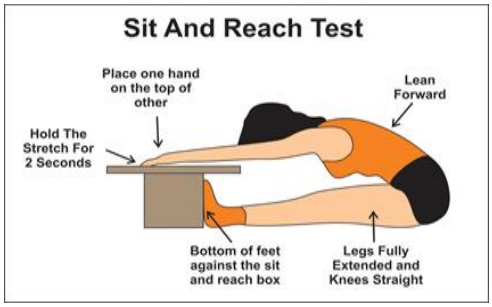

Figure 6: Sit and Reach Test (adopted from Mackenzie, 2005)

3.10. Reliability and Validity of Instruments

To maintain the validity and reliability of data, data collection tools like watch was standardized by comparing it with a different similar watch throughout the testing schedule. Beside, both pretest and posttest measurements have been taken by three sport science experts' data collectors and the average of the three measurements was taken as final data.

3.11. Methods of Data Analysis

A quantitative method of data analysis would be used for the collected data**.** After administering a field test on volleyball passing technical skills and selected fitness qualities before and immediately after intervention of core strength training, the researcher recorded these quantitative data in the form of pre test and post test results. The collected data was analyzed and interpreted into a meaningful idea using a computer in order to compare volleyball passing performance and selected fitness qualities to observe changes among groups. The significance level of the study was set at $p \leq 0.05$. Besides, the data were analyzed through statistical package software (SPSS) version 26 using descriptive statistics such as mean and standard deviation and by using inferential statistics such as ANCOVA. It is used to compare post tests between groups and also covariate (pre test) on dependent variables (post test) with effect sizes after intervention.

3.12. Ethical Considerations

While conducting research, and especially on participants, the assurance of ethical considerations is important. The following was performed to ensure ethical considerations in this study. These include, ethical standards require that researchers should not put participants in a situation where they might be at risk of harm physically, physiologically or psychologically at the time of taking test measures and time of training. Before beginning the research, the researcher obtained permission from the trainees to participate, whether they were volunteers or not. In addition, participants were not forced by the researcher into participating in the study and permission from BDU sport academy was obtained to conduct the research. Privacy of the subjects and confidentiality was strictly observed and maintained throughout the study.

CHAPTER FOUR

RESULT AND DISCUSION

4.1. Introduction

This chapter deals with the analysis of pre and post test data collected from experimental (n=11) and control (n=11) groups under the study. The purpose of this study was to determine the effects of core strength training on passing technical skills level and selected physical fitness qualities of junior volleyball players in case of Bahir Dar University male volleyball trainees. Passing technical skills such as forearm passing accuracy and overarm passing were used to measure technical skills level; In addition, the physical fitness qualities selected for this study were muscular endurance, explosive power and flexibility. Pre tests and post tests were taken from both experimental and control groups before and after 10 weeks of core strength training intervention and the scores were recorded. The collected data were analyzed using ANCOVA to analyze post test results between groups with effect sizes of strength training on variables respectively.

4.2. Results of the Study

4.2.1. Background Information of Participants

Table 2: Demographic Characteristics of the Study Participants

Group	N	Age	Height	Weight	Playing experience
		Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean± S.D
Experimental group	11	14.82±0.751	1.65±0.043	49.73±2.533	1.00±0.000
Control group	11	15.00±0.775	1.65±0.043	50.73±2.611	1.00±0.000

Key: N= number of players, S.D= standard deviation

As showed in table 2 above, study participants were found in mean ± SD of age (EG=14.82±0.751, CG= 15.00±0.775), height (EG=1.65±0.043, CG=1.65±0.043), weight (EG= 49.73±2.533, CG= 50.73±2.611) and playing experience (EG=1.00±0.000, CG=1.00±0.000).

This indicated that participants were relatively had the same age, height, weight and playing experience or it showed homogeneity of participants.

4.2.2 **Results for Passing Technical Skills**

Table 3: Descriptive Statistics of Passing technical skills

	GROUP			
	EG (N=11)		CG (N=11)	
	Mean ± std. deviation		Mean ± std. deviation	
Tests	PT	POT	PT	POT
Forearm passing accuracy	6.18±1.601	10.18 ±1.250	6.45±1.368	7.09±1.136
Overhead Passing (Wall volley)	30.55±3.267	40.64±4.178	31.00±4.290	31.45±3.984

Key: EG=experimental group, CG=control group, PT=pre test, POT=post test, N=number of players

The above table 3 depicts analyzed data of Forearm passing accuracy. The pre test mean score of EG (N=11) was found to be 6.18 with a standard deviation of 1.601 before core strength training and the pre test mean score of CG (N=11) was found to be 6.45 with a standard deviation of 1.368. But, after 10 weeks core strength training given to EG, the mean score of Forearm passing accuracy for EG has a change from pre to post test. But the mean value of CG stays very close from pre to post test. As the table shows, Forearm passing accuracy post test mean score of EG was found to be 10.18 with a standard deviation of 1.250 after core strength training. However, post test mean score of CG was found to be 7.09 with a standard deviation of 1.136.

As shown in the above table 3, the pre and post test results of Overhead Passing (Wall volley) were showed for both experimental and control group. The pre test mean score of EG (N=11) was found to be 30.55 with a standard deviation of 3.267 before core strength training and the pre test mean score of CG (N=11) was found to be 31.00 with a standard deviation of 4.290. But, after 10 weeks core strength training given to EG, the mean score of Overhead Passing (Wall volley) for EG has a change from pre to post test. But the mean value of CG stays very close from pre to post test. As the table reveals, Overhead Passing (Wall volley) post test mean score of EG was found to be 40.64 with a standard deviation of 4.178 after core strength training; while post test mean score of CG was found to be 31.45 with a standard deviation of 3.984.

