ADDIS ABABA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIOURAL STUDIES

DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION

Effects of eight weeks circuit training on muscular strength and endurance of students: the case of Enchini Secondary School

By

Dereje Gebeyehu Tafa

M.Ed. Thesis

Submitted to the Department of Science and Mathematics Education for partial fulfillment of the requirement of the Degree of Masters of Education in teaching Physical Education

October 2024

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Declaration

This is to certify that the Thesis prepared Dereje Gebeyehu entitled as "**Effects of eight weeks circuit training on muscular strength and endurance of students: the case of Enchini Secondary School**" and submitted to the Department of Science and Mathematics Education in partial fulfillme**n**t for the requirement of the Degree of Masters of Education teaching Physical Educations complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Board of examination

Advisor

Dr. Sutuma Edessa Signature: _____Date: _____

Internal Examiner

_____ Signature: _____Date:_____

External Examiner

_____ Signature: _____Date: _____

Chairperson

_____ Signature: _____Date: _____

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Abbreviation used in this text

EXG: Experimental Group

CIR: Circuit Training

MSE: Muscular Strength Exercise

MEE: Muscular Endurance Exercise

PT: Pre-training

POST: Post-training

Abstract

This study examines the effects of 8 weeks circuit-training program on muscular strength and muscular endurance of selected students from Enchini Secondary School. A total of 30 students of age 17-19 were selected using purposive sampling as study population. The circuit training regimen involved exercises designed to enhance muscular strength and endurance and was conducted twice a week for 40 minutes per session. The study employed a pre-test and post-test design to evaluate the effects of circuit training on the six station groups of participants conducting exercises. Data were collected on the performance of participants during the pretest before getting training and after two months circuit training on six stationed exercises and analyzed in comparison of the measurement results of posttest with the pretest outcomes. As a result of circuit training exercises for two months, the performance of participants on six station components was improved: pushups by ***15.4,*** *jumping jack by 15.9, Sit-up by 11.6, jump rope 15, step-up by 12.7 and pull-up by 6 and showed clear demarcations differences of the pre-test and post-test results. The study concludes that circuit training can significantly improve physical fitness in adolescent males, making it a valuable exercise modality for schools and fitness programs. Recommendations for future research include exploring various circuit training protocols including diverse participant groups and assessing long-term effects and psychological impacts.*

Key Words: Circuit-training, Effect, Fitness, Muscular endurance and Muscular strength

Chapter one

1. Introduction

1.1Background of the Study

Circuit training is a form of conditioning that combines resistance training with high-intensity aerobics aimed at enhancing strength and endurance. It consists of a series of exercises designed with specific objectives taking into account factors such as design, rationing, load variation and considering individual differences among trainees.

The primary goal of circuit training is to complete the exercises in the shortest time possible whose design is important to adjust the load across different stations to match with targeted major muscle groups.

Exercises of circuit training are a one complete round of all the prescribed activities and once a circuit is completed, the next exercise begins immediately with a minimum of rest time intervals. The intervals between exercises in circuit training are brief forms allowing for rapid progression to the next exercise (Kravis, Len, 1996).

Circuit training helps individuals to achieve and maintain fitness goals more effectively than other forms of exercise or diet. Circuit training also serves as a valuable educational tool, fostering self-reliance, teamwork and self-assessment.
According to Heaven et al (2004), circuit training is one of the most time-efficient methods for improving cardiovascular fitness and muscle endurance. Circuit training is particularly effective in accounting for individual differences in fitness levels of abilities that allows the gradual increase of training intensity. It can be achieved either through time-specific exercises with fixed rest periods or by completing exercises in the shortest possible time within a full circuit (cycle).

Circuit training promotes mutual respect among participants regardless of their individual abilities and encourages a positive learning environment (Reddy and Jota, 2012).

Circuit training provides an opportunity to focus on specific components of physical fitness that need improvement and there by offering a platform for self-assessment.

The method of circuit training is also time-efficient in enabling multiple individuals to train simultaneously while maximizing performance in the shortest time possible. It is a method that combines resistance training and high-intensity aerobics in a structured format targeting both strength building and muscular endurance.

The circuit composes of 6 to 10 strength and endurance exercises performed consecutively with each exercise done for a specified number of repetitions or for a set of time before moving to the next

exercise. Short rest periods separate the exercises within each circuit while longer rest periods separate the circuits. The total number of circuits in a session can vary from two to six depending on the individuals training level training period (preparation or competition) and training objectives (Ortega et al., 2008).

Circuit training is particularly effective in reducing the time required for training while allowing for an adequate training volume beneficial for beginners offering a multi-level effect on fitness. Circuit training involves a structured sequence of exercises performed consecutively with minimal rest between each exercise.

Once a participant completes one circuit of a full round of the prescribed activities they start the next circuit repeating the process.

The brief rest periods between exercises in circuit training lead to rapid transitions and continuous engagement (Commynes, 2018).

Circuit training exercises may serve as a valuable intervention to improve physical fitness by making effective exercises enhancing fitness in muscular strength and muscular endurance. Circuit training programs are designed with specific goals incorporating principles such as exercise design, rationing and load variation while accommodating individual differences. It can be customized to develop a range of physical attributions including strength, power, muscular endurance, speed, agility, neuromuscular coordination, flexibility and cardiovascular endurance practices.

1.2 Statement of the Problem

In this research-based study, effects of circuit training on muscular strength and muscular endurance are focused.

As a physical education teacher of Enchini Secondary school the researcher observed that many of the students are not at reach of physical exercises in all components of finesses.

Many of the students living far apart from the school do not arrive the school on time and usually come late since they cannot run or walk fast or do all activities. Many of the regular activities that support muscle strength and endurance including fast walking are not done properly.

Beyond its benefits, circuit training offers significant fitness advantages by fostering self-reliance, teamwork and self-assessment that encourages mutual respect and inclusivity allowing individuals of varying fitness levels to engage and support one another regardless of abilities (Reddy & Jota, 2012).

Therefore, the researcher decided to use circuit training to develop the muscle strength and endurance of students at Enchini Secondary School.

1.3 Objective of the study

1.3.1 General objective of the study

The general objective of the study is to develop the muscular strength and endurance of male students through circuit training at Enchini Secondary School.

1.3.2 Specific objectives of the study

The specific objectives of the study are to:

1. Identify effects of circuit training on muscular strength and endurance of students
2. Assess the effect of circuit training on muscular strength and endurance of students
3. Conduct circuit training for 8 weeks muscular strength and endurance of students
4. Measure the performance of participants after 8 weeks circuit training on muscular strength and endurance using pretest and posttests.
5. Find the effectiveness of circuit training in improving muscular strength and endurance in comparison of the pretest with posttest data

1.4 Research questions

This research is attempted to answer the following research questions.

1. Why do students lack muscular strength and endurance?
2. How can students improve their muscular strength and endurance?
3. What measurements are used in circuit training exercise on muscular strength and endurance?
4. What factors influence circuit training exercises of students on muscular strength and endurance?
5. What are the effects of circuit training on muscular strength and endurance of students?

1.5 Significance of the study

This study is highly significant in physical education adolescent fitness, offering insights that could influence both practice and fitness. Circuit training on muscular strength and endurance in secondary school supports students in providing clearer understanding of how and why this training method is used. It helps to improve both strength and endurances of muscle to work properly and do activities successfully.

1.6 Limitation of the study

This study encountered several limitations that impacted its execution and findings. The study focused exclusively on grade 10 male students of age 17 to 19 that narrowed the study population, sample size and constrained by logistical challenges. The research was limited to the period during which the circuit training program was implemented without extending to long-term follow-up. Consequently, the study did not evaluate the lasting effects of the training on muscular strength and endurance beyond the intervention period. Due to resource limitations, including data collection materials, time, and financial constraints the study could not include a larger number of subjects or a broader range of training methods.

1.7 Delimitation of the study

The study was confined to Enchini Secondary School within a particular educational environment. **T**he study concentrated on the impact of a circuit training program on muscular strength and endurance. The study utilized a specific circuit training program and compared results between participants and a control group without exploring other training methods or alternative fitness interventions. The time frame was limited to the duration of the intervention and did not encompass long-term effects or follow-up beyond the intervention period. These delimitation's ensured a focused investigation within a specific context and time frame providing insights into the effectiveness of circuit training for the targeted population while acknowledging the constraints and limitations of the study.

1.8 Organization of the paper

The study is organized in five chapters that the first chapter deals with **Introduction,** t**h**e second chapter is about **Review of related Litterateurs,** the third chapter is **Research Methodology**, the fourth chapter is **Results and Discussion** and the fifth chapter is summary, conclusion and recommendation.

1.9 Definition of key terms

Circuit training is a form of body conditioning that involves endurance training, resistance training, high-intensity aerobics and exercises performed in a circuit similar to high-intensity interval training.

Muscular endurance refers to the ability of the muscle to work over an extended period of Time without fatigue.

Muscular strength is health-related component of physical fitness that relates to the ability of the muscle to exert force and it is the amount of force a muscle can produce with a single maximum effort.

Chapter two

2. Review of Related literatures

2.1 Concepts of Circuit Training

Circuit training is a form of body conditions of resistance training using high intensity aerobics exercises targeting strength building or muscular endurance.

It is an exercise of circuit**,** which is one of the computations of all prescribed exercise in physical education program. Circuit training is a fertile field for the development of the educational aspects. In this concern, self-dependence work and self- assessment are widely available in the circuit training.

Circuit training method was originally introduced by R. E. Morgan and G.T. Adamson in 1957 at the University of Leeds, England (Crivitz Len 1996).

Circuit training can be used for general fitness purposes or can be adopted as a conditioning medium for various grounds sports used by many professional soccer and teams in football and competitive teams. It enables large number of performers to train together by employing consecutive exercises around which each performer progresses individually through derived dosage of exercise and timing.

In a circuit training, a number of exercises with specified objectives are considered by performing prescribed exercises at each station before moving on to the next one. The requirement at a specific station is to run a specific weight within the prescribed number of times.

Circuit training became an important device in conditioning girls for participation in track and field activities as well as in other sports activities (Global Journals, 2013).

Circuit training includes design, rationing and load variation of the principle of the individual differences among the trainees.

Traditionally, the time between exercise circuit training is short with rapid movement to the next exercise (Kraviz, Len 1996).

Circuit training is the most time efficient ways to enhance cardiovascular and muscle endurance. The initial objective of Circuit training can be achieved either by time-specific exercises with constant rest periods or by time exercises performed during the shortest possible time within an entire circuit of exercises within the shortest possible period (Reddy, M and Jyoti, 2012).

