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Effects of Repetition Training and New Interval Training Methods on Anaerobic Fitness: In the Case of Short and Middle Distance Athletes in Tilili Athletics Project

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By

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July, 2020

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EFFECTS OF REPETITION TRAINING AND NEW INTERVAL TRAINING METHOD ON ANAEROBIC FITNESS: IN THE CASE OF SHORT AND MIDDLE DISTANCE ATHLETES IN TILILI ATHLETICS PROJECT

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

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ADVISOR'S APPROVAL FORM

I hereby certify that I have supervised, read, and evaluated this thesis titled "**Effects Of Repetition Training And New Interval Training Methods On Anaerobic Fitness: In The Case Of Short and Middle Distance Athletes in Tilili Athletics Project**" by Birhanu Tebkew Fenta prepared under my guidance. I recommend the Thesis be submitted for oral defence .

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EXAMINERS' APPROVAL FORM

We hereby certify that we have examined this thesis entitled "**Effects of Repetition Training and New Interval Training Methods on Anaerobic Fitness: In The Case Of Short and Middle Distance Athletes in Tilili Athletics Project**" by Birhanu Tebkew Fenta. We recommend that the thesis is approved for partial fulfilling of the degree of Master of Science in Coaching Athletics.

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DECLARATION

I, here by that this thesis for the partial fulfillment of the requirement for the Degree of Masters of Science in athletics coaching on the title of **"Effects of Repetition Training and New Interval Training Method on Athlete's Anaerobic Fitness In The Case of Short and Middle Distance in Tilili Athletics Project''** is my real original work. In compliance with internationally accepted practices, I have duly acknowledged and referenced all materials used in this work. I understand that non-adherence to the principles of academic honesty and integrity, misrepresentation/fabrication of any idea/data/facts source will constitute sufficient ground for disciplinary action by the university and can evoke penal action from the sources, which have not been properly cited or acknowledged. It has not previously formed on the basis for the award of any Degree, Diploma of any University, other Institution of higher learning or publication.

Name: Mr. Birhanu Tebkew

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LIST OF ABBREVIATIONS

HITT=High Intensity Interval Training

LT=Lactate Threshold

MHR=Maximum Heart rate

NTG=New Interval Training Group

RAST=Running-based Anaerobic 35m Sprint Test

RTG=Repetition Training Group

SPSS=Statistical package for social science

Vo_2max=Maximal oxygen uptake

vVO2max=Velocity of Maximal Oxygen Uptake

ABSTRACT

The purpose of the study is to compare the effect of new interval training method and repetition training method on short and middle distance athlete's anaerobic fitness. Thirty (30) short and middle distance project athletes were selected comprehensively from the total 40 athletes. Based on the pre test result the subjects were assigned into repetition (n=15) and new interval (n=15) training group through randomization. The study design was Quasi-Experimental method. So as to measure the effect of the training, five anaerobic fitness tests, viz.400m drop off test, 150m endurance test, 30m flying test and RAST test were measured. To evaluate the effect of these training methods, whether there were a significant difference between pre and post results after 8 weeks of three days per a training intervention week, paired sample t test was employed. In addition, to examine differences between the two groups result on anaerobic fitness, an independent sample t- test at alpha value of ≤0.05 was employed. Both training methods have a significant effect on anaerobic efficiency, speed endurance, maximum speed, power and fatigue index as pre to post-test. There were a significant difference between repetition training and new interval training group in level of anaerobic efficiency (p=.020, MD=.807) and maximum speed (P=.008, MD=.448). However, there were no significant difference between two groups in the level of speed endurance (p=0.150), power (p=0.619) and fatigue index (p=0.788). Therefore, two months of both new interval training method and repetition training method was effective for the improvement in all the above-mentioned fitness variables. Repetition-training method is better than new interval training method in improvement of anaerobic efficiency and maximum speed, But, there were no significant difference between groups in speed endurance, power and fatigue index. Therefore, it would seem highly recommended to implement both repetition and new interval training programs to improve anaerobic fitness and repetition training should be more effective than new interval training.

Keyword: *Anaerobic Fitness, Repetition Training, New Interval Training*

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

To train athletes, a coach must have an understanding of the basic principles that govern a human being's physical and mental response to training. Intelligently and systematically applying a basic knowledge of biomechanics and physiology helps create good track and field athletes. The training a coach devises will become a recipe that combines conditioning, mobility and flexibility training, strength and plyometric training and specific event technique. Only in this way does optimum performance become a matter of planning, not happenstance (LA84 Foundation, 2012).

To provide a fitness foundation for all athletes and later to develop the specific fitness required for an event it is necessary for the coach to understand the characteristic of each fitness and how to develop them. A large number of interrelated factors can determine success in sports. Among these, training is the most decisive factor, which directly influences the improvement of athlete's performance (Laursen & Jenkins, 2002). Training is a program of exercises designed to improve the skills and increase the energy capacities of an athlete for a particular event (Edward et al, 2007) Training is a systematic process with the objective of improving an athlete's fitness in a selected activity. A long-term process is progressive and recognizes the individual athlete's needs and capabilities. Hardial (1991) also strengthen this concept as sports training is a pedagogical process based on scientific principles aiming at preparing sportsmen for higher performances in sports competitions.

The primary purpose of any training program is to optimize athlete's performance during training and competition. To accomplish this goal, coaches and athletes should design and implement comprehensive training programs which help athletes to have better physiological demands for a specific event (Cathal, 2013).

The amount of the training response lies on different factors like, the duration of the exercise bouts, their intensity, the frequency and recovery activities between intervals with which they are performed, the initial training status of athletes, genetic potential, age and gender of the individual (Wenger & Bell, 1986). Therefore, specifying an optimal training regimen for athlete's fitness improvement requires knowledge of applying different training methods for physiological adaptations (Helgerud et al., 2007). Perhaps most importantly, the coach must understand what adaptations will occur in response to the various forms of training available. Improvements in performance are generally a result of higher levels of fitness. This fitness comes from an improved understanding by coaches and athletes of training and its effects.

Obviously, there are different fitness qualities that the athletes should develop through scientific training. Anaerobic fitness is an important fitness quality for exercises, which does not require oxygen for energy production. When we refer to anaerobic fitness we are in fact referring to the anaerobic capacity of the athlete, which is best defined as 'the maximal amount of ATP re-synthesis via anaerobic metabolism during a specific type of short duration maximal intensity exercise' (Green, 1993). Anaerobic means 'without oxygen' and anaerobic endurance refers to the energy systems, which are capable of operating without oxygen present. Athletes allow muscles to operate using energy they already have in store (Thompson, 2009).

Another researchers (Bishop, et al. 2011; plisk 1991) states that anaerobic fitness is a complex fitness component that involves motor unit activity (nerve and muscles innervated by the nerve), metabolic factors (e.g., phosphocreatine recovery and hydrogen ion buffering), substrate use (e.g., the rate phosphagen, glucose and glycogen liberation of ATP), and force speed patterns that affect muscle activation and recruitment. Thus, anaerobic training workouts result neurological, metabolic and muscular adaptation. So as to develop anaerobic fitness different training methods should be implemented, but since the aim of this study is focusing on repetition training and new interval training methods let's focus on it.

Relating to different training methods for the development of anaerobic fitness various researchers gave different suggestion. According to Thorson (2013); interval training with the pace of 95%-100% of Vo2 max or 97% to 100% of your max heart rate –5 min max have a benefit to: Maximize aerobic power (V02 max). Increase lactic threshold levels. It improves your ability to run harder and longer without going into oxygen debt. Increases endurance which means that the runner can continue at a certain pace for a longer period. Builds muscle strength. Whereas repetition training with pace of 105-120% of VO2 max 2 minutes maximum have a benefit to improve anaerobic Glycolytic System, power, speed and economy.

The other researcher Gordon (2009) confirms that the most suitable training method for the improvement of anaerobic parameter is through the use of intervals of duration between 60 and 240s and at about 90–95 per cent of peak speed. Supporting this idea Draper, and Hodgson, (2008) stated that anaerobic training leads to improvements in glycolytic metabolic functioning and fatigue resistance. Interval training with high intensity and short recovery is perhaps the single most useful method for improving anaerobic endurance capacity. The result of this research also indicated that the physiological adaptation to Anaerobic endurance training will increase glycogen uptake during recovery, increase resting glycogen stores, improved glycolytic enzyme activity, Buffering capability, increased tolerance of H+ and even small improvements in aerobic metabolism. Therefore, many of the interval sessions employed in the development of endurance or team athlete will be for the development of anaerobic capacity. Behi et al. (2017) also explain as Anaerobic training of the right type, which emphasizes the lactate system, allows the athlete to clear and tolerate the buildup of the ‘acid’ part of lactic acid. Remember that lactic acid does not exist in the body. As soon as it is formed, it separates into a ‘lactate’ bit and an ‘acid’ bit. We have seen that the acid is the ‘bad guy’ but the athlete can use the lactate as a fuel source (Thompson, 2009).

Researchers, coaches and exercise professionals have consistently targeted specific muscles or movement patterns for the athletic race or event and designed progressively increasing training strategies (i.e overload principles). Fortunately, one of the most comprehensive practical application evidence based articles on anaerobic conditioning by

Plisk (1991) provides splendid guidance and theory-driven direction for overall anaerobic training program design. Key areas of attention presented by Plisk are repetition intensity-duration, exercise-to-relief ratio, total exercise volume, program duration, value of resistance training design and training progression.