Furthermore, from the above table 3 we can see that there were mean differences between the pre and post tests, yet it is impossible to determine here if these differences were statistically significant. Thus an ANCOVA was computed to examine whether the post and pre test scores had a statistically significant difference or not. The following table shows this test of significance.

Table 4: ANCOVA for Forearm Passing Accuracy

Tests of Between-Subjects Effects: forearm passing accuracy						
Dependent Variable: forearm passing accuracy post test						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	74.462[a]	2	37.231	106.716	.000	.918
Intercept	18.621	1	18.621	53.374	.000	.737
Forearm passing accuracy pre test	21.917	1	21.917	62.820	.000	.768
Groups	58.724	1	58.724	168.320	.000	.899
Error	6.629	19	.349			
Total	1722.000	22				
Corrected Total	81.091	21				

As indicated in the above table 4 ANCOVA shown that, there was a significant difference between experimental and control group with (F (1, 19) = 168.320; $p=0.00$) on forearm passing accuracy of volleyball trainees after 10 weeks of core strength training. On the other hand, there was significant difference between the covariate (pretest) and dependent variable (posttests) of forearm passing accuracy for volleyball trainees with F (1, 19) =62.820; p=0.00) in the experimental group.

Furthermore, ANCOVA also displayed the partial eta squared (effect size) of core strength training on forearm passing accuracy of volleyball trainees. According to Cohen's guidelines the partial Eta Squared value indicates (0.2 – small effect, 0.5 – medium effect, 0.8 – large effect); Thus, the effect size of core strength training on forearm passing accuracy was $\eta 2$=0.899 (89.9%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that

core strength training has large effect on the improvement of forearm passing accuracy of volleyball players.

Table 5: ANCOVA for Overhead Passing

Tests of Between-Subjects Effects: overhead passing(wall pass)						
Dependent Variable: overhead passing(wall pass) post test						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	753.319[a]	2	376.660	164.008	.000	.945
Intercept	8.603	1	8.603	3.746	.068	.165
Overhead Passing Pre Test (Wall Pass)	289.637	1	289.637	126.116	.000	.869
Groups	508.649	1	508.649	221.479	.000	.921
Error	43.635	19	2.297			
Total	29381.000	22				
Corrected Total	796.955	21				

As shown in the above table 5 ANCOVA shown that, there was a significant difference between experimental and control group with (*F (1, 19) = 221.479; p=0.00*) on overhead passing of volleyball trainees after 10 weeks of core strength training. Alternatively, there was significant difference between the covariate (pretest) and dependent variable (posttests) of overhead passing for volleyball trainees with F (*1, 19*) =126.116; p=0.00; $\eta 2$=0.869) in the experimental group.

Moreover, ANCOVA also shown the partial effect size of core strength training on overhead passing of volleyball trainees. According to Cohen's guidelines the partial Eta Squared value, the effect size of core strength training on overhead passing was $\eta 2$=0.921 (92.1%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of overhead passing of volleyball trainees.

4.2.3. Results for Physical Fitness Qualities

Table 6: Descriptive Statistics for Physical Fitness Qualities

	GROUP			
	EG (N=11)		CG (N=11)	
	Mean ± std. deviation		Mean ± std. deviation	
Tests	PT	POT	PT	POT
Muscular Endurance (Sit Up)	23.82±1.888	34.27±4.756	23.36±2.248	24.73±1.902
Explosive Power (Vertical Jump)	28.36±2.908	39.09±4.036	29.45±2.162	30.36±2.157
Flexibility (Sit And Reach)	19.36±4.545	26.36±5.297	20.36±5.025	20.64±5.372

Key: EG=experimental group, CG=control group, PT=pre test, POT=post test, N=number of players

The above table 6 displayed analyzed data of muscular endurance (sit up test). The pre test mean score of EG (N=11) was found to be 23.82 with a standard deviation of 1.888 before core strength training and the pre test mean score of CG (N=11) was found to be 23.36with a standard deviation of 2.248. But, after 10 weeks core strength training given to EG, the mean score of muscular endurance (sit up) for EG has a change from pre to post test. But the mean value of CG stays very close from pre to post test. As the table shows, muscular endurance (sit up) post test mean score of EG was found to be 34.27 with a standard deviation of 4.756 after core strength training; whereas post test mean score of CG was found to be 24.73 with a standard deviation of 1.902.

The descriptive statistics in the table 6 above shown the analyzed data of explosive power (vertical jump test) that the pre test mean score of EG (N=11) was found to be 28.36 with a standard deviation of 2.908 before core strength training and the pre test mean score of CG (N=11) was found to be 29.45 with a standard deviation of 2.162. But, after 10 weeks core strength training given to EG, the mean score of explosive power (vertical jump) for EG has a change from pre to post test. But the mean value of CG stays very close from pre to post test. As the table depicts, explosive power (vertical jump) post test mean score of EG was found to be

39.09 with a standard deviation of 4.036 after core strength training although post test mean score of CG was found to be 30.36 with a standard deviation of 2.157.

The above table 6 exposed analyzed data of flexibility (sit and reach test). The pre test mean score of EG (N=11) was found to be 19.36cm with a standard deviation of 4.545 before core strength training and the pre test mean score of CG (N=11) was found to be 20.36cm with a standard deviation of 5.025. But, after 10 weeks core strength training given to EG, the mean score of flexibility, for EG has a change from pre to post test. But the mean value of CG stays very close from pre to post test. As the table shows, flexibility (sit and reach) post test mean score of EG was found to be 26.36cm with a standard deviation of 5.297 after core strength training; whereas, post test mean score of CG was found to be 20.64cm with a standard deviation of 5.372. From the above table 6 we can see that there were mean differences between the pre and post tests, yet it is difficult to determine here if these differences were statistically significant. Thus, an ANCOVA test was computed to examine whether the post and pre test scores had a statistically significant difference or not. The following table shows this test of significance.