In designing the circuit training units, changing the load through the stations should be taken into consideration in a manner compatible to the basic muscle groups.

Circuit training has many educational advantages such as availing mutual respect opportunity among the individuals and respecting those with humble abilities and capabilities equally at the same level of respect to those of higher abilities (Reddy, M and Jota, 2012).

There are literally thousands of potential circuit training exercises that can be used to develop suitable routines. Many exercises require little or no expensive equipment, nothing more than a mat and a set of dumbbells and dozens of routines can be improvised.

The following types of circuit training exercises are useful for designing a classic routine of strength and endurance in many prolonged sports with intermittent bout of activity such as soccer and field hockey.

In view of this, circuit training is very time efficient helping to develop strength and stamina in a single session and athletes can make use of this general workout too-in the off season.

The feature of circuit training is as follow circuit training is flexible not rigid one. Based on the availability of time, one can either reduce the number of circuit or extended the number of circuit in their circuit training program.

circuit training can be conducted either in a short time of one complete of total body workout in about 10 minutes or in a too much time for more challenging workout taking up to four circuits completing taking up to 45-minute workout.

Circuit training can be done at home or gymnasium and circuit training can significantly improve overall. Circuit training is the best for beginners and those of average fitness looking to tone up and get shape (Jacobs Petal 2001).

During circuit training, heart rates fluctuate between aerobics and an aerobic zone more calories than either traditional steady state cardio or strength session alone. Greater cardiovascular endurance, when

Circuit training can increase aerobic oxygen consumption and VO_2 resulting in greater stamina and overall fitness with the performed over 8 weeks (Badalona 2011). The amounts of calories burned per workout depends on the intensity and duration of the exercise selected and the body weight.

Circuit training has been reported to burn approximately 500-600 kilo calories per hour depending on the body weight. But this numbers increase significantly when exercise also perform aerobic intervals.

Circuit training decrease fat mas, and strength training increase lean body mass, more metabolically active than fat. Routine strength training builds muscles that burn more calories both during training and at rest (basal metabolic rate) for a higher metabolism, which helps which fat loss and weight management (Gateman, et al. 2005).

2.2 Principles of circuit training

Circuit training is a form of body conditioning that involves endurance training, resistance training, high-intensity aerobics and exercises performed in a circuit similar to high-intensity interval training.

Specificity of circuit training states that sports training should be relevant and appropriate to the sport for which the individual is trained in order to produce a training effect to improve the range of movement for a particular joint action to perform exercises that involve in joint actions.

It is quite possible for an athlete to have good mobility in the shoulder joint but to have poor hip mobility. Conducting shoulder mobility exercises may further improve the shoulder mobility but it will not affect hip mobility.

In addition to developing general levels of all round mobility in an athlete, the coaches need to consider the specific mobility requirements of a given event.

The coach can analyze the technique of his event, identify which joint actions are involved and determine which is needed to be improved in terms of the range of movement. It is necessary to measure the range of movement for particular joint actions to determine the present range and future improvement. It is an important principle in strength training where the exercise must be specific to the type of strength required and related to the particular demands of the event.

Couching has the knowledge of the predominant types of muscular activity associated with particular event of movement patterns involved and the types of strength required.

Although specificity is important, it is necessary in every schedule to include exercises of a general natural power whose exercises are related too closely to the movement of any athletic event making a balanced development and provide a strong base upon which highly specific exercise can be built.

Training at low velocity increases low velocity strength substantially, but has little effect on high velocity strength (Comynes, tom, 2018).

Slow velocity training may be of values in stimulating maximum adaptation within the muscle. Muscle growth (and increase in contractile strength) is related to the amount of tension developed within the muscle.

When an athlete performs high velocity strength work, the force generated is relatively low and therefore fails to stimulate substantial muscular growth and if performed extensively, the athlete may not be induced to maximum adaptation with the muscles.

Therefore, it is important for the athlete to use fast and slow movements to train the muscles (Hawley, E., 2001).

2.3 Circuit Training Methods

Aerobic circuits are simply to raise work capacity and improve fitness used as a recovery time modality on days when the practitioners are beat up and need to back of the exercise seasons.

The intensity of these circuits is low and the rest interval between movements is minimal allowing the athlete to move from one exercise to the next at their own pace.
The rest time assigned within the interval of circuit training is 30-60 seconds of 8-12 repetitions using a 15-20 RM load.

The work requires more than 30 min in a circuit workout allowed to take a little bit longer rest at the end of a complete circuit (90-120 sec) before starting over. Commonly, a workout using this format would consist of a warm up (10- 15 min) 30min of circuit work and then 30-40min of tempo work on the field.

When using this method of circuit training for recovery purposes, we tend to focus more on joint mobility exercises, various stretches (yoga type sequences) and dynamic mobility activities (Patrick 2006 , Tempe, AZ.2009).

2.4 Rest time intervals of circuit training

The rest interval for the various circuits is essential. Too often coaches and athletes cut their rest interval short in order to try and "do more work" or just get things done in a faster period of time. If you want to properly develop some of these energy systems then the rest interval is an important rule to follow as it will ensure that you are able to put the greatest amount of effort into the work interval. There are times when doing things under fatigue and trying to repeat your effort in this manner are important, however, you should work up to this sort of training by first making sure that you can give 100% and slowly lowering the rest interval until you can repeat maximal or near maximal efforts with minimal rest (Patrick 2006, Tempe, AZ. 2009).

2.5 Intensity of exercise during circuit training

Intensity in circuit training refers to the quantitative, rather than the qualitative aspect of stimulation and experience. For example, the magnitude or amplitude of sound waves as distinguished from their frequency (Hawley, E., 2001).

2.6 Circuit training overload

A strength training principle states that the intensity of exercise must be high enough above normal for physiological adaptation to occur. If one wants to see results when lifting weights, he/she has to lift more than his/her muscles can handle that overload and cause the muscle fibers to grow stronger and sometimes bigger in order to handle the extra load.

When an athlete performs a mobility exercise, he/she should stretch to the end of his/her range of movement. In active mobility, the end of the range of movement is known as the active end position. Improvements in mobility can only be achieved by working at or beyond the active end position. Passive exercises involve passing the active end position, as the external force is able to move the limbs further than the active contracting of the agonist muscles. Kinetic mobility (dynamic) exercises use the momentum of the movement to bounce past the active end position a muscle will only strengthen when forced to operate beyond its customary intensity. The load must be progressively increased in order to further adaptive responses as training develops; and the training stimulus is gradually raised.

Overload can be progressed by increasing the resistance, increasing the number of repetitions with a particular weight, increasing the number of sets of the exercise (work) and increasing the intensity-more work in the same time i.e. reducing the recovery periods *(*Hanson and A.E. Jeukendrup 2004*).*

2.7 Recovery time among each circuit training stations

Recovery time implies the physiological processes that restore the body to its pre-exercise condition after exercise.

Recovery includes replenishment of muscle glycogen and phosphates (the energy Stores in the muscles), removal of lactic acid and other metabolites (the waste products of muscle activity) re-oxygenation of myoglobin (the special respiratory pigment which provides muscles with an extra source of oxygen) and replacement of protein (needed to repair muscles damaged during exercise). Recovery can be accelerated by ensuring body fluids lost in sweat which are to be replaced with water by replacing mineral salts lost in sweat (especially sodium and potassium) and by eating enough nutrients (especially foods that can be converted to muscle glycogen) in order to replace those lost minerals and fluids during the exercise.

Rest is required in order for the body to recover from the training and to allow adaptation to take place (Godfrey, R 2005).

2.8 Load Progressions during exercise

Progression means gradually increasing the amount of exercise. When a performer first starts exercising, their levels of fitness may be poor. If a coach increases the training too quickly, the body will not have time to adapt and this may result in injury. Slow and steady progress is the best way forward. Gradually increasing the frequency, intensity and duration of fitness sessions are important factors in developing an effective training program.

In terms of type of training, progression should be based on the principle of moving from easy activities to difficult ones. (Godfrey R., 2005).

2.9 Moderations of circuit exercise

Moderation means achieving a balance between "not training enough" and "overtraining". Achieving the right balance is very important. Without proper rest and recovery time, performers will become too tired to the trained effectively and efficiently become stressed and irritable. Even worse, overtraining can lead to injury.

This can occur through over stressing joints and tissues or through poor technique resulting from exhaustion (Godfrey, R.2005).

2.10 Reversibility or detraining in circuit training

The Reversibility Principle states that athletes lose the effects of training after they stop. During the off season, active participation in other sports or physical activities is essential. Improved ranges of movement can be achieved and maintained by regular use of mobility exercises. If an athlete ceases mobility training, the ranges of movement will decline over a period of time. When training ceases, the training effect will also stop. It is third of the rate of acquisition.

Athletes must ensure that they continue strength training throughout the competitive period, although at a much-reduced volume, or newly acquired strength will be lost (Godfrey, R, 2005). It is to be noted that members performing long-duration and moderate intensity exercise, (as this may put participants in a catabolic state,) they will start losing muscle mass.

Hence, it is important to test the importance of determining appropriate intensities through metabolic testing.

Determining VO_2 at various intensities and aerobic threshold, among other variables, will allow safe, effective and results-driven activity. Monitoring intensity and recovery with a heart rate monitor will enhance outcomes and provide an additional motivating variable to participants.

The effects on specific muscle fibers should also be considered. Slow twitch muscle fibers are more compatible with short, intense bouts of exercise such as sprinting (group cycling) and weightlifting. When training in one of these modes, the muscle tissue has a tendency to take on the appropriate properties.

As an illustration, imagine a marathon runner and a sprinter. The sprinter is composed of fast twitch muscles and carries a great deal more muscle mass, whereas the marathon runner has a lot of thin, slow-twitch muscle fibers. This may be extreme to prove a point; however, it is easy to see how much of a difference the type of training has on body shape.

Due to fewer rest periods, there will be a greater release of testosterone during circuit training, which helps muscles to grow. While it is true that performing a long aerobic session will lower the testosterone level and release cortisol (which causes the body to break down muscle tissue), this workout session will not take that long to complete.

Finally, since participants move through the workout quickly, they will not have to spend long hours in the fitness center and will be able to spend more time doing the things they never seemed to have time or energy to do (Godfrey, R., 2005).

2.11 Muscular strength

According to Intel & Roth (2002), muscular strength is health-related component of physical fitness that relates to the ability of the muscle to exert force and it is the amount of force a muscle can produce with a single maximum effort.

Strong, powerful muscles are important for the smooth and easy performance of everyday activities, such as carrying groceries, lifting boxes and climbing stairs as well as for emergency situations.