According to Thompson, (2009), Repetition training is breaking a total distance or any training load into smaller units which are repeated, hence repetitions. In walking and running the pace, distance and rest/recovery intervals and activity are prescribed. Usually done on the track but may be done in a park on grass or anywhere. Repetition training can be divided into two main types by pace or running rhythm: extensive and intensive. When the training emphasis is on general endurance, extensive repetition training is used; when the emphasis is on event-specific endurance, intensive repetition training is used.

Repetition training may also be divided into two main types according to the recovery activity that takes place during the 'intervals', the time between the faster repetition sections, these are Repetition Training and New Interval Training'. Thompson differentiated the difference between these training methods as the following; In standard Repetition Training, the rest period between repetitions and sets may be passive, walking or easy running. But in the 'New Interval Training', which has become popular because of its effectiveness in developing both the aerobic and lactate energy systems, the recovery in the intervals is a very active 'roll-on', running recovery. New interval training is a type of repetition training where the training effect occurs in the interval between the faster sections. Only repetition training that has the training effect taking place in the interval called 'interval training' (Thompson, 2009, (96)).

Based on the above concept, we can say that the term 'interval training' should only be used for the specific repetition training where the training effect takes place in the interval between the faster sections. So we can say,

"Interval training is always repetition training, but not all repetition training is interval training."

Another researcher Tirkey (2014) states about the effects of the two training method on 200m runners performance; He concluded that in endurance training, the repetition

method is used to improve components or factors of specific endurance or of anaerobic capacity; he consider as the repetition method is characterized by high intensity (90-100%) of work with intervals of complete recovery. Interval method is perhaps the most versatile method for improving endurance of various types depending on frequency, duration, mode of exercise and recovery activities between set and reps; by considering interval method done at relatively higher intensity with interval of incomplete recovery.

Generaly, it is already proved that interval training method and repetition training method are effective method for improving performance in athletics. However, many of the studied research did not consider interval training with active roll on recovery activities between training in their study. This is why the researcher is motivated to conduct this study specifically to analyze the improvement of anaerobic fitness by new interval training method and repetition training method.

1.2 Statement of the Study

The purpose of the present study was to compare the effect of new interval training and repetition-training methods on athlete's anaerobic fitness in the case of Tilili Athletics project. Throughout the process of designing appropriate training method for adaptations of specific physiological fitness parameters, it is important to know how these training methods should deliver and produce improvement in athlete's performance with least effort (Daniel, 2018).

Among various training methods, repetition and new interval training methods are commonly used to improve athlete's anaerobic fitness. According to Gordon (2009), for the improvement of anaerobic parameter, the most suitable training method is using intervals of duration between 60 and 240s and at about 90–95 per cent of peak speed. Therefore, many of the interval sessions employed in the development of endurance or team athlete will be for the development of anaerobic capacity.

It is already proved that interval training method and repetition training method are effective method for improving performance in athletics. Even though the result of most study shows that both interval and repetition training methods are effective equally in

improving anaerobic capacity (Tirkey, 2014**;** Pandey, & Verma, 2016), there is a little study in interval training methods with active recovery (roll-on).

Tilili athletics center has its own athletic club and project and it contains above 100 athletes; 70 project athletes (40=U-17, 30=U-13) and 30 club athletes. This athletics center is the source of nationally and internationally competent athletes since 2004 E.C. The researcher had a chance to attend and follow the training process, which are performed, by the coaches and athletes of the athletics centers. A researcher attended not only Tilili athletic center but also other athletic training center like Belayneh kinde athletic project, Birhan athletics project, Injibara athletics project, Sekela athletics project, Fagita athletics project, Awilma athletics project and the like. However, as a researcher observed and tested during taking coaching practice course at the project, the projects athletes have many anaerobic fitness problems, which were faced in competition as well as during training. As the above explained, though little literature suggest that most of the time both new interval training and repetition training are effective for the improvement of anaerobic fitness, but the coaches fail to deliver it and confused the difference between these training methods. In addition, most coaches did not deliver interval training with active roll on recovery rather than complete recovery between interval, uses usually training method and they didn't get and use new interval anaerobic training literature. Due to this reason researcher wants to compare the effect of repetition anaerobic training methods verses new interval anaerobic training methods on some selected anaerobic fitness variables by giving different training mode of speed endurance, anaerobic efficiency, maximum speed, average power output and fatigue index.

Most coaches, and athletes are confusing on which training method is more advisable and effective (repetition? or new interval training?) to improve anaerobic fitness from the two training methods because there is no clear research studied on this issue. Despite there have been studies examined the effects of repetition training and interval training on athlete's anaerobic fitness, far fewer studies have investigated the effects of repetition and interval training methods on athlete's anaerobic fitness in relation with active recovery activities ("roll- on") between workouts. Most of the time many coaches and athletes mainly give due emphasis to simply giving random training rather than selecting

appropriate training method for specific fitness improvement because there is no clear finding relating to comparing the two training methods. This indicates that such research must be conducted to determine the effect of these two training methods on athlete's anaerobic fitness improvement. So due to this and the like reason the researcher was motivated to conduct the present study.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of the study is to compare the effects of new interval training and repetition training methods on short and middle distance athlete's anaerobic fitness in Tilili athletics project.

1.3.2 Specific Objectives

The specific objectives are the following:

- Examine the effect of new interval training method on athlete's anaerobic fitness variables.
- Assess the effect of repetition training method on athlete's anaerobic fitness variables.
- Identify better training method for athlete's anaerobic fitness improvement from the two training methods and provide possible suggestions to improve anaerobic fitness of athlete's.

1.4 Hypotheses of the Study

To develop a specific direction, better understanding of the study and to ensure the entire research process remains scientific, valid and reliable the following hypotheses are formulated.

H_{O1}: New interval training method has no significant effect on anaerobic fitness variables.

H_{A1}: New interval training method has a significant effect on anaerobic fitness variables.

H_{O2}: Repetition training method has no significance effect on athlete's anaerobic fitness variables.

H_{A2}: Repetition training method has significance effect on athlete's anaerobic fitness variables.

H_{O3}: There is no a significant difference between new interval training method and repetition training methods on the effects of anaerobic fitness.

H_{A3}: There is a significant difference between new interval training method and repetition training methods on the effects of anaerobic fitness.

1.5 Significance of the Study

This study was designed to compare the effect of repetition training and new interval training methods on athlete's anaerobic fitness. Therefore, this study has the following significances in terms of its theoretical and practical contributions.

- The finding of this study may add knowledge to the already existing literatures by examining the effect of these two training methods (repetition and new interval) on athlete's anaerobic fitness.
- Results of the study may serve as a feedback for athletes, coaches and technical committee of Tilili athletics center in the process of delivering repetition and new interval training methods during their training programs.
- This study helps athletes and coaches in recognizing and convincing the effect of these two training methods for specific anaerobic fitness adaptations.
- The study also helps to coaches for preparing training plans regarding on specific training methods for anaerobic fitness improvement.
- The study may help the athletics center administrators to evaluate the training programs delivered for middle and short distance runners in the projects.
- This study may serve as a reference for other researchers to conduct their study on these training methods effect on athlete's anaerobic fitness.

1.6 Delimitation of the Study

This study was delimited to Tilili athletics center, which is located at Amhara region Awi Administration zone Guagusa Shigudad woreda Tilili town. The reason for selecting this athletics project is due to the location of the project suitability to deliver the designed training interventions, the presence of enough target population and this project is well organized for such kind of experimental designed studies. In order to give better conclusions about these training methods effect on athlete's anaerobic fitness, the study population was delimited to 30 (18 male and 12 female) short and middle distance runners in this athletics project.

Even though there are various training methods to improve athlete's anaerobic fitness, the study was delimited on examining repetition and new interval training methods only.
Investigating all the various possible effects of these two training methods (repetition and new interval training) on athlete's performance is beyond a single study; as a result the objective of this study was delimited to examine these training methods effect on athlete's anaerobic fitness only such as; anaerobic efficiency, speed endurance, maximum speed, power and fatigue index. The duration of the training period was restricted to three days per week and 40 up to 60minutes per sessions for two months.

1.7 Limitations of the Study

Through the process of conducting this study, the following limitations were faced:
In the process of collecting data in the study, finding sophisticated and modernized equipment to measure anaerobic fitness of athlete's was very difficult and beyond the capacity of the researcher. The availability of previous research works in a specific study area is an important input for the success of the research work. However, in the process of conducting this study there was a limitation on finding previous research works on new interval training method (*i.e*., having "roll on" recovery activities) specifically. The researcher could not control food habits and the way of life style, which could influence on the results, personally though orientation was given about these aspects to the subjects. In addition to this, unable to control environmental variations such as air

temperature and atmospheric pressures during testing periods were the limitations encountered in this study. Lack of internet and network access in the area where the researcher conducted research work and Lack of enough financial support to the researcher to process everything as possible as was also another difficulty for researcher.

1.8 Operational Definition of Terms

Repetition training: is a type of training with the rest period between repetitions and sets may be passive, walking or easy running.

Interval training: type of training that involves high intensity work intervals interspersed with brief recovery periods.

New-interval training: is any repetition training where athletes does "roll on" activities during the recovery intervals (Thompson, 2009 pp.96).

Project athlete: An athlete participating in athletics projects whose age is less than or equal to 17.