Table 7: ANCOVA for Muscular Endurance

Tests of Between-Subjects Effects: Muscular Endurance						
Dependent Variable: Muscular Endurance post test						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	670.002[a]	2	335.001	68.076	.000	.878
Intercept	1.908	1	1.908	.388	.541	.020
Muscular Endurance Pre Test	168.865	1	168.865	34.316	.000	.644
Groups	430.874	1	430.874	87.559	.000	.822
Error	93.498	19	4.921			
Total	19909.000	22				
Corrected Total	763.500	21				

As indicated in the above table 7 ANCOVA shown that, there was a significant difference between EG and CG with *F* (1, 19) = 87.559; *p=0.00)* on muscular endurance (sit up test) of volleyball trainees after 10 weeks of core strength training. On the other hand, there was significant difference between the covariate (pretest) and dependent variable (posttests) of muscular endurance (sit up test) for volleyball trainees with *F* (*1, 19*) =34.316; *p*=0.00) in the experimental group.

Additionally, ANCOVA also displayed that effect size of core strength training on muscular endurance (sit up test) of volleyball trainees. According to Cohen's guidelines the partial Eta Squared value, the effect size of core strength training on muscular endurance (sit up test) was *η2*=0.822 (82.2%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of muscular endurance of volleyball trainee's.

Table 8: ANCOVA for Explosive Power (Vertical Jump)

Tests of Between-Subjects Effects: Explosive Power(Vertical Jump)						
Dependent Variable: vertical jump post test						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	567.829[a]	2	283.915	89.112	.000	.904
Intercept	2.417	1	2.417	.758	.395	.038
Vertical Jump Pre Test	148.920	1	148.920	46.741	.000	.711
Groups	512.333	1	512.333	160.806	.000	.894
Error	60.535	19	3.186			
Total	27160.000	22				
Corrected Total	628.364	21				

As shown in the above table 8 ANCOVA shown that, there was a significant difference between EG and CG with *F* (1, 19) = 160.806; *p=0.00)* on explosive power (vertical jump) of volleyball trainees after 10 weeks of core strength training. On the other hand there was significant difference between the covariate (pretest) and dependent variable (posttests) of explosive power (vertical jump) for volleyball trainees with *F* (*1, 19*) =46.741; *p*=0.00) in the experimental group.

Besides, ANCOVA also exposed that partial effect size of core strength training on explosive power (vertical jump) of volleyball trainees. According to Cohen's guidelines the partial Eta Squared value, the effect size of core strength training on explosive power (vertical jump) was *η2*=0.894 (89.4%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of explosive power of volleyball trainee's.

Table 9: ANCOVA for Flexibility

Tests Of Between-Subjects Effects: Flexibility						
Dependent Variable: flexibility post test						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	705.536[a]	2	352.768	152.456	.000	.941
Intercept	5.623	1	5.623	2.430	.136	.113
flexibility	525.127	1	525.127	226.945	.000	.923
Groups	251.071	1	251.071	108.506	.000	.851
Error	43.964	19	2.314			
Total	12899.000	22				
Corrected Total	749.500	21				

As indicated in the above table 9 ANCOVA shown that, there was a significant difference between EG and CG with F (1, 19) = 108.506; $p=0.00)$ on flexibility (sit and reach test) of volleyball trainees after 10 weeks of core strength training. On the other hand, there was significant difference between the covariate (pretest) and dependent variable (posttests) of flexibility for volleyball trainees with F (*1, 19*) =226.945; p=0.00) in the experimental group.

Likewise, ANCOVA also displayed that Partial Eta Squared (effect size) of core strength training on flexibility (sit and reach test) of volleyball trainees. According to Cohen's guidelines the partial Eta Squared value, the effect size of core strength training on flexibility was *η2=0.851)*

(85.1%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of flexibility of volleyball trainee's.

4.3. Discussions

The purpose of this study was to investigate the effect of core strength training on passing technical skills and selected physical fitness qualities among Bahir Dar University male volleyball trainees. The subjects participated throughout the testing period and cooperated for the success of collection of required data. The experimental group participated in a 10-week core strength training program while the control group did not participate in this selected core strength training program. Experimental group were instructed not to start any additional programs during the 10-week period and only perform activities of normal daily living. Prior to the study, procedures and guidelines had presented orally and Subjects were agreed to participate. In this study core strength training showed improvements in passing performance and selected physical fitness qualities. The finding of this study in each variable are discussed as follows.

The findings of the study exposed that there were significance differences before the training and after 10 weeks of core strength training on trainee's forearm passing accuracy when assessed passing to target. As the data (table 4) displayed the result suggests that there was a significant difference between experimental and control group due to core strength training on forearm passing accuracy of volleyball trainees with F (1, 19) = 168.320; $p=0.00$). P<0.05 indicated that the significant improvement was observed on EG than CG of volleyball trainees forearm passing accuracy. On the other hand, there was significant difference between the covariate (pretest) and dependent variable (posttests) of forearm passing accuracy for volleyball trainees with F ($1, 19$) =62.820; p=0.00) in the experimental group, as a result of 10 weeks core strength training. Moreover, according to Cohen's guidelines the partial Eta Squared value indicates (0.2 – small effect, 0.5 – medium effect, 0.8 – large effect); Thus, the effect size of core strength training on forearm passing accuracy was $\eta 2$=0.899 (89.9%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of forearm passing accuracy of volleyball trainees.