They help to keep the skeleton in proper alignment, preventing back and leg pain and providing the support necessary for good posture and it can be developed by training with weights or by using the weight of the body for resistance during callisthenic exercises such as push-ups and sit-ups.

Strength and performance have direct relationship; according to the research result conducted on skeletal muscle mass and muscle strength in relation to extremity performance of older men and women suggest that low muscle mass, low muscle strength is associated with poor physical function (Paul, 2000).

Muscular strength exercises help to reduce the occurrence of joint and muscle injuries that may occur during physical activity. It is improved by performing strength training associated with increased muscular tone and strength and improves personal appearance and self-esteem.

This type of exercise is developed by performing different activity like push-up, sit-up, to lift heavy weight and others to keep the skeleton in proper alignment, preventing back and leg pain and providing the support necessary for good posture, which can be developed by training with weights or by using the weight of the body for resistance during callisthenic exercises of push-ups and sit-ups.

Strength and performance have direct relationship; according to the research result conducted on skeletal muscle mass and muscle strength in relation to extremity performance of older men and women suggest that low muscle mass, low muscle strength is associated with poor physical function (Paul, 2000).

According to Stephens (1988) and Stone (1990), muscular strength exercises help to reduce the occurrence of joint and muscle injuries that may occur during physical activity. Muscular strength is improved by performing strength training with increased muscular tone with personal appearance and self-esteem.

According to Botticelli (2007), the generality and specificity of muscle force production is influenced by the relationship of muscle groups and muscle function relative to strength training, fiber type used, the speed of muscular contraction, the amount of force produced, and the designated pattern of movement utilized when strength is exhibited during tackling, heading and in shooting for power. Meacham (2004) has point out that strength is specific in nature and for true assessment it would be necessary to test each major muscle group of the body.

Lab and field tests are similar and involve the assessment of one repetition of the maximum amount of resistance can overcome one time and strength can also be assessed using dynamometers.

In the absence of the above measurement, we can also use field tests such as wall-sit test that simply hold in the correct position as much as possible and record the time.

Muscular strength is improved by performing strength training (Olsen, 1988). Muscle force production is influenced by the relationship of muscle groups and muscle function relative to strength training, fiber type used, the speed of muscular contraction, the amount of force produced, and the designated pattern of movement utilized. Strength is exhibited during tackling, heading and in shooting for power. Meacham (2004) has point out that strength is specific in nature and for true assessment it would be necessary to test each major muscle groups.

In the absence of the above measurement, we can also use field tests such as wall-sit test. In this case we simply hold in the correct position as much as possible and record the time. Muscular strength is improved by performing strength training (Olsen, 1988). Associated with increased muscular tone and strength, it improves personal appearance and self-esteem. This type of exercise is developed by performing different activity like push-up, sit-up, to lift heavy weight, and others (Stephens, 1988).

Muscular strength refers to the maximum amount of force a muscle can exert against an opposing force. Fitness testing usually consists of one-time maximum lift using weights, bench press and leg press. Muscular strength and performance have direct relationship. According to the research result conducted on the skeletal muscle mass and muscle strength in relation to lower extremity performance of older men and women suggest that low muscle Strength, but not low muscle mass is associated with poor physical function (Paul et al., 2000).

2.12 Muscular endurance

Muscular endurance refers to the ability of the muscle to work over an extended period of Time without fatigue. Performing push-ups and sit ups or crunches for one minute is commonly used in fitness testing of muscular endurance. In training setting muscular strength and muscular endurance can go in line.

According to the research conducted on the effects of strength training on endurance capacity of top-level endurance athletes, strength training can lead to enhanced Long-term and short-term endurance capacity both in well trained individuals and highly trained top-level endurance athletes, especially when high-volume, heavy-Resistance strength training protocols is applied (Asgardand Andersen, 2010). Muscular endurance is a health-related component of physical fitness that relates to the muscle's ability to continue to perform without fatigue.

According to Corbin (2003), muscular endurance as the maximum number of repetitions or muscle contractions one can perform against a given resistance.

Muscular endurance is specific in nature. 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 are 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). (Lee et al., 1997) also defined Muscular endurance can be developed through push-up, sit-up, rope skipping, jogging, and others.

2.13 Benefit of Circuit Training

Study show that circuit training helps women to achieve to their goals and maintain them longer than other forms of exercise of diet. Morgan and Anderson (1953) claim from a health perspective is that this investigation clearly shows that performance of this circuit of exercise. This level of intensity elicited oxygen consumption value (39% to 51.5% of VO_2 max that meet establish guidelines of recommended intensity (40% to 85% of VO_2 max) of exercise for developing and maintaining cardio respiratory fitness (kina 2013).

Chapter three

3 Research Methodologies

3.1The study site

The study was conducted on 30 randomly selected students from Enchini Secondary School found in West Showa Zone of Adea Berga District of Oromia Regional National State 68 km away from the capital.

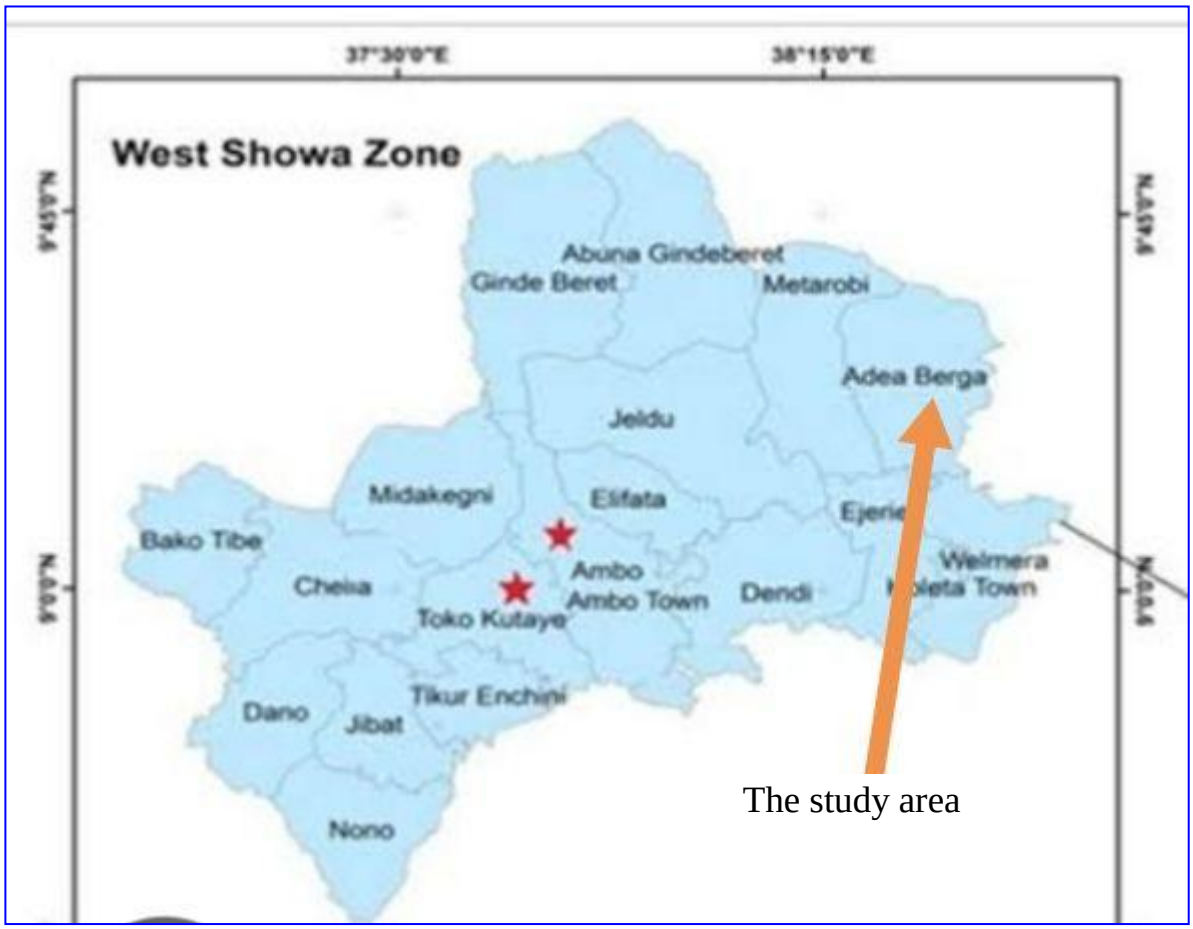


Figure 1 Map of the study Area

3.2 Research design

In this study, experimental based research method was designed. The population of the study was 30 male students selected through stratified sampling techniques from Enchini Secondary school to conduct circuit training exercise for two consecutive months in six groups of circulation two days per week (Monday and Thursday) for 40 to 60 minutes per day.

The objective was to develop muscle strength and endurance of the participant through circuit training exercises so that 30 students were put into six groups of five members to begins the circuit training sessions with low intensity exercises and follow with training principles of circulating.
The design was to assign all 30 selected students to undergo six circular exercises of circuit training including: 1) push up, 2) jump jack, 3) sit ups, 4) rope jump, 5) step up and 6) pull ups before the beginning of circuit training and measure their performances through pretests using observation checklists and record data as baselines.
After the pretest on performance of practitioners, circuit training exercises were provided for two months on six selected parameters.
After circuit training exercises, posttests to measure the performances of participants was planned though six groups of parameters and identify developments on muscular strength and endurances.
In the pretest and posttest circuit training exercises on muscular strength and muscular endurance, all 30 practitioners were engaged for eight weeks beginning with warm- up and cool-down exercises on push up, sit up, rope jump, jumping jack, step up and pull ups.
The following circle shows 6 stations of circuit training, which is designed to develop muscular strength and endurance of students and each station lasts for one minute with 30s rest intervals.
The participants change the position after completing one station by the correct order of exercises.
Performance assessment of participants was measured through the pretest and posttest and recorded using overt observation checklists while conducted six stations-based circuit training. The population of the study was 30 students selected through stratified sampling techniques from Enchini Secondary school to undergo circuit training. It was planned to commence with measuring and identifying the ability of all 30 participants on muscular strength and endurance through six stations composing five members using push up, jumping jack, sit up, rope jump steps up and pull up exercises. The performance of practitioners was measured and recorded in observation worksheets using pretest at as baseline information data of performances. Then, experimental field-based circuit training was conducted to investigate its effects circuit training on muscular strength and endurance of the population of the study. The circuit training exercises were provided for 8 weeks on the same exercise contents and the performance of the population was measured after two months of training through posttest and the results were analyzed comparatively.