1.9 Organization of the Study

This study has consists of five chapters. The first chapter deals with the back ground of the study, statement of the problem, hypothesis of the study, objectives of the study, significance of the study, delimitation of the study, limitation of the study and definitions of terms used in the study. The second chapter deals with the review of related literature, and the third chapter deals with the research design and methodology of the study. The fourth chapter deals with presentation, analysis and discussion of the data, and the last chapter deals with the summary of the findings, conclusion and recommendations of the study.

CHAPTER TWO

2 REVIEW OF RELATED LITERATURE

2.1 Introduction

Most studies done in exercise and sport agree that in the process of athlete's performance improvement, regular sport training is an important factor. However, researchers do not agree on the more beneficial method of training from repetition and new interval training methods for anaerobic fitness improvement.

Thus, this chapter focused on reviewing various literatures and research findings, which is assumed to have relevance to the study. Topics covered in this chapter are; first describing anaerobic fitness, factor affecting anaerobic fitness, effects of training on anaerobic fitness, benefit of anaerobic fitness, explaining new interval and repetition training methods and their benefit and their differences in relation with training variables and methods of doing these methods. In addition, types of repetition and interval training methods and their effect on anaerobic fitness was discussed And finally training variables of the two training methods outlined.

2.2 Anaerobic Fitness

Sport performance needs various fitness qualities like aerobic fitness, anaerobic fitness, and so on. Among them anaerobic fitness plays a vital role to be effective athlete in many direction. When we refer to fitness, it is mostly related to endurance, which means an athlete who has more endurance is physically fitter than athlete who has less endurance. The main factor, which limits and at the same time affects performance, is fatigue. According to Thompson, (2009), an athlete is considered to have good endurance when he does not easily fatigue or can continue to perform in a state of fatigue. Endurance, of all the components of fitness, should be developed first. Without endurance, it is difficult to repeat other types of training enough to develop the other components of fitness. Thompson (2009) divided endurance in to two; namely aerobic and anaerobic endurance.

Aerobic endurance means muscular work and movement done emphasizing the use of oxygen to release energy from the muscle fuels; anaerobic endurance refers to the energy systems which are capable of operating without oxygen present. They allow muscles to operate using energy they already have in store. Anaerobic endurance also divided in to two important types. The first is speed endurance, which involves principally the aerobic and lactate systems but emphasizes the lactate system. Developing speed endurance helps an athlete to run at speed despite the buildup of acid. The second type of anaerobic endurance is the endurance needed to maintain maximal velocity speed in sprinting, hurdling, throwing and jumping, where the ATP-CP system is emphasized (Jung, 2003).

According to Siff,. and Verkhoshanski (1998) Many forms of physical activity require rapid bursts of power during which energy requirements far exceed the body's oxygen delivery capacity. This oxygen delivery capacity depends on the energy system during engaging exercise. In general, energy system can be aerobic and anaerobic energy system. These two energy production is concerned with creating the ATP necessary for every cell in the body to function. However, it is important most commonly to discuss the energy systems in relation to the energy requirements for a particular activity. The predominant energy system and energy requirements differ for adventure sports; so the body needs a variety of systems to produce ATP. The purpose of all three systems (aerobic, glycolysis, and ATP-PCr) is to create ATP to replace the stores in cells as they are used up when the cell is working (Draper and Hodgson, 2008). The two anaerobic sources of energy production are the phosphagen system (ATP-PCr) and glycolysis. In fact ATP is produced by the breakdown of fuel molecules-carbohydrates, proteins, and fats. During physical activity, three different processes work to split ATP molecules, which release energy for muscles to use in contraction, force production, and ultimately sport performance (the International Triathlon Union, 2007). The intensity and duration of physical activity determines which pathway acts as the dominant fuel source. International Triathlon Union describes the three-energy system as the following:

2.2.1 Long Term (Aerobic) System

The long term system produces energy through aerobic (with oxygen) pathways. This system is dominant at lower intensities and efforts lasting longer than 2 to 3 minutes.

Production of energy, or ATP, occurs in the mitochondria of the muscle fibers. Mitochondria contain special enzymes that permit the breakdown of fuels (e.g. glycogen, fatty acids) through interaction with oxygen to produce large amounts of energy. Training the aerobic system increases the number and size of the mitochondria, making the muscles more efficient at using oxygen for fuel.

2.2.2 Short Term (Anaerobic Lactic) System

As intensity increases, it becomes increasingly difficult for the body to provide enough oxygen to fuel aerobic pathways. The short term, or anaerobic lactic (without oxygen, with lactic acid) system begins to contribute more energy to fuel the muscle. Fuel for this system comes from glucose in the blood and stored glycogen in the muscle. Along with energy (ATP), lactic acid is produced as a byproduct of this system. As exercise intensity increases, so does the accumulation of lactic acid in the blood and muscles. If this accumulation becomes too high, then the short term system cannot continue. At maximum intensity, this system is exhausted within 60 to 120 seconds. Athletes experience shortness of breath, pain (burning sensation), and weakness in the muscles. In athletics, the aerobic and anaerobic lactic systems often operate in tandem, with energy being supplied through both pathways as intensities fluctuate. A well-trained aerobic system allows athletes to perform at higher intensities before lactic acid builds up and recover faster after hard efforts.

2.2.3 The Immediate (Anaerobic Alactic) System

When sudden, explosive or immediate movements are required, a third system produces ATP at a very high rate. The anaerobic alactic (without oxygen, without lactic acid) or ATP-CP system is fueled by stored ATP and another high energy substance, creatine phosphate (CP). Because these fuel stores are relatively small, the immediate system only supplies energy for up to about 10 seconds of high intensity activity. ATP-CP stores can be replenished in a few minutes of rest. During a triathlon, this system is dominant during races starts, very explosive movements like flying bike mounts, and accelerations or surges that are less than 10 seconds in duration.

2.2.4 Energy System Integration

The energy systems do not work independently. During exercise, all the systems operate simultaneously in different degrees, depending on the energy demands placed on the body. During a triathlon, the long term system is dominant, but the immediate and short term systems are accessed when an athlete increases their intensity. While a majority of the triathlete's training will rely on the long-term system for energy, some training (starts, surges, and fast repeats) should make use of the immediate and short-term systems. This type of balanced training will lead to improvements in maximum oxygen uptake and work efficiency; more work done at less cost.

2.3 Factor Affecting Anaerobic Fitness

Several factors are associated with success in sport performance and training is a major part of it. In fact, athlete's endurance, according to the type of exercise, is affected by factors such as aerobic power, efficiency, biomechanical, neuromuscular and cardiovascular adaptations, anaerobic power, lactate threshold and adaptation of the endocrine system (Smart & Steele, 2012; Ribeiro et al, 2012). So much of the physiological differences between elite and novice athletes' endurance depend on training methods they use (Casamichana, Castellano & Dellal, 2013). The limits for developing fitness capacity link closely to natural endowment. For two individuals in the same exercise program, one might show 10 times more improvement than the others might (Gent & Norton, 2013). Genetics research indicates a genotype dependency for much of one's sensitivity in responding to maximal aerobic and anaerobic power training, including adaptations of most muscle enzymes. Genetic makeup plays such a predominant role in training responsiveness that it makes it almost impossible to predict a specific individual's response to a given training stimulus (Katch, Mcardle, Katch, 2011). In the mid-1960s, the renowned Swedish physiologist Dr. Per-Olof Åstrand (Chapter 1) prophetically commented concerning the yet to be quantified role of genetics in exercise performance: "To be an Olympic-caliber performer, you must choose your parents wisely." Future research in molecular genetics may someday uncover a practical

means to identify responders and non-responders and individualize conditioning programs to optimize overall improvements for each.

Kenney, Wilmore and Costill , (2012), lists the main factors affects anaerobic capacity are: Age, Fiber type (a greatest % of fast twitch fibers is associated with a greatest force output), Lactate tolerance. When using anaerobic energy system, particularly anaerobic glycolysis system, to create energy, the accumulation of fatigue induced by products can have a significant effect on an athlete's output. With anaerobic training, such as sprint training on the track or on a cycle ergo meter, there are increases in both peak anaerobic power and anaerobic capacity (Kyrolainen, Belli, & Komi, 2001). However, results have varied widely across studies, from those that showed only minimal increases to those showing increases of up to 25%. With anaerobic training, which includes sprint training and resistance training, there are changes in skeletal muscle that specifically reflect muscle fiber recruitment for these types of activities. At higher intensities, type II muscle fibers are recruited to a greater extent, but not exclusively, because type I fibers continue to be recruited. Overall, sprint and resistance activities use the type II muscle fibers significantly more than do aerobic activities (Tanaka, & Swensen, 1998). Consequently, both type IIa and type IIx muscle fibers undergo an increase in their cross-sectional areas. The cross-sectional area of type I fibers also is increased but usually to a lesser extent. Furthermore, Paavolainen, Nummela and Rusko (2000) described, with sprint training there appears to be a reduction in the percentage of type I fibers and an increase in the percentage of type II fibers, with the greatest change in type IIa fibers. In two of these studies, in which subjects performed 15 s to 30 s all-out sprints, the type I percentage decreased from 57% to 48% and type IIa increased from 32% to 38%. This shift of type I to type II fibers is not typically seen with resistance training (Kenney, Wilmore & Costill , 2012),.