Furthermore, the data (table 3) showed the mean values of forearm passing accuracy was 6.18 before core strength training, which was improved to 10.18 after 10 weeks core strength training, this means the forearm passing accuracy of EG increased by 4 point after 10 weeks of core

strength training. But the pre and post test score of CG stay very close, 6.45 and 7.09 pre test and post test respectively. The increment of the rate of this score in EG was one indicator of the improvement of the players passing to target. The reason behind this change was core strength training that they were engaged in. Therefore, the researcher rejected H_0.1 at 0.05 level of confidence. Meanwhile, the finding of forearm passing accuracy discussed above was in accordance with the findings of Barzouka, *et al* (2022) who investigated on effects of balance training program on technical skills in youth volleyball player. As a result, balance training contribute for improvement of forearm passing accuracy. Besides, According to Widmer R. (2020) incorporating strength training in to volleyball training is beneficial for passing accuracy as targeted muscles are challenged to build up the strength it takes to actively achieve a quicker reaction time, as well as quick first step to get to the volleyball in a controlled and relaxed athletic position.

The results of the study shown that there were significance differences before the training and after 10 weeks of core strength training on trainee's overhead passing (wall pass test) when assessed passing performance. As the data (table 5) presented, the result suggests that there was a significant difference between experimental and control group on overhead passing (wall pass) of volleyball trainees with $F\ (1, 19) = 221.479;\ p=0.00).\ P<0.05$ indicated that the significant improvement was observed on EG than CG of volleyball trainees overhead passing. Then again, there was significant relationship between the covariate (pretest) and dependent variable (posttests) of overhead passing for volleyball trainees with $F\ (1, 19) = 126.116$; $p=0.00$; $\eta 2=0.869$) in the experimental group, as a result of 10 weeks core strength training. Moreover, according to Cohen's guidelines effect size of core strength training on overhead passing was $\eta 2=0.921$ (92.1%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of overhead passing of volleyball trainees.

In addition, the data (table 3) showed the mean values of overhead passing (wall pass) was 30.55 before core strength training, which was improved to 40.64 after 10 weeks core strength training, this means the overhead passing (wall pass) of EG increased by 10.09 point after 10 weeks of core strength training. But the pre and post test score of CG stay very close, 31.00 and 31.45 pre test and post test respectively. The change of the rate of this score in EG was one indicator of the

improvement of the trainee's overhead passing skill. The reason behind this change was core strength training that they were engaged in. Consequently, the researcher rejected H_0.2 at 0.05 level of confidence. This result is supported and argued by the findings of Selvakumar & Palanisamy (2017) on effects of strength training on passing skill performance of volleyball players. Likewise, Zemenu (2020) have been conducted research on effects of strength training on passing skill level of junior volleyball players. The results indicated that, strength training showed significant effect on overhead passing of junior volleyball players.

The outcomes of the study displayed that there were significance differences before the training and after 10 weeks of core strength training on trainee's muscular endurance when assessed their fitness level. As the data (table 7) exposed the result suggests that there was a significant difference between experimental and control group on muscular endurance (sit up test) of volleyball trainees with $F\ (1,\ 19) = 87.559;\ p=0.00).\ P<0.05$ indicated that the significant improvement was observed on EG than CG of volleyball trainees muscular endurance. Alternatively, there was significant difference between the covariate (pretest) and dependent variable (posttests) of muscular endurance (sit up test) for volleyball trainees with $F\ (1,\ 19) =34.316$; $p=0.00$) in the experimental group, as a result of 10 weeks core strength training. Likewise, according to Cohen's guidelines, the effect size of core strength training on muscular endurance (sit up) was $\eta 2=0.822$ (82.2%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of muscular endurance of volleyball trainees.

Moreover, the data (table 6) showed the mean values of muscular endurance (sit up) was 23.82 before core strength training, which was improved to 34.27 after 10 weeks core strength training, this means the muscular endurance of EG increased by 10.45 point after 10 weeks of core strength training. But the pre and post test score of CG stay very close, 23.36 and 24.73 pre test and post test respectively. The boost of the rate of the score in EG was one indicator of the improvement of the trainee's muscular endurance. The reason behind this change was core strength training that they were engaged in. Hence the researcher rejected H_0.2 at 0.05 level of confidence. This result is in accordance with the findings of Boyacı & Tutar, (2018) on effect of core training on muscular endurance. As a result, Core training athlete's muscular endurance has been developing in a positive direction. Likewise, Gaganpreet & Jogiswar (2019) conducted a

study on effects of core specific fitness training program on muscular endurance of school going children. The result indicated that, core strength training showed significant effect on muscular endurance of school going children.

The findings of the study revealed that there were significance differences before the training and after 10 weeks of core strength training on trainee's explosive power (vertical jump) when assessed their fitness level. As the data (table 8) showed, the result suggests that there was a significant difference between experimental and control group on explosive power (vertical jump) of volleyball trainees with *F (1, 19) = 160.806; p=0.00)*. *P<0.05* indicated that the significant improvement was observed on EG than CG of volleyball trainees explosive power (vertical jump). On the other hand, there was significant difference between the covariate (pretest) and dependent variable (posttests) of explosive power (vertical jump) for volleyball trainees with *F* (*1, 19*) =46.741; *p*=0.00) in the experimental group, as a result of 10 weeks core strength training. Furthermore, according to Cohen's guidelines effect size of core strength training on explosive power (vertical jump) was *η2=0.894 (89.4%)*, it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of explosive power of volleyball trainees.