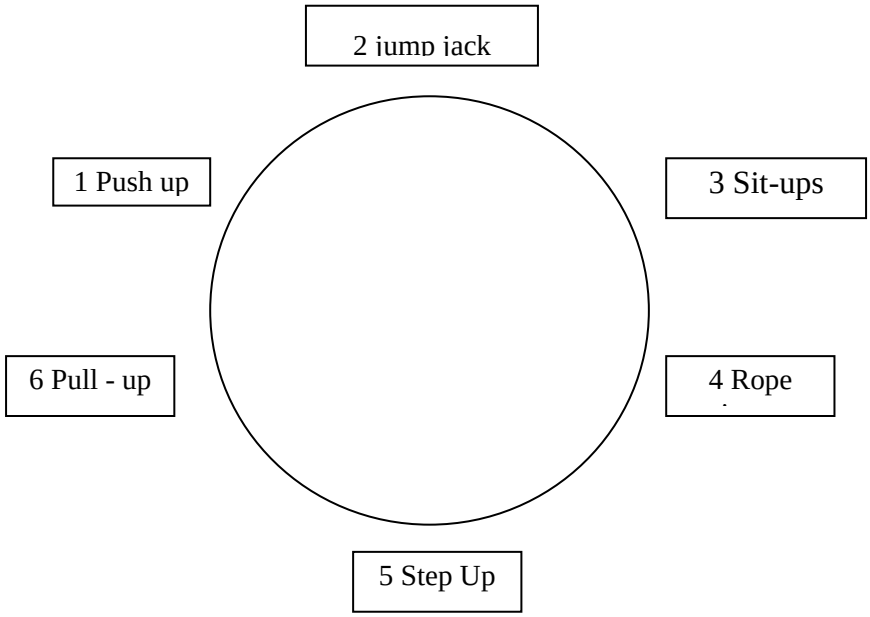


Figure 2 Six circuit training stations

3.3 Methods

As designed, selected 30 students were set into six groups of circuit training during the pretest and posttest to measure the performance of participants.

The pretest measurement on performance of participants throughout six circuit training components was conducted without any training input to investigate the basic information on performance and use basic data from which all changes were evaluated as development.

Then, circuit training was provided on practical exercises of six groups using all test parameters of the components for 40 to 60 minutes throughout 8 weeks twice a week on Monday and Friday beginning with low-intensity exercises and adhered to established training. This structured approach was to enhance muscular strength and endurance through consistent and progressive exercises over the period of three-months or 8 weeks. After 2 consecutive months circuit training, posttest measurement was conducted and data was collected using observation checklists.

After the circuit training, posttests were conducted on the same components using the same parameter.

Data on performances of participants were collected using observation checklist and recorded in which any increment or reductions was as evaluated in comparison of the posttest against the pretest.

Data analysis and evaluation methods were descriptive approach through both qualitative and quantitative strategies.

3.4 Data collection tools

3.4.1 Observation Checklist

Overt observation checklist containing variables of performances score value of tests for each test parameters by rules.

3.5 Sampling technique and Sample Size

Totally 50 students were registered for the circuit-training program of which 30 students were stratified using personal health history and suitability based on responds to questionnaires distributed to all 50 interested students.

Based on screened results of the health conditions, 30 students of ages 17-19 years old were selected from the original 50 for participation in the circuit-training program.

Table 1 Schema of data sampling of circuit training exercises

Station groups	Pretests	Circuit training	Posttest	Development
G1=5 members	Push up	Exercises	Push up	Differences
G2=5 members	Jump jack	Exercises	Jump jack	Differences
G3=5 members	Sit up	Exercises	Sit up	Differences
G4=5 members	Rope jump	Exercises	Rope jump	Differences
G5=5 members	Step up	Exercises	Step up	Differences
G6=5 members	Pull up	Exercises	Pull up	Differences

3.6 Circuit training protocol

The circuit training protocol was structured to enhance various aspects of muscular strength and endurances. Participants of a single group demonstrated performances in a series of exercises in a circuit format and each session began with a warm-up on running on the spot, arm circling, skipping jumps, astride jumping, one-knee raising, vaulting in threes, free walking, kicking out-stretched hands with one foot every third step and back pushing and pressing to the chest with assistance from the hands to prepare the participants for the rigorous activity.

Chapter four

4. Data Evaluation and Results

4.1 Data presentation

Research data were collected on six components of circuit training during the pretest and posttests using overt observation checklists. The components of circuit training selected to develop muscle strength and endurances of participants dealt with the six-station exercise of push up, jump jack, sit ups, rope jump, step up and pull ups.

Table 2 Data collected through 1m push up exercises

Participant	Pretest	Participant	Pretest	Participant	Pretest
p1	20	p11	15	p21	18
p2	30	p12	32	p22	24
P3	36	p13	16	p23	25
p4	22	p14	20	p24	28
p5	24	p15	21	p25	24
p6	15	p16	17	p26	20
p7	20	p17	13	p27	15
p8	27	p18	30	p28	21
p9	20	p19	18	p29	17
10	28	p20	20	30	17

Table 2 shows data collected on 1minute push up exercises of six groups of 30 participants in circuit training during the pretest to check up the performances of participants using overt observation checklist. It was conducted on the first station of circuit training cycle, which viewed various results depending up on individual ability.

Table 3 Data collected through 1minute push up exercises

Participant	Posttest	Participant	Posttest	Participant	posttest
P1	34	p11	50	p21	30
p2	36	p12	42	p22	38
P3	42	p13	30	p23	40
p4	52	p14	25	p24	40
p5	54	p15	28	p25	33
p6	36	p16	40	p26	35
p7	38	p17	28	p27	22
p8	48	p18	46	p28	45
p9	28	p19	34	p29	38
p10	34	p20	30	p30	38

Table 3 indicates data collected on 1 minute push up exercises of station one after two solid months on circuit using posttests to identify the post training performances of participants in comparison

with the performance of participants during the pretests.

The result viewed development in performances throughout all 30 participants showing the circuit training had great input and improved performances (table 4).

Table 4 Data collected through 1minute push up exercises

Participants	Pretest	Posttest	Development
p1	20	34	14
p2	30	36	6
P3	36	42	6
p4	22	52	30
p5	24	54	30
p6	15	36	21
p7	20	38	18
p8	27	48	21
p9	20	28	8
p10	28	34	6
p11	15	50	35
p12	32	42	10
p13	16	30	14
p14	20	25	5
p15	21	28	7
p16	17	40	23
p17	13	28	15
p18	30	46	16
p19	18	34	16
p20	20	30	10
p21	18	30	12
p22	24	38	14
p23	25	40	15
p24	28	40	12
p25	24	33	9
p26	20	35	15
p27	15	22	7
p28	21	45	24
p29	17	38	21
p30	17	38	21
	21.8	37.2	15.37

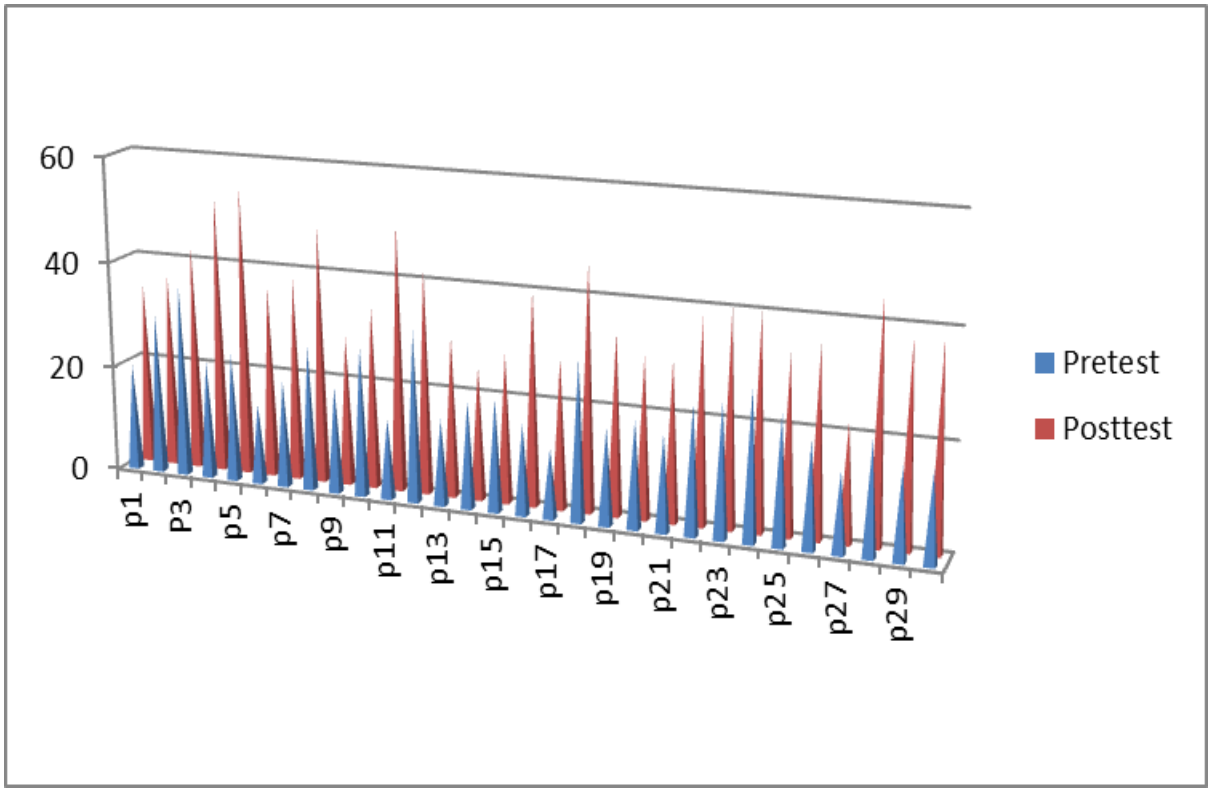
Table 4 displays the pretest and posttest results of 1 minute push-up exercise performance of 30 participants in six groups containing five members before and after the circuit training. The range of

scores varied from a minimum of 13 push-ups to a maximum of 36 with a standard of 23 ranges of variability in performances.

After completing 8 weeks of circuit training, the post-training push-up test results showed a minimum of 22 push-ups to a maximum of 54 push-ups.

The increase in the number of push-ups from 22 in the pre-test to 32 in the post-test highlights a significant enhancement in muscular endurance attributable to the circuit training program. This improvement underscores the effectiveness of the training regimen in strengthening the core muscles and increasing endurance.

Overall, these findings demonstrate that the circuit training program had a substantial and positive impact on the participant's muscular endurance, as evidenced by the significant increase in their push-up performance.