2.4 Effects of Training on Athlete's Anaerobic Fitness

According to Livingstone, 2006 the human body is structured in such a way that it maintains relatively stable internal physiological conditions, or homeostasis. Blood volume, haematocrit, arterial pressure and core temperature are among the most

important physiological indicators of homeostasis. When this balance is disturbed, the body reacts acutely in an attempt to preserve homeostasis and, if the 'disturbance' continues, it adapts its functions to a higher level. Physical training aims to cause such an imbalance in the body over a period of time (encyclopedia; theory and methodology of training). Cavanagh and Kram, (1985). also stated that When an athlete trains, the body has to supply muscle and organs with energy at a higher rate than resting. Stored supplies cover these excess energy needs. The drainage of energy stores as well as the accumulation of by-products, such as lactic acid, in the blood and cells leads to fatigue.

The final goal of athletes and coaches all through the process of sport is to produce successful performance within specific periods during competitions. To produce improvements in sport performance examining training variables like intensity and volume are very important in order to prescribe optimal training program. In addition delivering appropriate training loads for athletes avoids both under and overtraining and increase the chance of achieving desired performances within a given periods of time (Daniel, 2018). Among these fitness qualities, which determine athlete's performance during competition, anaerobic fitness plays a vital role for those of athletes participating in an exercise, which lies on anaerobic metabolic pathways. Anaerobic fitness is the ability to produce energy without oxygen. According to Thompson (2009) there are two anaerobic pathways that creates energy with the absence of oxygen, these includes the ATP-PC energy system and Anaerobic glycolysis system. Both of this system has a limited capacity and a crucial high intensity bout such as jumping for mark or sprinting to make contest.

Thompson states effects of training on anaerobic energy with various training variables and he explain in his book of 2009 as; During high intensity training, oxygen supply cannot meet the demands of the aerobic energy system to produce sufficient energy, thus placing greatest emphasize on anaerobic pathways to meet energy demands. Laursen and Jenkins, (2002) concluded that as intensity and speed of modern sports training increases, so does the importance of anaerobic capacity to be able to provide explosive energy for athletes. When using anaerobic energy system, particularly anaerobic glycolysis system, to create energy, the accumulation of fatigue induced by products can have a significant

effect on an athlete's output. With anaerobic training, such as sprint training on the track or on a cycle ergo meter, there are increases in both peak anaerobic power and anaerobic capacity. However, results have varied widely across studies, from those that showed only minimal increases to those showing increases of up to 25%. With anaerobic training, which includes sprint training and resistance training, there are changes in skeletal muscle that specifically reflect muscle fiber recruitment for these types of activities.

At higher intensities, type II muscle fibers are recruited largely, but not exclusively, because type I fibers continue to be recruited. Overall, sprint and resistance activities use the type II muscle fibers significantly more than do aerobic activities. Consequently, both type IIa and type IIx muscle fibers undergo an increase in their cross-sectional areas. The cross-sectional area of type I fibers also is increased but usually to a lesser extent. Furthermore, with sprint training there appears to be reductions in the percentage of type I fibers and an increase in the percentage of type II fibers, with the greatest change in type IIa fibers. In two of these studies, in which subjects performed 15 s to 30 s all-out sprints, the type I percentage decreased from 57% to 48% and type IIa increased from 32% to 38%.16, 17 This shift of type I to type II fibers is not typically seen with resistance training (Kenney, Wilmore & Costill , 2012),.

Just as aerobic training produces changes in the aerobic energy system, anaerobic training alters the ATP-PCr and anaerobic glycolytic energy systems. These changes are not as obvious or predictable as those that result from endurance training, but they do improve performance in anaerobic activities. Anaerobic training (30 s bouts) increases the activities of several key glycolytic enzymes. The most frequently studied glycolytic enzymes are phosphorylase, phosphofructokinase (PFK), and lactate dehydrogenase (LDH). The activities of these three enzymes increased 10% to 25% with repeated 30 s training bouts but changed little with short (6 s) bouts that stress primarily the ATP-PCr system.6 In a more recent study, 30 s maximal all-out sprints significantly increased hexokinase (56%) and PFK (49%) but not total phosphorylase activity or LDH. Because both PFK and phosphorylase are essential to the anaerobic yield of ATP, such training

might enhance glycolytic capacity and allow the muscle to develop greater tension for a longer period of time(Kenney, Wilmore & Costill , 2012).

Costill and coworkers reported their findings from a study of resistance training and its effects on the ATP-PCr system. Their participants trained by performing maximal knee extensions. One leg was trained using maximal work bouts that were repeated 10 times. This type of training preferentially stressed the ATP-PCr energy system. The other leg was trained with repeated 30 s maximal bouts, which instead preferentially stressed the glycolytic system. The two forms of training produced the same muscular strength gains (about 14%) and the same resistance to fatigue. the activities of the anaerobic muscle enzymes creatine kinase and myokinase increased because of the 30 s training bouts but were almost unchanged in the leg trained with repeated 6 s maximal efforts. This finding leads us to conclude that maximal sprint bouts (6 s) might improve muscular strength but contribute little to the mechanisms responsible for ATP and PCr breakdown.

2.4.1 Physiological Adaptation to Anaerobic Endurance Training

Anaerobic training leads to improvements in glycolytic metabolic functioning and fatigue resistance. Interval training is perhaps the single most useful method for improving anaerobic endurance capacity. Through such training, the timing of exercise and recovery periods can be closely monitored and altered as training progresses. For anaerobic endurance performance, high-intensity exercise bouts with short recovery periods (not long enough to enable lactate clearance to near resting levels) are typically employed. The intensity and duration of exercise would be increased and the recovery duration decreased to maintain the training stress overtime. Anaerobic training, due to the recruitment of Type II fibres, will also lead to improvements in strength and fiber cross sectional area (Draper & Hodgson, 2008). According to Kenney, Wilmore and Costill , (2012) the significant physiological adaptation that are generally seen in athletes who train an aerobically. These adaptations help the athlete perform high intensity activity with rapid recovery between each exercise session. This enables the athlete to perform repeated bouts of exercise with minimal reductions in performance. To develop the most effective program, it is important that the coach understand the physiological demands

the athlete experiences during competition. However very little is known about physical demands and physiological responses of many anaerobic athletes.

2.4.2 Physiological Adaptation to High Intensity Anaerobic Training

- Increase in the transformation of type II fibers to a more glycolytic subtype
- Significant elevations in glycolytic enzymes (phosphofructokinase, phosphorylase, lactate dehydrogenase)
- Increase in maximum blood lactate concentration
- Reduce blood lactate concentrations during submaximal exercise
- Improve buffering capacity

In additions, Draper and Hodgson (2008) stated that anaerobic endurance training leads to greater glucose uptake during recovery and increased resting glycogen stores. The increase in glycogen stores will result in an increased anaerobic ability during exercise. A key mechanism for improvement in anaerobic endurance capacity relates to improved glycolytic enzyme activity. Just as sprint and strength training lead to improvements in phosphagen enzyme activity, anaerobic training such as interval training leads to increased enzyme activity such as phosphofructokinase (PFK) and hexokinase (HK). HK catalyses the first reaction in glycolysis where glucose is altered to glucose-6-phosphate and PFK catalyses the third step in glycolysis (fructose-6-phosphate to fructose-1,6-diphosphate). Both these reactions involve the addition of one phosphate (from the breakdown of ATP) to the resultant of the step.

Research indicates that improvement in enzyme activity for PFK and HK can be as high as 50 percent above pre-training levels. Some studies have found additional improvements in the functioning of phosphorylase and lactate dehydrogenase (LDH), but these findings are less consistent. Phosphorylase is the catalyst for the initial reaction in glycogen breakdown in glycogenolysis, the equivalent of HK in glycolysis, while LDH is the enzyme responsible for catalysing the conversion of pyruvate to lactate at the end of glycolysis. Although the increases in glycolytic enzyme activity are not as substantial or as influential as realized through aerobic training, the increased glycolytic enzyme activity still results in improved force generation and the ability to sustain contractions

during anaerobic endurance exercise. Anaerobic endurance ability is improved after training through improved buffering capabilities within the blood and active muscles. Research indicates that buffering capabilities are improved by 25 per cent in response to anaerobic training. The net effects of the increased buffering capability will be to delay the onset of fatigue, thereby improving anaerobic performance. In addition, anaerobic training has been shown to lead to an increased tolerance of H+ produced during fast rate glycolysis. Individuals who engage in anaerobic training develop an improved tolerance of H+ accumulation as lactic acid dissociates during high-intensity exercise, thought to occur due to improved motivation or an ability to cope with the pain associated with decreasing pH. Lastly, and perhaps surprisingly, anaerobic training has been shown to result in small improvements in aerobic metabolism that help to delay fatigue. Anaerobic endurance training, such as interval sessions, has been shown to result in improved activity in Krebs cycle enzymes such as citrate synthase, succinate dehydrogenase and malate dehydrogenase (that catalyse steps 1, 7 and 9, respectively). Although these improvements are not as substantial as those realized through aerobic training, they still contribute to a reduction in the anaerobic load and increase time to fatigue during high-intensity endurance activities (Draper & Hodgson, 2008).