Besides, the data (table 6) showed the mean values of explosive power (vertical jump) was 28.36cm before core strength training, which was improved to 39.09cm after 10 weeks core strength training, this means the explosive power (vertical jump) of EG increased by 10.73cm after 10 weeks of core strength training. But the pre and post test score of CG stay very close, 29.45cm and 30.36cm pre test and post test respectively. The change of score in EG was one indicator of the improvement of the trainee's explosive power. Hence the researcher rejected H_0.3 at 0.05 level of confidence. The reason behind this change was core strength training that they were engaged in. This result is supported and argued by the findings of Şahin, & Özdal, (2020) conducted on effect of core exercises on vertical jump of volleyball players. This confirmed that the core training program has positive effects on vertical jump when applied with volleyball training. Similarly, (Bilici, & Selçuk, (2018) conducted a study on evaluation of the effect of core training on the leap power and motor characteristics of the volleyball players. Analysis of the results showed that core strength training programs induced a statistically significant increase in explosive power of volleyball players. The result is also supported by the

finding of Genc *et al*, (2010); Effect of 8-week core training exercises on physical and physiological parameters. This Confirmed that core strength training has significant effect on explosive power of volleyball players.

The results of this study revealed that there were significance differences before the training and after 10 weeks of core strength training on trainee's flexibility (sit and reach test) when assessed their fitness level. As the data (table 4) revealed, the result suggests that there was a significant difference between experimental and control group on flexibility of volleyball trainees with *F (1, 19) = 108.506; p=0.00). P<0.05* indicated that the significant improvement was observed on EG than CG of volleyball trainees flexibility. On the other hand there was significant difference between the covariate (pretest) and dependent variable (posttests) of flexibility(sit and reach test) for volleyball trainees with *F* (*1, 19*) =226.945; *p*=0.00) in the experimental group, as a result of 10 weeks core strength training. Besides, according to Cohen's guidelines effect size of core strength training on flexibility was *η2=0.851)* (85.1%), it was greater than 0.8 (80%) after 10 weeks core strength training. This indicated that core strength training has large effect on the improvement of flexibility of volleyball trainees.

Additionally, the data (table 6) showed the mean values of flexibility was 19.36cm before core strength training, which was improved to 26.36cm after 10 weeks core strength training, this means flexibility of EG increased by 7cm after 10 weeks of core strength training. But the pre and post test score of CG stay very close, 20.36cm and 20.64cm pre test and post test respectively. The increment of the rate of this score in EG was one indicator of the improvement of the volleyball trainee's flexibility. The reason behind this change was core strength training that they were engaged in. Hence the researcher rejected H_0.4 at 0.05 level of confidence. This result is in accordance with the findings of Gaganpreet & Jogiswar (2019) on effect of core specific fitness training program on flexibility of school going children. The result indicated that, core training showed significant effect on flexibility of school going children. Similarly, Zemenu (2020) have been conducted a research on effects of strength training on flexibility of junior volleyball players. The results indicated that, strength training showed significant effect on flexibility of junior volleyball players.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The purpose of this study was to determine effects of 10 weeks core strength training on passing technical skills level and selected physical fitness qualities of junior volleyball trainees in Bahir Dar University male volleyball project. For this purpose, the researcher reviewed the available literatures in order to decide the focus of the study and methods.

In order to attain the general objectives of the study, the following specific research objectives were formulated to:

1. Evaluate effects of core strength training on forearm passing accuracy of junior volleyball trainees.
2. Find out effects of core strength training on overhead passing skill of junior volleyball trainees.
3. Examine effects of core strength training on explosive power of junior volleyball trainees.
4. Measure effects of core strength training on muscular endurance of junior volleyball trainees.
5. Determine effects of core strength training on flexibility of junior volleyball trainees.

Based on the above specific objectives, the hypotheses were formulated. Subjects for the study were 22 males who were participating in Bahir Dar University male volleyball project. Subjects divided in to two groups, an experimental and control group. The experimental group performed in a 10 weeks of additional core strength training program. However, the control group did not perform core strength training program. Then, they did perform as equal as normal training activities with the experimental players for the regular volleyball training program. All subjects participated in all passing technical skill level tests: (forearm passing accuracy, overhead passing) and physical fitness quality tests: (muscular endurance, explosive power, flexibility): Both had taken pre and post testing.

True experimental method was employed to collect a data used to analyze the change mean scores to experimental and control groups. Fitness and technical skills profiling had achieved by means of tests. The data was gathered from tests of experimental and control groups results in the form of pre-test and post-test method had been organized using appropriate and relevant statistical method of analysis. ANCOVA to compare between groups pre to post tests with effect sizes, which assist to come up with findings had used.

Through ANCOVA the data were analyzed. Hence the following major findings were determined.

1. The finding of this study revealed forearm passing accuracy was significantly improved in pre to post tests of EG, and also significant improvement were observed on EG than CG of overhead passing of volleyball trainees after exposed to 10 weeks core strength training. Hence, Core strength training has large effect size on improvement of forearm passing accuracy of volleyball trainees

2. The finding of this study showed overhead passing skill was significantly improved in pre to post tests of EG, and also significant improvement were observed on EG than CG of overhead passing of volleyball trainees after exposed to 10 weeks core strength training. Hence, Core strength training has large effect size on improvement of overhead passing skill of volleyball trainees.

3. The finding of this study indicated that significant improvement in muscular endurance in pre to post test of EG was observed. EG had shown significant improvement but In CG no significant change was found as a result of core strength training. Consequently, core strength training has large effect size on improvement of muscular endurance of volleyball trainees.

4. The finding of this study revealed that explosive power was significantly improved pre to post tests of EG after 10 weeks of core strength training. EG had shown significant improvement as a result of core strength training, but in CG there was no significant change was recorded. Thus, core strength training has large effect size on improvement of explosive power of volleyball trainees.

5. Finding of this study indicated that there was a significant improvement of flexibility pre to post tests of EG as a result of core strength training. EG showed significant increase in flexibility with the consequence of core strength training, but no significant improvement was found in CG. Accordingly, core strength training has large effect size on improvement of flexibility of volleyball trainees.

5.2. Conclusion

Based on the major finding of this study, the following points were stated as a conclusion.