Graph 1 Development of muscular strength and enducrance through Push up

Table 5 Data collected through 1minute jumping jack exercises during pretest

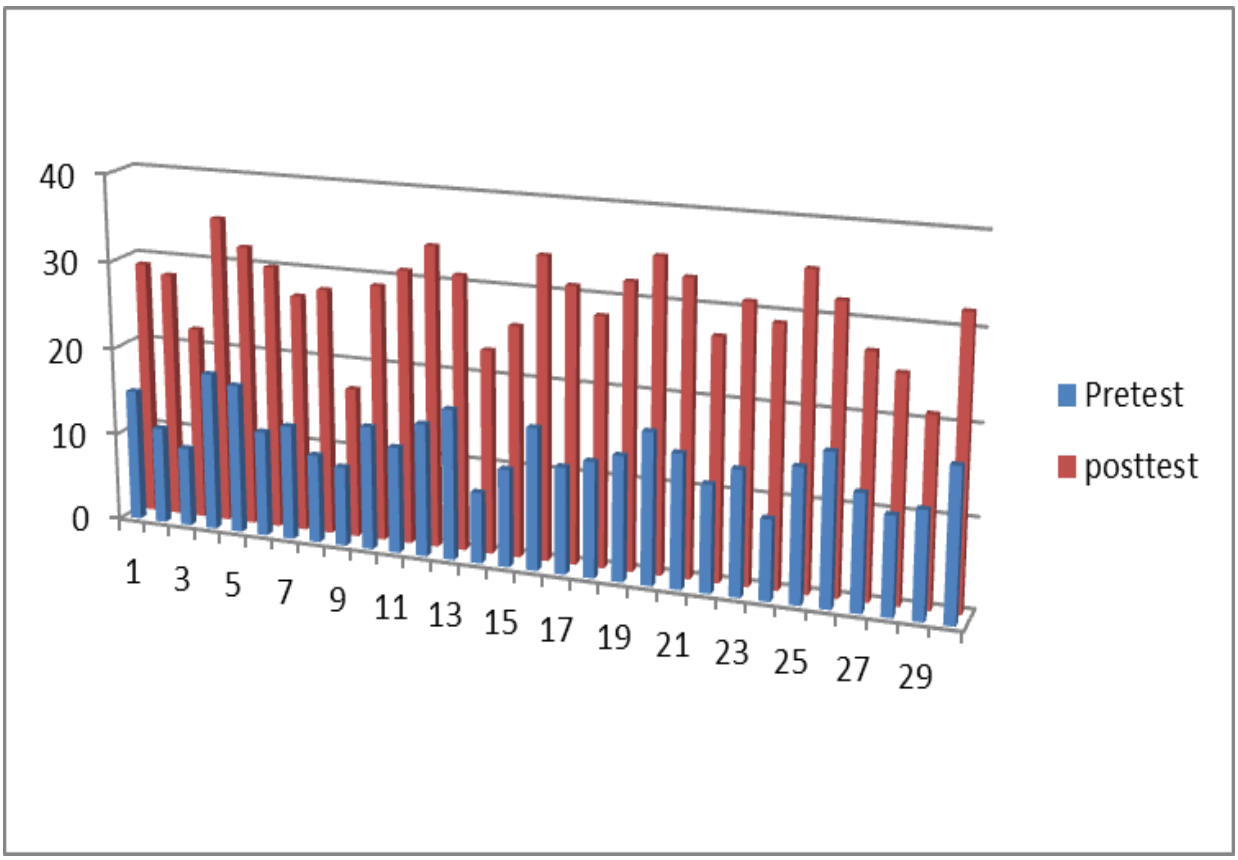
Participants	Jumping jack	Participants	Jumping jack
p1	15	p16	16
p2	11	p17	12
p3	9	p18	13
p4	18	p19	14
p5	17	p20	17
p6	12	p21	15
p7	13	p22	12
p8	10	p23	14
p9	9	p24	9
p10	14	p25	15
p11	12	p26	17
p12	15	p27	13
p13	17	p28	11
p14	8	p29	12
p15	11	p30	17

Table 5 above shows the result of performances of participants on station two 1 minute jump jack exercises during the pretest before two months circuit training was provided. As usual, the result of individuals showed different muscular strength and endurance on jump jack performances at first before circuit training.

Table 6 Data collected through 1minute jump jack exercises

Participant	Posttest	Participant	Posttest	Participant	Posttest
p1	**29**	p11	**31**	p21	**33**
p2	**28**	p12	**34**	p22	**27**
p3	**22**	p13	**31**	p23	**31**
p4	**35**	p14	**23**	p24	**29**
p5	**32**	p15	**26**	p25	**35**
p6	**30**	p16	**34**	p26	**32**
p7	**27**	p17	**31**	p27	**27**
p8	**28**	p18	**28**	p28	**25**
p9	**17**	p19	**32**	p29	**21**
p10	**29**	p20	**35**	p30	**32**

The above table 6 shows the performance results of six groups containing five members of all 30 participants during the posttest after two months of circuit training using station two of jump jack exercises collected through observation checklist and summarized in table 7 and Graph 2.



Graph 2 Performance differences on jump up pretest and posttest

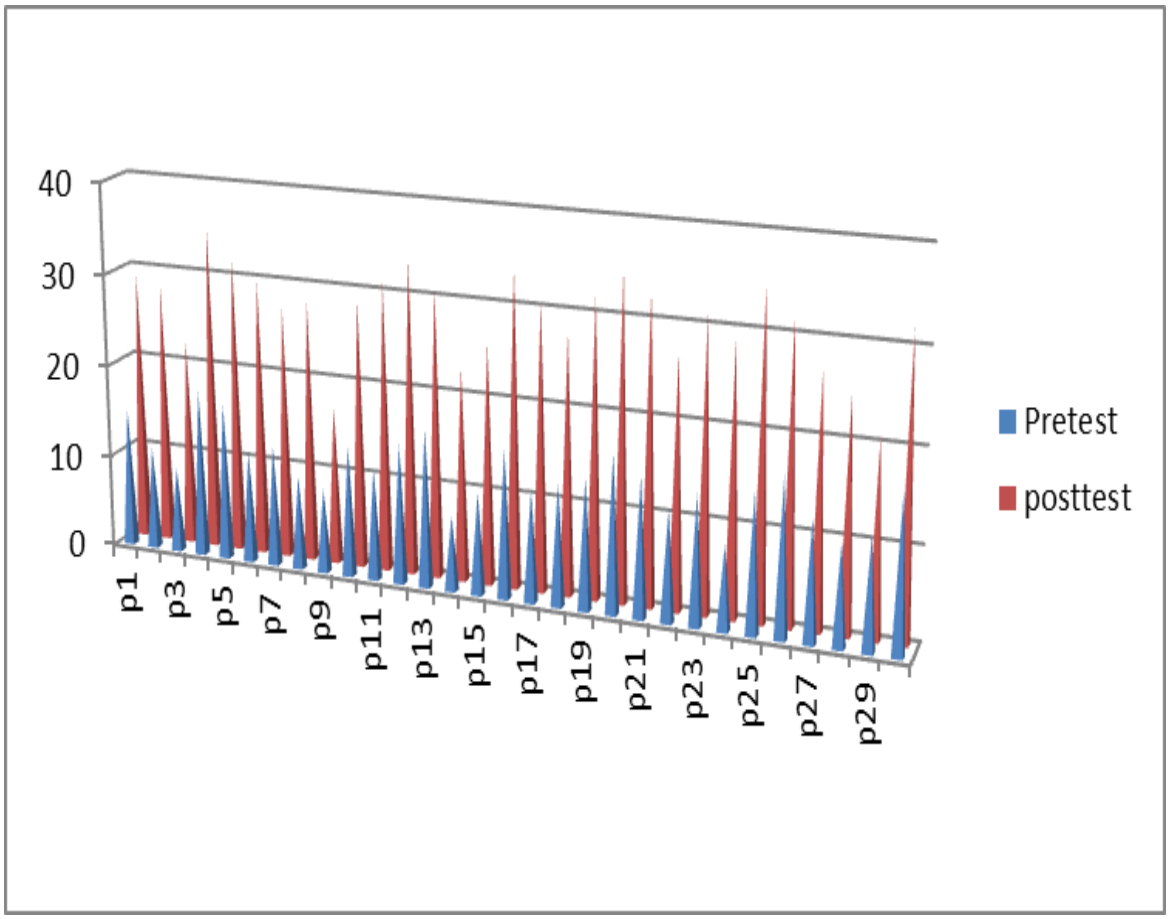
Table 7 Data collected through 1minute jumping jack pretest and posttest

Participants	Pretest	Posttest	Development
p1	**15**	**29**	**14**
p2	**11**	**28**	**17**
p3	**9**	**22**	**13**
p4	**18**	**35**	**17**
p5	**17**	**32**	**15**
p6	**12**	**30**	**18**
p7	**13**	**27**	**14**
p8	**10**	**28**	**18**
p9	**9**	**17**	**8**
p10	**14**	**29**	**15**
p11	**12**	**31**	**19**
p12	**15**	**34**	**19**
p13	**17**	**31**	**14**
p14	**8**	**23**	**15**
p15	**11**	**26**	**15**
p16	**16**	**34**	**18**
p17	**12**	**31**	**19**
p18	**13**	**28**	**15**
p19	**14**	**32**	**18**
p20	**17**	**35**	**18**
p21	**15**	**33**	**18**
p22	**12**	**27**	**15**
p23	**14**	**31**	**17**
p24	**9**	**29**	**20**
p25	**15**	**35**	**20**
p26	**17**	**32**	**15**
p27	**13**	**27**	**14**
p28	**11**	**25**	**14**
p29	**12**	**21**	**9**
p30	**17**	**32**	**15**
	13.26	**29.13**	**15.86**

Table 7 displays performance results on jumping jack of participants before and after the circuit training showing a minimum of 9 and a maximum of 18.

The range of pretest jumping jack is nine. The range of scores varied from a minimum of 17 to a maximum of 35 with performances differences of 18 indicating a great change in the result of posttest in comparison to pretest.

This improvement underscores the effectiveness of the training regimen in strengthening muscles and increasing endurance Graph 3).