2.5 Benefits of Anaerobic Fitness

According to Morehouse and Miller, (2012), aerobic exercise is 19 times more efficient than anarobic exercise. The more intense the exercise becomes, the faster and less economically your body's fuel is used and the faster lactic acid accumulates. Anaerobic and aerobic fitness is always unseparated fitness components in ways of fitness development. Once you have developed cardiac efficiency though aerobic exercise, it is time to develop your ability to exercise anaerobically, to increase your ability to withstand oxygen debt (Lydiard, 1999). Its common sense, the slower you run, the farther you can run; the effort and speed are determined by your aerobic capacity. When your Maximum Steady State is low, you can be running anaerobically at a relatively slow speed. As your fitness improves, the speed that was anaerobic before is now high aerobic. Therefore, you want to get your Steady State, your best aerobic pace, at a high level before tackling anaerobic training. With anaerobic training, your objective is to create a

big oxygen debt and lower your blood pH level so that your metabolism is stimulated to build buffers against fatigue. This is done with interval or repetition training (Lydiard 1999).

Engaging in anaerobic training is benefited in various performance development. actually The effects of training are related to the type of exercise used, its intensity, and its volume. With trained athletes, higher intensity and volume of exercise are needed in order for adaptations to continue. Heavier loads are most effective for fiber recruitment. Fleck and Kraemer, (2003) Stated that Skeletal muscle adaptations to anaerobic muscular endurance training may include increased mitochondrial and capillary number, fiber type transitions, buffering capacity, enhanced muscular endurance, resistance to fatigue, and metabolic enzyme activity, especially in the untrained. This anaerobic training also has been shown to increase Running economy, Vertical jump, Sprint speed, Tennis serve velocity, Swinging and throwing velocity, Kicking performance,which is related to motor performance (Fry ,et, al, 1993 & Meeusen,et,al, 2013)

According to Katch, Mcardle, and Katch, (2011) Changes in anaerobic power and capacity occur *without* concomitant increases in aerobic functions. These researchers concluded adaptations and benefits with sprint-power training include:

1. *Increased levels of anaerobic substrates.* Muscle biopsies taken before and after resistance training reveal increases in the trained muscle's resting levels of ATP, PCr, free creatine, and glycogen, accompanied by an improvement in muscular strength. Other studies show higher levels of ATP and total creatine content in the trained muscles of sprint runners and track speed cyclists compared with distance runners and road racers.
2. *Increased quantity and activity of key enzymes that control the anaerobic phase of glucose catabolism.* The most dramatic increases in anaerobic enzyme function and fiber size occur in fast-twitch muscle fibers. The changes do not reach the magnitude observed for oxidative enzymes with aerobic training.
3. *Increased capacity to generate high levels of blood lactate during all-out exercise.* Enhanced lactate producing capacity probably results from a training-induced increased levels of glycogen and glycolytic enzymes and improved motivation and "pain" tolerance to fatiguing exercise.

4. Improved Buffering Capacity: Individuals who engage in anaerobic training tolerate higher blood lactate levels and lower pH values than untrained counterparts.

This raises speculation that anaerobic training improves the body's capacity for acid–base regulation, perhaps by enhancing chemical buffers or alkaline reserve. Research has yet to demonstrate that exercise training augments buffering capacity. Motivational factors probably improve training-induced tolerance to elevated plasma acidity.

According to (NBFE(National board of fitness examiners)(ISSA, 2020) For clients who prefer to found it out with a slow run, introducing interval, sprints, or intense weight training can be a challenge. Help them see the importance of incorporating anaerobic workouts into their sessions by explaining the important changes this kind of exercise produces and how it can be benefit over all fitness and health.

A) More fast twitch muscle fiber for strength

While aerobic workouts produce more slow twitch muscle fibers for better endurance, anaerobic exercise increases the size and quantity of powerful fast twitch fibers. This shift improves the power and strength of muscles and also increases hypertrophy, or size.

B) Better lactic acid tolerance for endurance

Anaerobic activity is short lived compared to aerobic workout because the lack of oxygen triggers a production of lactic acid. The buildup of lactate is what causes fatigue forces you to take a break from exercise. But, the more you engage in this kind of workouts the greater your tolerance will be to high levels of lactic acid. This improves strength and muscle endurance.

C) Increased glycolysis, ATP, CP, and creatine.

Some of the anaerobic changes triggered by an anaerobic workout include increased breakdown of glucose , the process known as glycolysis. This kind of exercise will also boost level of ATP, the primary source of energy in muscles, as well as CP, creatine phosphate, which can be quickly changed to ATP and used for energy. Levels of creatine also go up, which helps supply energy for muscle contraction.

D) Increased growth hormone and testosterone

High intensity workouts that last for about 45 to 75 minutes will trigger important hormonal changes, including a boost in the production of testosterone and growth

hormone. These along with other hormones are necessary for increasing muscle hypertrophy.

As a general, intense anaerobic workouts increase fast twitch muscle size and quantity, improving muscle power, strength, and size. Anaerobic exercise helps build tolerance to lactic acid that causes fatigue, improving muscle endurance. Metabolic changes due to anaerobic activity helps increase the amount of energy available to muscles, which allows them to act more quickly and powerfully when recruited. Hormones that promote muscle growth are boosted by anaerobic workouts. In short some of the best anaerobic exercise benefits are: increased muscle power and strength, increased muscle hypertrophy, maximized short term energy availability in muscles, improved muscle endurance(NBFE(National board of fitness examiners)(ISSA, 2020).

2.6 Training Methods for Anaerobic Fitness

According to Mazoochi, Fateminezhad, and Taher (2013) Coaches and athletes are always looking for training methods to improve physical capabilities of athletes. Therefore, different training methods have been developed and used based on the science of physiology and exercise. Another reseracher Livingstone (2006) also confirms the necessity of identifying the specific training method for specific fitness development. He describes as; the necessity of superior performance in sport has impelled coaches to use increasingly effective and sophisticated training methods. As levels of a particular fitness component increase, a higher exercise stress is required to create overload and lead to specific physiological adaptations. Performance improvements in most sport activities have been directly linked to changes in structures and metabolic capacities of skeletal muscle (Livingstone 2006). So in order to reach at best performance improvement, identifying the best training method for each fitness is mandatory. Training requirements vary in competitive running events as one goes from short sprints to long distances. Kenney, Wilmore and Costill (2012) also support this concept as; the primary emphasis for the short sprints is on training the ATP-PCr system, for longer sprints and middle distances, the primary emphasis is on the glycolytic system; and for the longer distances, the primary emphasis is on the oxidative system.

Most evidences suggest that with anaerobic training, your objective is to create a big oxygen debt and lower your blood pH level so that your metabolism is stimulated to build buffers against fatigue. This is done with interval or repetition training (Lydiard 1999). Once you have built those buffers, your anaerobic training is complete: to continue this type of training is to invite injury.The training methods depends on various training variables such as; intensity, duration, mode of exercise, and recovery activity. Not every type of exercise is appropriate for all sports. The performed exercise has to be sport-specific and focus on the muscles and organs stressed during the actual competition (Livingstone, 2006).

The ATP-PC system is the major energy source for intense bouts of activity that last for 2–10 seconds. This type of activity is important not only for weightlifters and field event throwers and jumpers in athletics, but also for running. Training to improve the ATP-PC system involves short, very intense bouts of activity followed by recovery. Interval training is employed. Training the glycolytic energy system also involves interval training, although at a marginally lower exercise intensity than above and for a longer duration for each repetition (Birch, MacLaren & George, 2005). Different types of training programs can be used to meet the specific training requirements of each event, such as in running and swimming, and each sport. In addition, knowing how they are used to improve the specific energy systems is the primary action of coaches and athletes (Kenney, Wilmore & Costill 2012). Repetition and interval training methods can increase the fitness of athletes' anaerobic capacity. Mazoochi, Fateminezhad and Mazoochi (2013) stated that Interval and Repetition training can be Used for increasing aerobic and anaerobic fitness of the athletes. New Interval Training also the most popular because of its effectiveness in developing both the aerobic and lactate energy systems, the recovery in the intervals is a very active 'roll-on', running recovery (Thompson 2009).

Some evidence suggest that the effectiveness of anaerobic training is mostly depends on genetically acquired muscle fibers type. According to Lydiard (1999) it is necessary to bring resistance to the leg muscles to develop the muscle fibers; in particular, the white (fast twitch) muscle fibers that are mainly responsible for giving better speed. He compare the two training (osotonic and isometric) on anaerobic fitness in hill circuit

training and concluded as; I have found that a form of osotonic exercise will develop white muscle fibers better than isometric exercise and that quite quickly the speed can be developed. As a general; various training methods should be employed to improve anaerobic fitness like interval training, repetition training, new interval training, and hill training and so on. But more emphasis must be given to intensity, duration, recovery and volume of each training methods.

2.7 Anaerobic Response to Training

The physiological response to exercise is dependent on the intensity, duration and frequency of the exercise as well as the environmental conditions. During physical exercise, requirements for oxygen and substrate in skeletal muscle are increased, as are the removal of metabolites and carbon dioxide. Chemical, mechanical and thermal stimuli affect alterations in metabolic, cardiovascular and ventilator function in order to meet these increased demands (Burton, Stokes & Hall, 2006).