- Core strength training had found to be an effective mode of training for the improvement of forearm passing accuracy of junior volleyball trainees.
- Core strength training had a significant effect on overhead passing technical skill of junior volleyball trainees.
- Core strength training had a significant effect on improvement of muscular endurance of junior volleyball trainees.
- Core strength training had a significant increase in explosive power of junior volleyball trainees.
- Core strength training was found effective in a significant improvement of flexibility of junior volleyball trainees.

5.3. Recommendations

Based on results, discussions and findings of the study, the following would be recommended:

- As core strength training was found to have a positive impact on developing volleyball passing technical skills, all volleyball trainee's and coaches should include the scientific method of core strength training at least 3 days per week for 40-60 minutes each day, in addition to the regular training program in their training sessions.
- Volleyball coaches should emphasize core strength exercise to improve volleyball trainee's passing performance rather than training in traditional methods or devoting the majority of their time solely to games.
- Asserting that the focus of core strength training should be directed not only preventing injuries but also develop muscles which contribute to volleyball performance.
- The study was conducted only to determine effects of core strength on passing performance (forearm passing accuracy and overhead passing skill) and selected physical fitness qualities (muscular endurance, explosive power and flexibility)). So, it is recommended for other researchers to deal with other physical fitness variables like agility, speed etc. and other volleyball technical skills such as spiking, blocking, serving in various age categories and sex. Hence, these are other principal areas for further research.

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Appendices

Appendix A: Researcher's 10 Weeks Core Strength Training Program

The studied players were divided in to two groups: experimental and control group. Experimental group was subjected to additional core strength training and control group followed standard volleyball training. Experimental group performed additional units of core strength training lasting about 40-60 minutes each session, three days per week (Tuesday, Thursday and Saturday) for 10 weeks, from (March 18 to June 05-2014 E.C). The training protocol focused on core strength training based on such exercises as free weight (body weight) exercises. The training load increased progressively throughout the experiment, changing the number of sets and repetitions in accordance with standard training protocols. Before the training, general and special warm-ups appropriate for the movements were performed for 10–15 min. Core exercises were done 10 weeks to the subjects located in experimental group in addition to volleyball training.

Moreover, for core strength training program, 8 movements particular to the core area was adopted (Plank, Side Plank, Crunch, Reverse Crunch, Bird Dog, Glute Bridge, Russian Twists, and Superman). The duration and number of repetitions over which these exercises were performed varied due to the demands of the exercises. Before starting the core training program, experimental group were applied core exercises for 1 week. Experienced conditioning coaches demonstrated proper exercise technique throughout the study period. Coaches consistently encouraged the subjects to maintain proper technique performance. While creating core training program in this research, it was prepared based on Willardson's book "Core Development" from the National Strength and Conditioning Association (NSCA) "Sports Performance Series" books (Willardson, 2018).

No	Exercise	1- 2 Week		3 - 4 Week		5 - 6 Week		7 - 8 Week		9 - 10 Week		Rest and recovery
		Sets	Reps	Sets	Reps	Sets	Reps	Sets	Reps	Sets	Reps	30 second rest between sets and
1	**Plank**	2	15sec	2	20sec	3	25 sec	4	25 secs	4	30sec	
2	**Side plank**	2	15sec	2	20sec	3	25 sec	4	25 secs	4	30sec	
3	**Crunch**	2	15sec	2	20sec	3	25 sec	4	25 secs	4	30sec	
4	**Reverse crunch**	2	15sec	2	20sec	3	25 sec	4	25 secs	4	30sec	
5	**Bird dog**	2	15sec	2	20sec	3	25 sec	4	25 secs	4	30sec	1 minute rest between exercise
6	**Glute Bridge**					2	20 secs	3	25 secs	4	25 secs	
7	**Russian Twists**					2	20 secs	3	25 secs	4	25 secs	
8	**superman**					2	20 secs	3	25 secs	4	25 secs	

Appendix B: Participant Information Sheet and Informed Consent Form

Researcher's Name: Seid Teshome

Advisor's Name: Mr. Chalachew Chekol

Research title: Effects of core strength training on passing technical skills and selected physical fitness qualities of junior volleyball trainees in case of Bahir Dar University male volleyball project.

Dear participants,

At present, I am conducting a research study which aims to determine the Effects of core strength training on passing performance and selected physical fitness qualities of junior volleyball trainees. So you are kindly requested to participate in this research as described below.

The research study will be carried out and governed by the regulations for research on human beings. These regulations require that the researcher should obtain a signed agreement (consent from you to participate in this research.

The researcher will explain to you in detail the purpose of the study, the procedure to be used, the potential benefits and risks, confidentiality and rights in this study. Thus you can ask the researcher and questions that you may have about the study. After discussion, if you agree to participate in this study, please sign this form in the presence of the researcher. You may discontinue at any time from the study if you choose to do so.

Purpose of the Study

The purpose of this research project is to determine the Effects of core strength training on passing performance and selected physical fitness qualities of junior volleyball trainees in case of BDU male volleyball project. Moreover, the aim of this study is to write a thesis as a partial requirement for the fulfillment of master's program in coaching volleyball.

Procedure of the Study

You will undertake volleyball passing technical skills and physical fitness level test. These tests will help the researcher to describe the initial volleyball passing technical skills and physical fitness capacity of the group. The whole group will be divided in to two groups, either

experimental or control group. Both experimental and control group will undertake volleyball technical-tactical training. However, the control group will continue a normal volleyball technical-tactical training while the experimental or intervention group will undertake additional strength training sessions for 10 weeks period and three times a week. Pretesting for a whole group will be taken approximately for two days. Then, post test will be run or the test that will be taken before the training will be repeated at the end of the 10 weeks intervention training. The post test for the whole group will be taken approximately for two days, too.