Graph 3 Performance differences on jump jack pretest and posttest

Table 8 Data collected through 1minute step up exercises

Participant	Pretest	Participant	Pretest	Participant	Pretest
p1		p11		p21	
p2		p12		p22	
p3		p13		p23	
p4		p14		p24	
p5		p15		p25	
p6		p16		p26	
p7		p17		p27	
p8		p18		p28	
p9		p19		p29	
p10		p20		p30	

Table 9 Data collected through 1minute step up test

Participant	Posttest	Participant	Posttest	Participant	Posttest
p1	**21**	p11	**19**	p21	**29**
p2	**17**	p12	**17**	p22	**31**
p3	**16**	p13	**21**	p23	**21**
p4	**18**	p14	**27**	p24	**25**
p5	**19**	p15	**33**	p25	**27**
p6	**20**	p16	**31**	p26	**18**
p7	**29**	p17	**22**	p27	**21**
p8	**23**	p18	**29**	p28	**19**
p9	**29**	p19	**25**	p29	**28**
p1	**24**	p20	**29**	p21	**25**

Table 10 Performance differences of participants on sit up pretest and posttest

Participants	Pretest	Posttest	Development
p1	11	21	10
p2	10	17	7
p3	13	16	3
p4	8	18	10
p5	7	19	12
p6	11	20	9
p7	15	29	14
p8	13	23	10
p9	14	29	15
p10	12	24	12
p11	9	19	10
p12	10	17	7
p13	11	21	10
p14	13	27	14
p15	14	33	19
p16	15	31	16
p17	9	22	13
p18	16	29	13
p19	12	25	13
p20	14	29	15
p21	15	29	14
p22	15	31	16
p23	12	21	9
p24	11	25	14
p25	13	27	14
p26	10	18	8
p27	11	21	10
p28	11	19	8
p29	16	28	12
p30	13	25	12

Tables 8 and 9 above respectively demonstrate the results of performances of participant during the pretest before and posttests after circuit training on 1 minute sit up exercises showing variances among individuals.

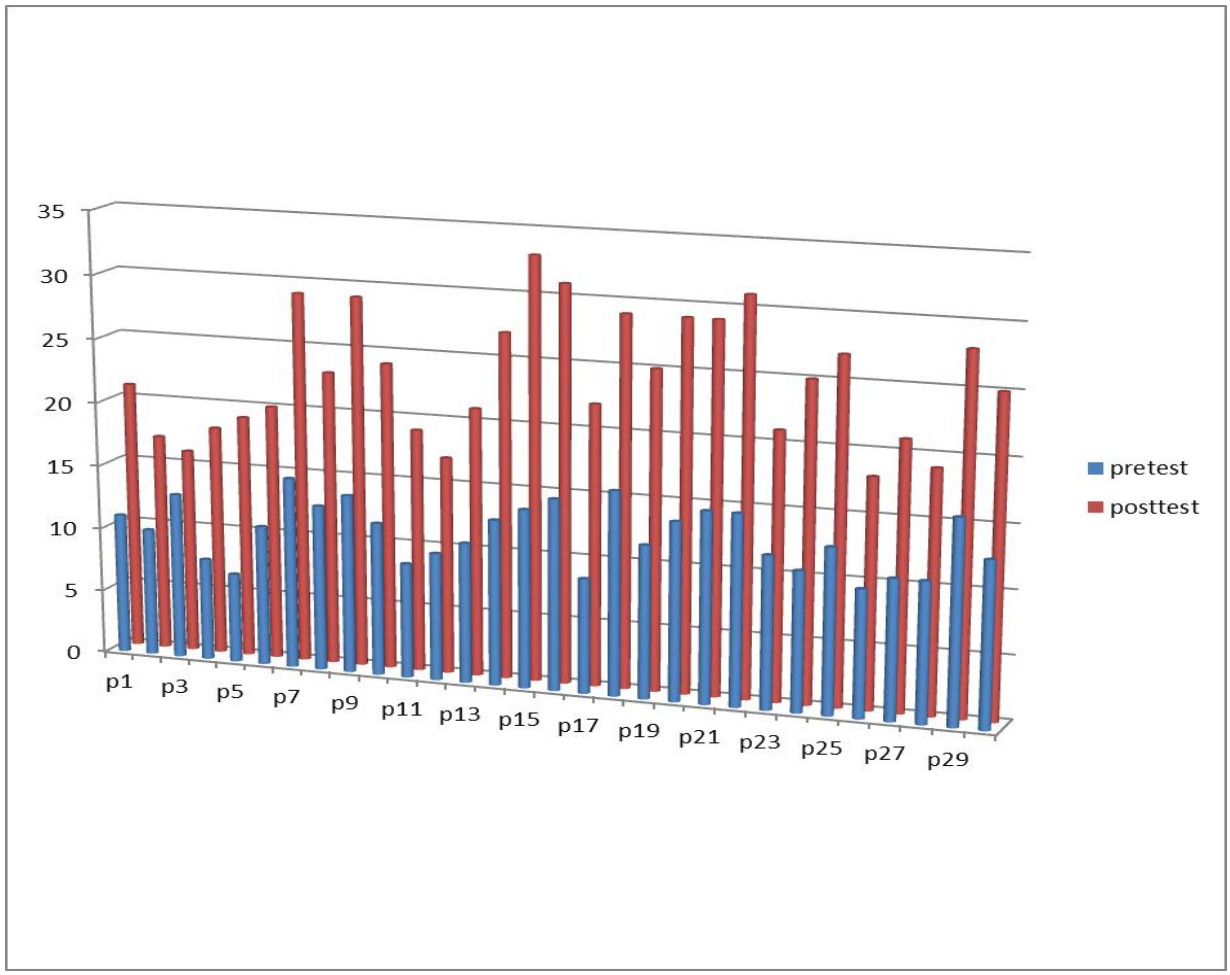
Nevertheless, the differences of performances of individual participants were summarized in table 10 to identify how far the participants have shown developments in muscular strength and endurances.

Table 10 displays the results for sit-up performance among the 30 subjects before and after the circuit training showing ranges of scores varied from a minimum of 7 to 16 sit-ups to a maximum.

After completing 8 weeks of circuit training, the post-training sit-up test results showed a variation of improvement in the average number of sit-ups performed by the participants. There is an

improvement in the posttest circuit training. This improvement underscores the effectiveness of the training regimen in strengthening the core muscles and increasing endurance.

Overall, these findings demonstrate that the circuit training program had a substantial and positive impact on the participant's muscular endurance and strength as evidenced by the significant increase in their sit-up performance.



Graph 4 Performance differences on sit up pretest and posttest exercises

Figure 2 Participants making body warm up before beginning circuit training

Figure 3 Sit-up exercise

Table 11 Data collected through 1minute rope jump test

Participant	Pretest	Participant	Pretest	Participant	Pretest
p1	**13**	p11	**13**	p21	**14**
p2	**14**	p12	**9**	p22	**11**
p3	**9**	p13	**8**	p23	**11**
p4	**15**	p14	**11**	p24	**14**
p5	**16**	p15	**13**	p25	**9**
p6	**13**	p16	**14**	p26	**11**
p7	**12**	p17	**12**	p27	**12**
p8	**16**	p18	**13**	p28	**12**
p9	**17**	p19	**9**	p29	**14**
p10	**12**	p20	**12**	p21	**13**

Table 12 Data collected through 1minute rope jump test

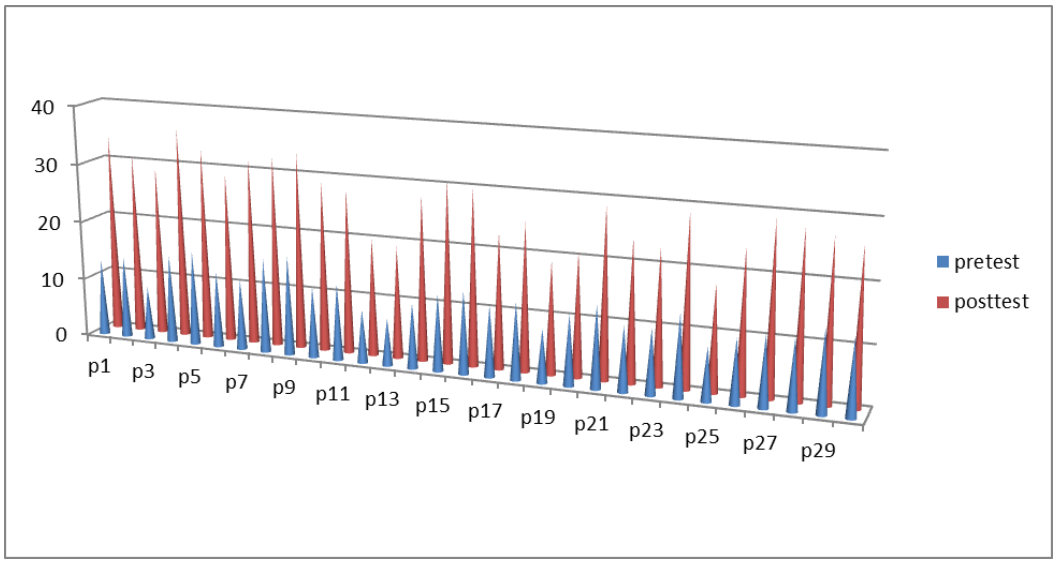
Participant	Posttest	Participant	Posttest	Participant	posttest
p1	**34**	p11	**28**	p21	**15**
p2	**31**	p12	**20**	p22	**13**
p3	**29**	p13	**19**	p23	**12**
p4	**36**	p14	**28**	p24	**15**
p5	**33**	p15	**31**	p25	**9**
p6	**29**	p16	**30**	p26	**13**
p7	**32**	p17	**23**	p27	**17**
p8	**33**	p18	**25**	p28	**16**
p9	**34**	p19	**19**	p29	**13**
p10	**29**	p20	**21**	p21	**13**

Table 13 Data collected through 1minute rope jump pretest and posttest

Participants	Pretest	Posttest	Development
p1	**13**	**34**	**21**
p2	**14**	**31**	**17**
p3	**9**	**29**	**20**
p4	**15**	**36**	**21**
p5	**16**	**33**	**17**
p6	**13**	**29**	**16**
p7	**12**	**32**	**20**
p8	**16**	**33**	**17**
p9	**17**	**34**	**17**
p10	**12**	**29**	**17**
p11	**13**	**28**	**15**
p12	**9**	**20**	**11**
p13	**8**	**19**	**11**
p14	**11**	**28**	**17**
p15	**13**	**31**	**18**
p16	**14**	**30**	**16**
p17	**12**	**23**	**11**
p18	**13**	**25**	**12**
p19	**9**	**19**	**10**
p20	**12**	**21**	**9**
p21	**14**	**29**	**15**
p22	**11**	**24**	**13**
p23	**11**	**23**	**12**
p24	**14**	**29**	**15**
p25	**9**	**18**	**9**
p26	**11**	**24**	**13**
p27	**12**	**29**	**17**
p28	**12**	**28**	**16**
p29	**14**	**27**	**13**
p30	**13**	**26**	**13**

Table 13 displays the results for rope jump performance among the 30 subjects before and after undergoing the circuit training program. The pre-training rope jump reflects the average number of rope jump performed by participants prior to the start of the training. The range of scores varied from a minimum of 9 rope jump to a maximum of 16 rope jump. After completing 8 weeks of circuit training the post-training rope jump test results showed a value of 18 rope jump. This post-training range represents a notable improvement in the average number of rope jump performed by the participants. The range of scores extended from 16 to 34.