2.8 Interval Training Method and Anaerobic Fitness

Researchers, coaches and athletes define interval training in varies ways. The most acceptable definition given by Kenney, Wilmore and Costill (2012) states interval training as a type of training method which is repeated, brief, fast-paced exercise bouts interspersed with short rest intervals between bouts. In this type of training as with other forms of physiologic conditioning, exercise intensity must overload the specific energy system which is desired for improvement through sport-specific muscle activation (Katch, McArdle & Katch, 2011). Thompson (2009) also defined interval training as a special type of repetition training where the raining effect takes place during the recovery intervals between the faster paced runs or repetitions. Interval training is any form of training with a set recovery period built into the session. Hence, weight training, circuit training, and plyometrics are forms of interval training. Nevertheless, most coaches associate interval training with periods of running, swimming, rowing etc. with periods of rest between exercises. As a result, interval training can develop any energy system depending on the intensity and duration of the exercise or the length of recovery between

bouts of exercise (WJEC/CBAC). This type of training can be done in aerobic and anaerobic methods.

2.8.1 Aerobic Interval Training

Aerobic interval training is an interval training which elicits aerobic metabolism at a higher ratio than anaerobic metabolism which can perform either in short aerobic interval training (10-30 seconds each exercise interval) form or in Long Aerobic Interval Training (30-60 seconds each exercise interval) form (Billat, 2001). Sometimes aerobic interval training is also known as "repeated maximal sprints" or "maximal dynamic exercise sprint training. Furthermore, this type of training method can be done in old and new interval training methods.

2.8.1.1 "Old" Interval Training

"Old" interval training is also known as repetition training and is developed by Gerschler which is the most influential coach in Germany and his colleague Herbert (Carter, 2011). Gerschler's method was designed to maximize cardiovascular fitness using a series of short, fast runs that were repeated a number of times.

In this type of training coaches and athletes should always focus on the time of the exercise interval and the recovery interval as a result the total training program lies on stopwatches. In addition Gerschler's method focused on cardiac physiology and the adaptations that can be made in training the heart, and by considering Exercise increases heart rate and rest slows it down and repeated physical exercise will slow heart rate while pumping the same volume of blood Gerschler and Reindell concluded from their experiments allowed 90 seconds rest interval to return heart rate from 180 bpm to 120-125 bpm and then the next exercise interval could start. As a result, Gerschler felt it was the recovery that strengthened the heart and there was a strong stimulus of the stroke volume immediately after the beginning of the recovery phase, so the recovery became a big focus (Carter, 2011).

2.8.1.2 "New" Interval Training

According to Thompson (2009),

''New Interval Training' is simply and very specifically any repetition training where what the athlete does during the 'recovery intervals' is crucial and actually has a profound effect on the training of the metabolic energy systems."

Even though an athlete uses a stopwatch with this form of training, the athlete doesn't highly depend on stopwatch rather he will judges how fast he is running and it is meant to be more rhythmic and dictated by the perception of pace. The major difference between the old and new interval training techniques is the transition from the work period to the recovery period, which describes as a "Roll-on Recovery". Unlike old interval training method an athlete could stop, walk or jog during the recovery period, but new interval training method entails a continuation of running but at a less intense pace. In order to strengthen the importance of this type of training method Thompson wrote in athletics weekly the Following.

It's a training method that I have developed as I produced a very successful group of athletes, establishing six world best performances on the roads at distances from 15 kms to 30 Kms, including the Half Marathon.

2.8.2 Anaerobic Interval Training

Billat (2001b) defined anaerobic interval training as energy expenditure that uses anaerobic metabolism (without the use of oxygen) that lasts less than 90 seconds, utilizing an exhaustive effort. This type of interval training can be delivered into two ways. In the first method training the variable which is going to be measured is the time limit or the number of repetitions that an individual was able to sustain for different pause durations. And also, the intensities used in these method should not maximal but at about 130% to 160% of maximal oxygen with work periods of 10 to 15 seconds interrupted by short rest intervals (15 to 40 seconds) (Margaria et al., 1969). The second method which is recently used and athletes repeat maximal bouts with different pause durations (30 seconds to 4 to 5 minutes). In this method the changes in maximal dynamic power during

successive exercise periods and characterized the associated metabolic changes in muscle (Balsomet, Seger, & Sjodin, 1992).

2.9 New Interval Training Method

Before the name of new interval training was developed there was named as Kenyan interval. Kenyan interval training a form of repetition training that Peter Thompson developed in the mid-1970s to mimic the fluctuating rhythms of the internationally emerging Kenyan athletes. As an example, repetitions of 400m might be run with straights at 66 seconds pace and the bends at 70 seconds pace, rather than running 400s at a steady 68 seconds pace. Originally, the 'Kenyan Intervals' were actually 'Kenyan Repetitions'. But at that time Thompson, like many coaches, incorrectly used the term 'Interval Training' interchangeably with 'Repetition Training'. Now the 'Kenyan Intervals' have become a type of new Interval Training and are true 'Intervals'.

Peter Thompson introduced the term new interval training in 1995 to describe a form of repetition training where what the athlete does during the 'recovery intervals' is crucial and actually has a profound effect on the training of the metabolic energy systems. The method is characterised by the very active roll-on recovery intervals during which the cells 'learn' to use and clear lactate, developing the synergistic relationship between the lactate and aerobic energy systems. As the definition of Thompson, (2009) the activity that is done in the interval between faster repetitions is called a 'roll-on recovery' and this is what defines the New Interval Training. It is where the metabolic training effect takes place. Roll-on recoveries are at a pace controlled by the athlete and become more active as the athlete's lactate utilization and clearance abilities develop. The goal, whether it's an experienced or inexperienced athlete, would be not to slow down suddenly at the end of the faster repetition and then speed up as the next repetition approaches but to transition smoothly and quickly from the pace of the faster repetition to the pace of the active roll-on recovery interval. Most runners doing repetition training do the reps too fast, with too long a recovery and too inactive a recovery-New interval training provides the solution to this developing rhythmic training that is more related the demands of running and is founded on sound physiological principles.

2.10 Benefit of New Interval Training

'Interval Training' is simply and very specifically any repetition training where the training effect takes place during the recovery intervals between the faster paced runs. The *'New Interval Training'* is simply and very specifically any repetition training where what the athlete does during the 'recovery intervals' is crucial and actually has a profound effect on the training of the metabolic energy systems.

What the athlete does in the interval between the faster repetitions in the New Interval Training is an active 'roll-on' running recovery. The effect of this active roll-on recovery is to supercharge the development of the synergistic relationship between the lactate and aerobic energy systems, improving performance at all paces and distances. You will run faster for longer as your running economy; your velocity at VO2max, the vVO2max, and the time you can run at your vVO2max, the timevVO2max, all improve. New Interval Training helps us to understand why some types of running training have worked so well in the past and, importantly, explains how to make new and even more effective training sessions for the future. Training effects occur specifically during the active roll-on recovery intervals between the faster runs. During the active roll-on recovery intervals the body's metabolism is trained to develop more energy, more quickly. Active roll-on recovery intervals train the body to both utilise and clear lactate so your body will become more efficient and powerful at using lactate as a fuel for energy production. Understand why some existing training methods have been effective in the past and learn how to make these more effective. All idea of this paragraph has been taken from Thompson (2009)

What does ‘a very active roll-on, running recovery’ really mean? Some coaches find it useful to ask athletes to imagine that they are riding a bicycle. When you are pedalling along it is like being in the faster repetition distance of the session. When you come to the recovery interval it should feel like you stop pedalling – but you do not touch the brakes at all – you just roll, naturally on. This very active ‘roll-on’, running recovery could be 25” to 35” or more per 100m for an inexperienced athlete. For experienced juniors and seniors in the Specialisation and Performance stages of athlete development, a 100m roll-

on may easily be 25" or less. The roll-on recovery distance can be 100m, 200m, 300m or any distance that is suitable to the stage of development of the athlete, to provide variety and create different effects on the lactate energy system.

2.11 Repetition Training Method

According to Thompson (2009), Repetition training is breaking a total distance or any training load into smaller units which are repeated, hence repetitions. In walking and running the pace, distance and rest/recovery intervals and activity are prescribed. Usually done on the track but may be done in a park on grass or anywhere. Thompson divides repetition training into two main types by pace or running rhythm: namely extensive and intensive. When the training emphasis is on general endurance, extensive repetition training is used; when the emphasis is on event-specific endurance, intensive repetition training is used.

On the other hand, the researcher Steinhofer (1993) defined the repetition training method is also based on a pre-planned alteration of loads and recoveries. However, the aim is for complete or nearly complete recoveries between the repetitions (for example, heart rate < 100/min., subjective feeling, and regulated duration). Intensity, as a rule, is usually quoted as maximal to submaximal and the volume as limited. By supporting this idea, Pandey and Verma (2016) found that the experimental groups trained by repetition training method improved significantly on the performance of 200 meters sprint whereas the control group did not show any significant improvement. Thus, this training method is one of the best training methods for the improvement of performance of middle and short distance runners. Repetition training is necessary for all the sports and games according to their nature and need. According to the definition of Thompson (2009) the breaking of training distance into smaller, more manageable , parts. The parts are repeated, hence 'repetition training'. A typical, simple traditional repetition session might be 15 repetitions of 400m, which would be referred to as a '400m rep session', or doing'400m reps'.