Benefits and risks

Individuals participating in this study will receive a copy of all test results and gain a better understanding of their performance in volleyball passing technical skills and physical fitness capacity compared with the group average. In addition, you will also receive ongoing education and coaching throughout the training. The risk of being participating in this study is very minimal, but while administering the tests and during training session you may experience localized muscle fatigue in your body. You might feel some muscle soreness and fatigue during and after the cessation of the exercise tests and training but I do not expect any unusual risks as a direct result of this study. If any unexpected physical injury occurs, appropriate first aid will be provided, but no financial compensations will be given. There would not be any direct payment for participating. But the finding from this research may reveal important information for the investigator and you.

Confidentiality

The information you will provide will be remained confidential. There will be no information that will identify you in particular. The finding of the study will be general for the study participants and will not reflect anything particular of individual persons. The test will be coded to exclude showing names. No reference will be made in oral or written reports that could link participants to the research. Generally, the information will be used only for research purposes without identifying you as an individual.

Rights

Participants for this study are fully voluntary. You have the right to declare to participate or not in this study. If you decide not to participate, you have the right to withdraw from the study at any time and this will not label you for any loss of benefits.

Declaration of Informed Voluntary Consent

I have read the participant information sheet. I have clearly understood the purpose of the research, the procedures, the risks and benefits, issues of confidentiality and the rights of participating. I have been given the opportunity to ask questions for things that may have been unclear. I was informed that I have the right to withdraw from the study at any time. Therefore, I declare my voluntary consent to participate in this study with my initial (signature) as indicated below.

Name of participant: _____

Signature of participant: _____

Date: _____

I certify that I have explained fully to the above participant about the purpose, the procedures, confidentiality, rights, the potential benefits and the possible risks involved in this research study:

Name of investigator: _____

Signature of investigator: _____

Date: _____

(Source: Zemenu T. (2020)

Appendix C: Physical Activity Readiness Questionnaire (PAR-Q)

Dear Participants,

Physical activity readiness questionnaire is the first step to take in to consideration if one planned to involve in regular exercise. Many health benefits are associated with participating in regular exercise. The physical activity readiness questionnaires are designed to identify the small number of participants for whom strength training might be inappropriate or those who should seek medical advice concerning the type of activity most suitable for them. The following questions are prepared and distributed to participants regarding to their health status for the participation of the designed strength training.

Direction: please read the following questions carefully and indicate your correct responses to each questions by writing on blank space or by putting a tick (x) mark under one of the two boxes ("YES or ―NO" options) given below that represents your idea accurately.

Participant's full name: _____

Participant's signature: _____

Date: _____

No	Questionnaires	Yes	No
1	Do you currently participate in regular exercise at least 3 times per week?		
2	Do you have upper and lower extremities pain which has been aggravated by physical exercise?		
3	Do you have chest pain when you were not doing physical activity before this time?		
4	Do you have upper or lower back pain which has been aggravated by exercise?		
5	Have you currently take medications?		
6	Do you have high blood pressure?		
7	Do you have diabetes mellitus or any other metabolic disorder?		
8	Do you ever lose consciousness or do you lose your balance because of dizziness?		
9	Do you have a joint or bone problem that may be made worse by a change in your physical exercise?		
10	Do you have coronary heart disease?		
11	Have you ever suffered from shortness of breath at rest or when you perform physical exercise?		

Adapted from Zemenu T. (2020)

Appendix D: Profile of Participants

A. Experimental Group (EG)

No	Name / code of participants	Age (year)	Height (cm)	Weight (k/g)	Playing experience
1	EG1	15	1.65	47	1
2	EG2	16	1.71	55	1
3	EG3	14	1.60	50	1
4	EG4	15	1.62	52	1
5	EG5	14	1.61	46	1
6	EG6	15	1.64	51	1
7	EG7	15	1.70	48	1
8	EG8	14	1.60	49	1
9	EG9	16	1.72	51	1
10	EG10	15	1.67	50	1
11	EG11	14	1.65	48	1

B. Control Group (CG)

No	Name / code of participants	Age (year)	Height (cm)	Weight (k/g)	Playing experience
1	CG1	14	1.60	51	1
2	CG2	16	1.69	55	1
3	CG3	14	1.63	48	1
4	CG4	15	1.65	51	1
5	CG5	15	1.73	52	1
6	CG6	16	1.68	54	1
7	CG7	15	1.61	49	1
8	CG8	16	1.70	53	1
9	CG9	15	1.63	47	1
10	CG10	15	1.64	50	1
11	CG11	14	1.60	48	1

Appendix E: Demographic Characteristics of the Study Participants

Group	N	Age	Height	Weight	Playing experience
		Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean± S.D
Experimental group	11	14.82±0.751	1.65±0.043	49.73±2.533	1.00±0.000
Control group	11	15.00±0.775	1.65±0.043	50.73±2.611	1.00±0.000

Key: N= number of participant, S.D= Standard Deviation

Appendix F: Description of Volleyball Technical Skills and Selected Physical Fitness Qualities

NO	Parameters	Types of tests	Unit
1	Forearm passing to target	Forearm passing accuracy test	Number
2	Overhead passing	Wall volley test	Number
3	Muscular endurance	Sit up test	Number
4	Explosive power	Vertical jump test	Centimeter
5	Flexibility	Sit and reach test	Centimeter

Appendix G: Pre and Post Test Results of Passing Performance of Experimental Group Volleyball Trainees

Name / code of participants	Volleyball Passing performance test			
	Overhead passing		Forearm passing accuracy	
	Wall volley test		Forearm passing to target test	
	PT	POT	PT	POT
EG1	30	40	4	9
EG2	35	49	5	9
EG3	25	36	6	10
EG4	29	38	7	11
EG5	31	42	4	8
EG6	32	41	7	10
EG7	30	40	8	12
EG8	27	36	5	10
EG9	36	44	6	11
EG10	32	45	9	12
EG11	28	36	7	10