The increase in the number of rope jump from 16 rope jump in the pre-test to 34 in the post-test highlights a significant enhancement in muscular endurance attributable to the circuit training program.



Graph 5 Performance differences on rope jump pretest and posttest exercises

Table 14 Data collected through 1minute step up test

Participant	Pretest	Participant	Pretest	Participant	Pretest
p1	9	p11	14	p21	10
p2	11	p12	12	p22	9
p3	14	p13	10	p23	11
p4	15	p14	10	p24	11
p5	12	p15	13	p25	15
p6	16	p16	11	p26	13
p7	11	p17	9	p27	12
p8	14	p18	12	p28	13
p9	15	p19	13	p29	14
p10	13	p11	14	p21	12

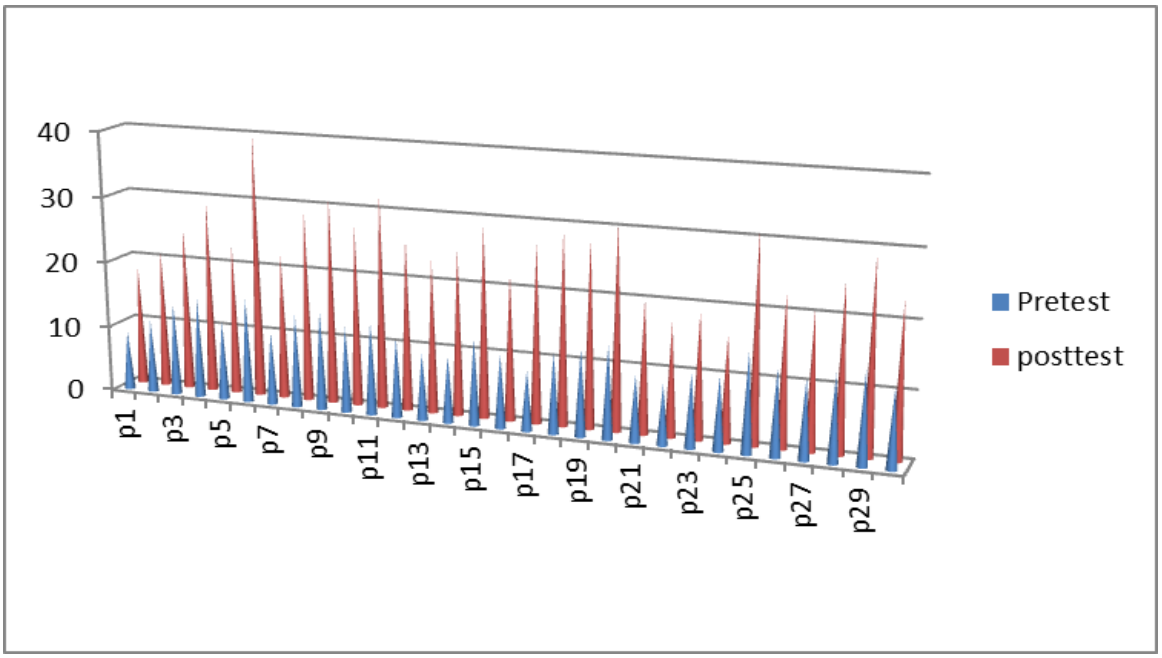
Table 15 Data collected through 1minute step up test

Participant	Posttest	Participant	Posttest	Participant	posttest
p1		p11		p21	
p2		p12		p22	
p3		p13		p23	
p4		p14		p24	
p5		p15		p25	
p6		p16		p26	
p7		p17		p27	
p8		p18		p28	
p9		p19		p29	
p10		p11		p21	

Table 16 Data collected through 1minute step up pretest and posttest

Participants	Pretest	Posttest	Development
p1	9	18	9
p2	11	21	10
p3	14	25	11
p4	15	29	14
p5	12	23	11
p6	16	40	24
p7	11	22	11
p8	14	29	15
p9	15	31	16
p10	13	27	14
p11	14	32	18
p12	12	26	14
p13	10	23	13
p14	10	25	15
p15	13	29	16
p16	11	22	11
p17	9	27	18
p18	12	29	17
p19	13	28	15
p20	14	31	17
p21	10	20	10
p22	9	17	8
p23	11	19	8
p24	11	16	5
p25	15	31	16
p26	13	23	10
p27	12	21	9
p28	13	25	12
p29	14	29	15
p30	12	23	11

Table 16 shows the results of performances of practitioners on step up before and after circuit training. The range of scores varied from a minimum of 9 to a maximum of 16 step-ups after completing 8 weeks circuit training whereby step-up performance showed a score of a minimum 16 to 40 with score differences of 24 that effectively developed muscular strength and endurances.



Graph 6 Performance differences on step up pretest and posttest exercises

Table 17 Data collected through 1minute pull up test

Participant	Pretest	Participant	Pretest	Participant	Pretest
p1	**4**	p11	**4**	p21	**5**
p2	**5**	p12	**2**	p22	**6**
p3	**8**	p13	**6**	p23	**7**
p4	**7**	p14	**4**	p24	**4**
p5	**7**	p15	**5**	p25	**3**
p6	**2**	p16	**2**	p26	**6**
p7	**3**	p17	**3**	p27	**5**
p8	**5**	p18	**6**	p28	**6**
p9	**3**	p19	**3**	p29	**2**
p10	**7**	p20	**6**	p30	**4**

Table 18 Data collected through 1minute pull up test

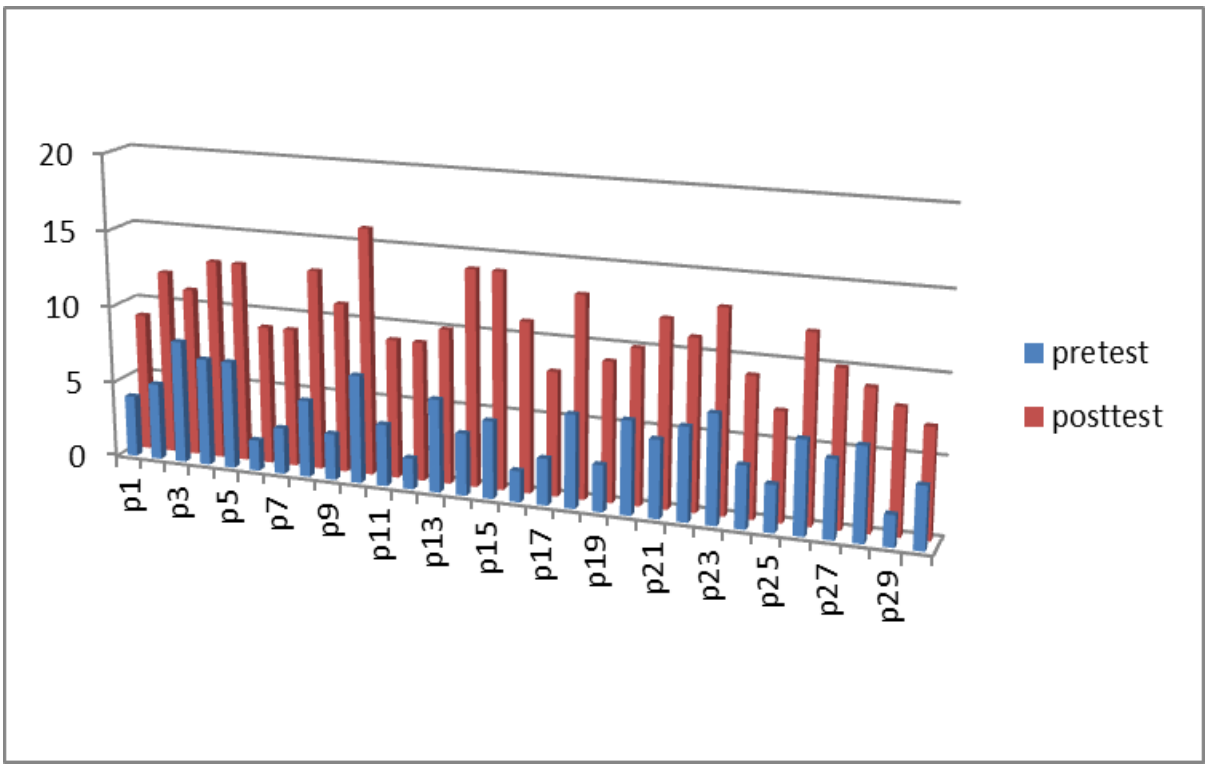
Participant	Posttest	Participant	Posttest	Participant	Posttest
p1	**9**	p11	**9**	p21	**12**
p2	**12**	p12	**9**	p22	**11**
p3	**11**	p13	**10**	p23	**13**
p4	**13**	p14	**14**	p24	**9**
p5	**13**	p15	**14**	p25	**7**
p6	**9**	p16	**11**	p26	**12**
p7	**9**	p17	**8**	p27	**10**
p8	**13**	p18	**13**	p28	**9**
p9	**11**	p19	**9**	p29	**8**
p10	**16**	p20	**10**	p30	**7**

Table 19 Data collected through 1minute pull up pretest and posttest

Participants	Pretest	Posttest	Development
p1	**4**	**9**	**5**
p2	**5**	**12**	**7**
p3	**8**	**11**	**3**
p4	**7**	**13**	**6**
p5	**7**	**13**	**6**
p6	**2**	**9**	**7**
p7	**3**	**9**	**6**
p8	**5**	**13**	**8**
p9	**3**	**11**	**8**
p10	**7**	**16**	**9**
p11	**4**	**9**	**5**
p12	**2**	**9**	**7**
p13	**6**	**10**	**4**
p14	**4**	**14**	**10**
p15	**5**	**14**	**9**
p16	**2**	**11**	**9**
p17	**3**	**8**	**5**
p18	**6**	**13**	**7**
p19	**3**	**9**	**6**
p20	**6**	**10**	**4**
p21	**5**	**12**	**7**
p22	**6**	**11**	**5**
p23	**7**	**13**	**6**
p24	**4**	**9**	**5**
p25	**3**	**7**	**4**
p26	**6**	**12**	**6**
p27	**5**	**10**	**5**
p28	**6**	**9**	**3**
p29	**2**	**8**	**6**
p30	**4**	**7**	**3**
	4.7	**10.7**	**6**

Table 19 displays performance results of pull-up exercises of participants before and after circuit training. The range of scores varied from a minimum of 2 pull-ups to a maximum of 8 pull-ups in the pretest result and a minimum of 9 pull-ups to a maximum of 16 pull-ups in the session of posttest.