The other researcher Tirkey, (2014) explain in detail as: The repetition method is characterized by high intensity (90-100%) of work with intervals of complete recovery. It is the best method for improvement of speed abilities including speed endurance. In endurance training, the repetition method is used to improve components or factors of specific endurance or of anaerobic capacity. For the improvement of specific endurance the repetition method is used in the form of repetitions of the complete distance or part distance with the purpose of improving pace judgment of competition tactics. This researcher conducted his study on analyzing the performance of 200m by interval and repetition training method and he concluded that both training methods are effective method for improving performance in athletics. Training loads are usually defined by the following parameters: 1) Volume can be described by the running distance (m, km, miles) or the running time (sec, min, hours) or by the number of repetitions or number of sets of repetitions. 2) Intensity, which would be the pace, rhythm or running speed (min/km, min/mile, seconds per 400m lap, etc.) 3) Rest/Recovery is the time, or interval, between different repetitions or sets of repetitions (sec, min or distance). Repetition training may also be divided into two main types according to the recovery activity that takes place during the 'intervals', the time between the faster repetition sections. Namely; Repetition Training and New Interval Training'.

In general repetition is the most acceptable training for the development of various fitness depends on repetition, duration, intensity, recovery and recovery activities.

2.12 The Difference between Repetition and New Interval Training

In standard Repetition Training, the rest period between repetitions and sets may be passive, walking or easy running. But in the 'New Interval Training', which has become popular because of its effectiveness in developing both the aerobic and lactate energy systems, the recovery in the intervals is a very active'roll-on', running recovery Thompson (2009). Clearly, we can say,

"Interval training is always repetition training but not all repetition training is interval training."

Standard repetition training is the type of repetition training which is sometimes called classic (traditional) or standard repetition training or simply repetition training methods. Let's first take a quick look at traditional 'repetition training', since all interval training is a specific type of repetition training. You are aware that coaches and athletes frequently use repetition training by breaking training distances down into parts , with the parts being repeated, hence 'repetition training'. When you watch a typical traditional repetition session at the track the faster sections, the 'reps', are obvious and the recovery duration between reps is usually clearly defined in terms of either time, such as 90 seconds recovery, or distance, such as 100m recovery. But the recovery activity itself in these traditional repetition training sessions is usually poorly defined, if at all, as just "rest", "walk", or "jog". This repetition training, the breaking down of training into smaller, more manageable, repeated bites has probably happened since the very first time that a man or woman put on clothing for a formal training session and we do start to find clear references to 'repetition training' by the early 1900s. Move on rapidly through history from the early 1900s to the present day and our understanding of how the body produces metabolic energy has vastly changed and it is possible to identify and define a *'New Interval Training'*, where the training effect we're looking for happens specifically in the recovery intervals between the reps, the faster runs. In the case of *New Interval Training* on the track the recovery interval is defined usually in terms of distance and the athlete does a specific active 'roll-on' recovery. The following diagram illustrates the clear difference between *New Interval Training* and traditional Repetition Training.

2.13 Diagram of Repetition and New Interval Training Method

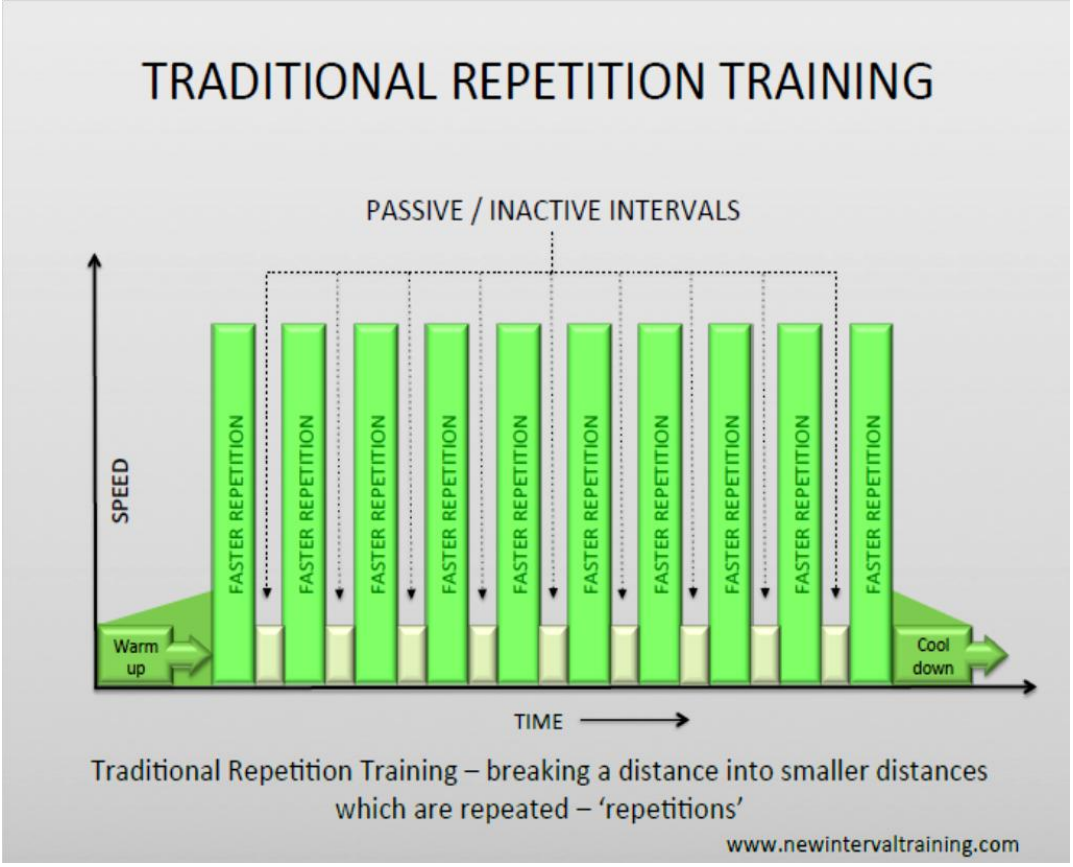

Figure 1: *Graph of Traditional Repetition Training*

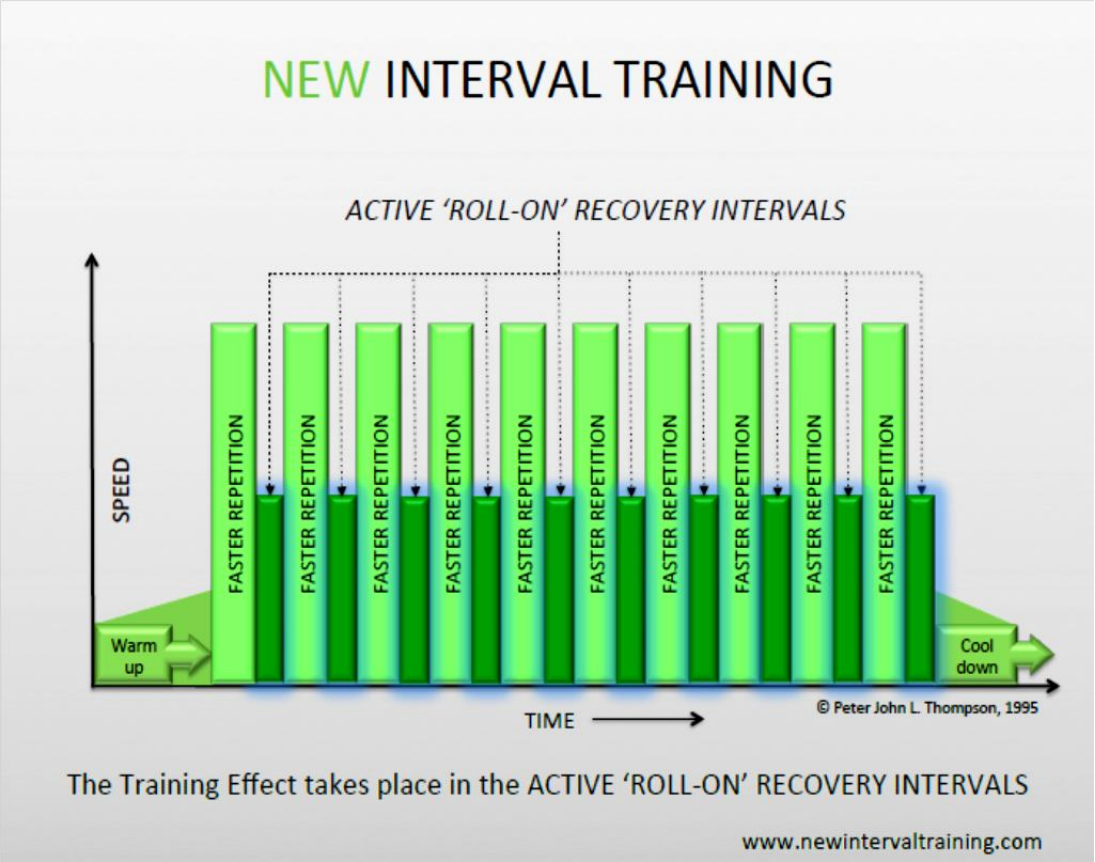

Figure 2: *Graph of New Interval Training*

2.14 Training Variables of Interval and Repetition Training Methods

According to Gondon (2009) training provides the stimulus for bodily development but crucially also need to recognize that this development only occurs when the stress is reduced and the body is allowed to recover. Therefore, we can begin to recognise the relationship between the training session or period and recovery time and the associated development of the athlete. In addition addressing the fundamentals of training which are quite simply – How hard should we train, how long should we train for and how often should we train? is important. It is the association between these variables that forms the framework for our understanding of the training response and athlete development.