Key: PT= pre test, POT= post test

Appendix H: Pre and Post Test Results of Passing Performance of Control Group Volleyball Trainees

Name / code of participants	Volleyball Passing performance test			
	Overhead passing		Forearm passing accuracy	
	Wall volley test		Forearm passing to target test	
	PT	POT	PT	POT
CG1	28	29	4	5
CG2	37	37	5	6
CG3	29	30	7	8
CG4	31	31	8	9
CG5	38	38	7	8
CG6	35	36	8	7
CG7	30	31	8	8
CG8	33	32	6	7
CG9	29	29	7	7
CG10	26	27	6	7
CG11	25	26	5	6

Key: PT= pre test, POT= post test

Appendix I: Pre and Post Test Results of Muscular Endurance (Sit up Test), Explosive Power (Vertical Jump Test) and Flexibility (Sit and Reach Test) for Experimental Group Trainees.

Name / code of participants	Physical Fitness Tests					
	Muscular endurance		Explosive power		flexibility	
	Sit Up Test		Vertical jump test		Sit and reach test	
	PT	POT	PT	POT	PT	POT
EG1	25	32	30	41	26	38
EG2	26	38	32	48	18	26
EG3	21	28	26	37	19	25
EG4	24	33	32	42	13	20
EG5	23	32	25	35	25	31
EG6	24	36	31	40	22	29
EG7	22	30	28	37	21	27
EG8	26	43	27	34	20	26
EG9	26	40	31	42	21	27
EG10	21	29	25	38	17	22
EG11	24	36	25	36	11	19

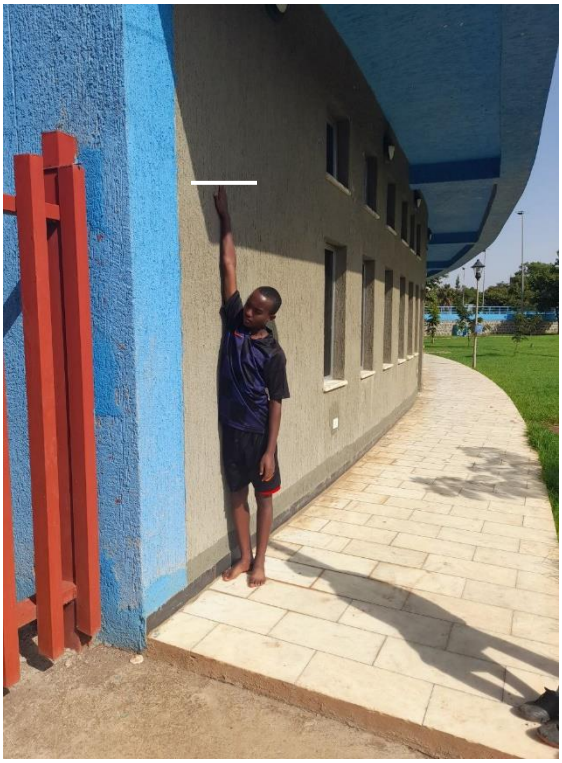
Key: PT= pre test, POT= post test

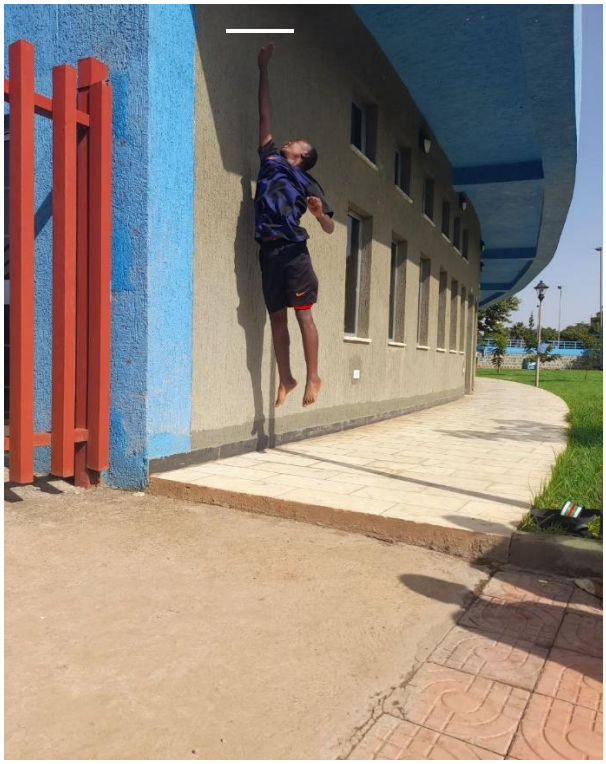
Appendix J: Pre and Post Test Results of Muscular Endurance (Sit up Test), Explosive Power (Vertical Jump Test) and Flexibility (Sit and Reach Test) for Control Group Trainees.

Name / code of participants	Physical Fitness Test					
	Muscular endurance		Explosive power		flexibility	
	Sit Up Test		Vertical jump test		Sit and reach test	
	PT	POT	PT	POT	PT	POT
CG1	21	23	28	30	18	19
CG2	25	26	33	34	25	26
CG3	23	24	26	27	24	24
CG4	23	25	31	32	27	28
CG5	22	23	32	32	23	23
CG6	24	25	28	29	18	19
CG7	27	28	29	30	18	16
CG8	26	27	30	29	11	12
CG9	21	22	31	33	14	13
CG10	25	26	29	30	25	26
CG11	20	23	27	28	21	21

Key: PT= pre test, POT= post test

Appendix K: Pictures during Physical Fitness Qualities Test





Appendix L: Pictures during Passing Technical Skills Test