After 8 weeks of circuit training the post-training pull-ups test results showed a value of 8 maximum pull-ups. The range of scores extended from 8 to 16 pull-ups.



Graph 7 Performance differences on pull up pretest and posttest exercises

4.3 Results and Discussion

4.3.1 Results

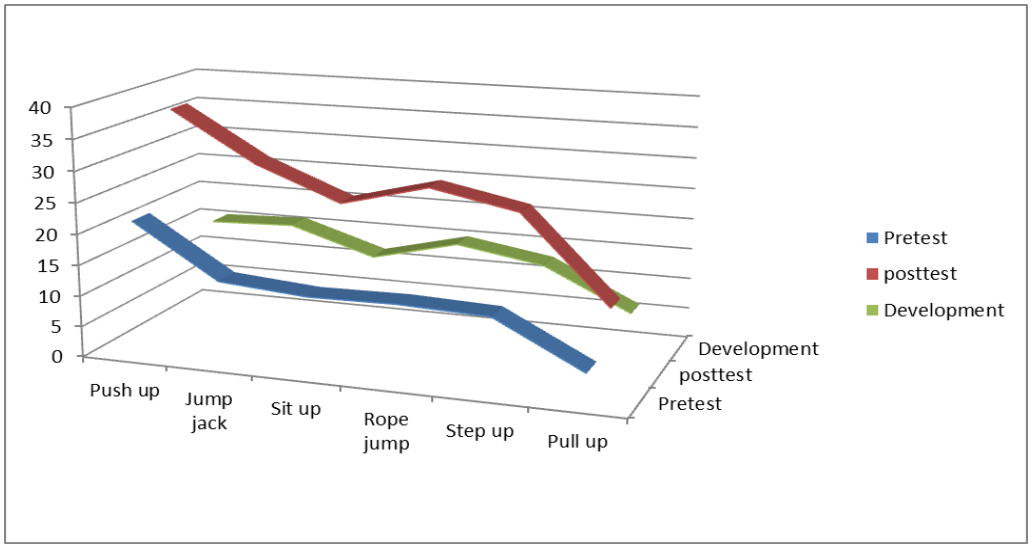
The average performances of participants of six stations-based circuit training exercises of individual were summarized with pretest and posttest results are displayed.

As a result of circuit training exercises input, the performance of participants on six components of push-ups was improved by **15.4,** jumping jack by **15.9**, Sit-up by 11.6, jump rope 15, step-up by 12.7 and pull-up by 6 and showed clear demarcations differences of the pre-test and post-test results (table 20).

As a result of input through circuit exercises, the performances of participants in all six components of training exhibited effective and significant improvement the performance of practitioners both in muscular strength and endurance.

Table 20 Performance summary on six stations exercises

Circuit stations	Pretest	posttest	Improvement
Push up	**21.8**	**37.2**	**15.4**
Jump jack	**13.3**	**29.2**	**15.9**
Sit up	**12.2**	**23.8**	**11.6**
Rope jump	**12.4**	**27.4**	**15.0**
Step up	**11.9**	**24.6**	**12.7**
Pull up	**4.7**	**10.7**	**6.0**



Graph 8 Result of circuit training

4.3.2 Discussion

The study has demonstrated effective and successful results in improving the performances of practitioners in all six stations of circuit training that underscored the effectiveness of the circuit training intervention with great benefits.

Previous studies have demonstrated that circuit training significantly enhances muscular endurance by incorporating a variety of exercises that challenge different muscle groups and energy systems (Tremblay et al., 2010).

The findings of this study are supported by several previous research efforts including a study by Boozed et al. (2017) found that circuit training with its combination of resistance and aerobic exercises

The research by Scram et al (2016) highlighted that circuit training enhances cardiovascular fitness and muscular endurance through continuous, varied exercises performed in a high-intensity format.

These findings validate that circuit training has a positive impact on physical fitness variables. The positive effects on muscular strength and endurance suggest that circuit training can be an effective exercise modality for enhancing physical fitness.

Future research could explore the long-term effects of circuit training and its impact on other fitness components and populations to further validate and extend these findings.

This study evaluated the effect of 8 weeks circuit-training program on selected muscular strength and muscular endurance among male students at Enchini Secondary School.

Mayoral-Vega et al. (2013) conducted a study on the effects of a circuit training program on muscular endurance and strength focusing on evaluating the impact of a circuit training combined with maintenance on muscular strength and endurance and found improvements.

This finding is consistent with the work of Kilda and Jordan (2013), who noted that circuit training can lead to substantial improvements in both aerobic capacity and muscular endurance.

This finding aligns with research by Retimes et al (2009), which found that circuit training can significantly increase muscular strength due to its focus on resistance exercises and high-intensity intervals.

Chapter five

5. Summary, Conclusion and Recommendation

5.1 Summary

The purpose of this study was to assess the effects of a circuit-training program on muscular strength and muscular endurance in male students at Enchini Secondary School.

A total of 30 male students aged 17-19 years participated in the experimental group Over 8 week's period, the students engaged in circuit training twice a week, with each session lasting 40 up to minutes. The effectiveness of circuit training program increases both muscular strength and endurance.

The study's results are consistent with existing literature that highlights the benefits of circuit training for improving physical fitness. Circuit training's structured approach, combining various exercises with minimal rest periods, appears to effectively enhance key fitness variables. Overall, the study confirms that circuit training can lead to significant improvements in muscular strength and endurance among adolescents.

5.2Conclusion

Circuit training led to significant improvements in both muscular endurance and muscular strength among the students in the experimental group. The pre-test and post-test comparisons showed that the training had a measurable positive effect on these fitness variables. The data revealed a progressive enhancement in students' muscular strength and endurance from pre-test to post-test.

This indicates that the exercise training program effectively contributed to the gradual improvement of the students' physical performance.

The circuit training program effectively improved the students' muscular endurance and strength. The structured approach and varied exercises included in the training regimen were instrumental in developing beneficial exercise modality for improving selected fitness variables. The significant changes observed in the experimental group demonstrate the effectiveness of circuit training in enhancing muscular fitness.

5.3 Recommendations

The study highlighted positive impact of circuit training on the physical fitness of male students at Enchini Secondary School by reinforcing its value as an effective training strategy for improving muscular endurance and strength. Based on the findings of the study, the following recommendations are proposed:

1. Repetition of the exercises provides significant effects observed from the 8 weeks circuit training program on muscular endurance and strength, it is recommended that similar studies be conducted with male subjects to validate and expand upon these findings. Repeating the study with different populations or settings could provide further insights into the effectiveness of circuit training.
2. **Engagement in Circuit Training** has substantial benefits of circuit training on muscular endurance and strength. It is recommended that male students engage in circuit training programs to enhance their physical fitness in implementing such training can be beneficial in improving overall muscular performance.
3. **Promotion of Circuit Training** in **s**chools and fitness programs should be encouraged and motivate male students to participate in circuit training. Promoting this training method can help students maintain and improve health-related physical fitness components, contributing to their overall well-being.
4. **Exploration of Other Training Methods:** the future research should explore other training methods to assess their impact on physical fitness variables. Investigating different exercise regimens can provide a broader understanding of effective strategies for enhancing muscular endurance and strength, and offer valuable information for optimizing fitness programs.

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7. Appendices

A) Performances on components of circuit training during pretest and posttest

	Push up			Jump Jack			Sit-up			Rope Jump			Step Up			Pull Up		
Participant	Pretest	Posttest	Difference	Pretest	Posttest	Difference	Pretest	Posttest	Difference	Pretest	Posttest	Difference	Pretest	Posttest	Difference	Pretest	Posttest	Difference
p1	20	34	14	15	29	14	11	21	10	13	34	21	9	18	9	4	9	5
p2	30	36	6	11	28	17	10	17	7	14	31	17	11	21	10	5	12	7
p3	36	42	6	9	22	13	13	16	3	9	29	20	14	25	11	8	11	3
p4	22	52	30	18	35	17	8	18	10	15	36	21	15	29	14	7	13	6
p5	24	54	30	17	32	15	7	19	12	16	33	17	12	23	11	7	13	6
p6	15	36	21	12	30	18	11	20	9	13	29	16	16	40	24	2	9	7
p7	20	38	18	13	27	14	15	29	14	12	32	20	11	22	11	3	9	6
p8	27	48	21	10	28	18	13	23	10	16	33	17	14	29	15	5	13	8
p9	20	28	8	9	17	8	14	29	15	17	34	17	15	31	16	3	11	8
p10	28	34	6	14	29	15	12	24	12	12	29	17	13	27	14	7	16	9
p11	15	50	35	12	31	19	9	19	10	13	28	15	14	32	18	4	9	5
p12	32	42	10	15	34	19	10	17	7	9	20	11	12	26	14	2	9	7
p13	16	30	14	17	31	14	11	21	10	8	19	11	10	23	13	6	10	4
p14	20	25	5	8	23	15	13	27	14	11	28	17	10	25	15	4	14	10
p15	21	28	7	11	26	15	14	33	19	13	31	18	13	29	16	5	14	9
p16	17	40	23	16	34	18	15	31	16	14	30	16	11	22	11	2	11	9
p17	13	28	15	12	31	19	9	22	13	12	23	11	9	27	18	3	8	5
p18	30	46	16	13	28	15	16	29	13	13	25	12	12	29	17	6	13	7
p19	18	34	16	14	32	18	12	25	13	9	19	10	13	28	15	3	9	6
p20	20	30	10	17	35	18	14	29	15	12	21	9	14	31	17	6	10	4
p21	18	30	12	15	33	18	15	29	14	14	29	15	10	20	10	5	12	7
p22	24	38	14	12	27	15	15	31	16	11	24	13	9	17	8	6	11	5
p23	25	40	15	14	31	17	12	21	9	11	23	12	11	19	8	7	13	6
p24	28	40	12	9	29	20	11	25	14	14	29	15	11	16	5	4	9	5
p25	24	33	9	15	35	20	13	27	14	9	18	9	15	31	16	3	7	4
p26	20	35	15	17	32	15	10	18	8	11	24	13	13	23	10	6	12	6
p27	15	22	7	13	27	14	11	21	10	12	29	17	12	21	9	5	10	5
p28	21	45	24	11	25	14	11	19	8	12	28	16	13	25	12	6	9	3
p29	17	38	21	12	21	9	16	28	12	14	27	13	14	29	15	2	8	6
p30	17	38	21	17	32	15	13	25	12	13	26	13	12	23	11	4	7	3