Intensity refers to the concept of how hard an athlete should train as the intensity of training. Quite simply, intensity can be viewed as the amount of work done (training) within a period of time. Therefore, the more training completed in a specified unit of time

(session) the more intense that session is and vice versa. The intensity of an exercise or training is both sport- and training session-specific. Of the three variables of training it would appear that intensity is the primary stimulus for athletic development. Indeed the literature shows a clear association between both physiological adaptations to training and intensity of training (Mikesall & Dudley, 1984) and between training intensity and performance (Martin et al., 1986).

On initial inspection, one might logically conclude that if the primary stimulus for both performance and physiological gains is intensity, just bombard the athlete with continuous bouts of high intensity exercise because they are bound to improve.

Another component of training is how often the athlete trains; from this point forward this will be referred to as the frequency of training. Quite simply the frequency of training refers to the number of training sessions or units that occur within a specified timeframe. The timeframe could be a day, week, month or year. The frequency of training sessions is dependent on many factors such as training status of the athlete, stage of athlete development, training phase and sporting discipline. The general approach adopted by most coaches and athletes is to complete between 5 and 14 sessions within a one week block of training (Gordon, 2009). Duration of training a component of training, which refers to how long an athlete trains for from now on. The duration of training is a quantitative variable (i.e. can be measured) that signifies the amount or time of training completed in a session or unit (Smith, 2003). Intensity and duration of training are inextricably linked; for example you cannot program a long duration session >2 hours at supra-maximal intensities. Even for an interval session, an athlete would not be able to maintain intensity for the full duration. So although programd separately when structuring training, they are quite obviously linked.

Training volume is used to clarify the total amount of training performed within a given timeframe such as a week or month, therefore it is the composite of training duration and frequency. The volume of training implies the total amount of work done by the athlete, so an athlete could have a high or low volume training week, depending on the combination of frequency and duration sessions. Either way our understanding of this

interplay between frequency and duration is important when exploring the physiological development of an athlete. Training load reflects the interaction of intensity, frequency and duration of training conducted by the athlete. If structured and sequenced correctly by the coach, training load will provide the overall stimulus for the development of the athlete either physiologically, psychologically or biomechanically (Gordon, 2009).

According to Kenney, Wilmore and Costill (2012) one can adapt interval training procedures for each sport or event by first selecting the form or mode of training and then manipulating the following primary variables to fit the sport and athlete:

- Rate of the exercise interval
- Distance of the exercise interval
- Number of repetitions and sets during each training session
- Duration of the rest or active recovery interval
- Type of activity during the active recovery Interval
- Frequency of training per week

Distance of the exercise interval: Refers to the distance to be covered (time taken) during each work period and is determined by the specific event that an individual participates. For example, Individuals who participate in short distances events may practice short exercise intervals of 30 to 200 meters. A 1,500 meter runner may run exercise intervals as short as 200 meters to increase speed; but most their training should focus at distances of 400 to 1,500 meters (400m-1500m), or even longer distances, to increase endurance and decrease fatigue or exhaustion during a race.

Number of repetitions and sets during each training session: these variables should also highly determine by the type of sport event that an athlete participates. During shorter and more intense exercise interval, the will greater the number of repetitions and sets. As the exercise interval is lengthened in both distance and duration, the number of repetitions and sets should be correspondingly reduced.

Duration of the rest or active recovery interval: The duration of the recovery interval (whether active or passive) will depend on how rapidly the individual recovers from the

exercise interval. The extent of recovery is best determined by the reduction of the individual's heart rate to a predetermined level during the recovery interval.

For younger athletes heart rate is generally allowed to drop to between 130 and 150 bpm before the next exercise interval begins. The recovery interval duration represents a multiple of the exercise interval, and is known as the Work-to-rest ratio (WR Ratio) or exercise-to-relief interval According to Katch, McArdle and Katch (2011) for ATP –Pcr energy system the WR ratio will be**1:3.** Therefore, a person who runs 10 second intervals, the recovery interval equals 30 seconds. For training the short-term glycolytic energy system, the WR Ratio is **1:2 (***i.e.* a 2 minute recovery interval follows a 1 minute exercise interval). These specified ratios allow sufficient restoration of high-energy phosphates and lactate removal so subsequent exercise proceeds with undue fatigue.

For training the long-term aerobic energy system, the WR Ratio usually equals 1:1 or 1:1.5. For training HIIT type sessions utilizes a 2:1 WR Ratio (*i.e.* for a person who runs 20 second intervals, the recovery interval equals 10 seconds). A consecutive repeat exercise-relief interval ensures that cardiovascular response and aerobic metabolism eventually maintain near-maximal levels throughout the exercise intervals and recovery intervals. Generally, performing exercises continuously equal to the exercise intensity exhausts the person within several minutes, and an individual is forced to stop the training.

Even though the WR ratio states in such condition, the onset of fatigue, or the inability to continue exercise at a given intensity, depends on fitness level and training status, exercise intensity, and environmental conditions (Porcari, Bryant & Comana, 2015).

Type of activity during active recoverky interval: during the recovery interval the type of activity performed by an individual may vary from complete rest (passive recovery) to slow walking or rapid walking to slower running to roll-on (active recovery).

In support, Katch, McArdle and Katch (2011) confirms that recovery interval also known as recovery period may done either Passively, known as rest-relief or passive recovery; or Actively, known as exercise-relief or active recovery. Generally, the more

intense the exercise interval, the less intense the activity performed in the recovery interval. When an individual have good aerobic fitness, he will be able to increase the intensity of the exercise interval or decrease the duration of the recovery interval, or both.

Rate of the exercise interval: Determine the intensity of the exercise interval either by establishing a specific duration for a set distance or by using a fixed percentage of the person's maximal heart rate (MHR).

Frequency of training per week: The frequency of training highly depends on the fitness level of an individual and the purpose of the interval training. Most of elite sprinter and middle-distance runner work out for five to seven days a week.

CHAPTER THREE

3 RESEARCH METHODS

3.1 Introduction

This chapter presents the research methods used in conducting this research including the study area where the research has been done, the research design which was implemented, how data will be gathered, and methods of data analysis will used to conduct this study. So as to achieve the objectives which are mentioned above in chapter one, the researcher will use the following methods up to the overall completion of the study.

3.2 Study Area

The study was conducted in Tilili, which is found in Guagusa shegudad woreda of the Awi Administration Zone in Amhara region. Amhara southwestern part of the region and North western part of the county, Ethiopia. Tilili is found about 436.3 km away from the capital city of Ethiopia, Addis Ababa and 128.4km from Bahir Dar, the capital city of the Amhara National, Regional state and 16.5km from Injibara, which is the capital city of the zone. Geographically, Tilili is found in $10^{o}51'10"$N latitude and $37^{o}1'17"$E longitude, in Guagusa shekudad woreda at an elevation of 2446 meters above sea level. Map of the study site will indicated on appendix 'G'. The underlying benefits with high altitude (>2000 m) A number of physiologic changes occur to allow for acclimatization at high altitude. your body is being forced to acclimate to the atmosphere which contains lower amounts of oxygen. This, in turn, helps improve your body's ability to deliver oxygen to your muscles. Thus, exercising at higher altitudes helps your body had better prepare for lower oxygen workouts. Cardiovascular and circulatory systems will begin to function at more optimal levels. Based on figures from the 2007 census, guagusa shekudad has an estimated total population of 83,930, of whom 41,427 are males and 42,503 are females. And

amongst them only a total of 9043 (10.78%) were urban inhabitants, who have been lived in the capital town of this woreda (Tilili).

3.3 Research Design

Because of its experimental nature of the study, quasi-experimental research design approach was employed to examine the effect of repetition and new interval training methods on athlete's anaerobic fitness. Since it helps the researcher to examine, evaluate, and analyze the effects of repetition training and new interval training methods on athlete's anaerobic fitness, quantitative methods of data analysis was used.

3.4 Population, Sample Size and Sampling Technique

Purposive sampling technique was used to select the project namely Tilili athletics project among athletics project those are found in Amhara region; because the researcher has been lived around the area and anaerobic fitness problem was more faced in that project.

Tilili athletics center has its own athletic club and projects of under 17 (U-17) and under 13 (U-13). From this target population the researcher has selected U-17 project purposively because project athletes has been the most exposed stages for fitness improvement and the reason why I excluded U-13 project athletes is; it is not advisable to train anaerobic training three time per a week for this stage since they are kids.

Out of forty (40) U-17 athletes of Tilili athletics center, the researcher has selected all thirty (30) short and middle-distance runners of the project athletes comprehensively for this study. Then, based on their pretest result all 30 athletes were assigned into two groups through randomization (*i.e.*15 athletes for repetition training group and 15 athletes for new interval training group). The need for selecting these event athletes is because of anaerobic nature of the training intervention which was delivered during the study and the nature of dependent variable (anaerobic fitness) which was measured in this study is directly associated with middle and short distance running performance than other events.

Due to potentially confounding results related to greater physical training volume, subjects who undertake in additional training outside of this study was forced to stop their extra training. Nutrition control phase would not possible.

Table 1: Tilili Athletics Project Study Participant Athletes

Events	**Number of athletes**		
	Male	Female	Total
short distance	7	4	11
Middle distance	11	8	19
Total	18	12	30

3.5 Training Protocol

Following selecting of athletes, anaerobic fitness pre-test measures was taken over one week period. After taking pre-test results subjects was assigned into one of two experimental groups (new interval training group and repetition training group). Then 8 weeks of designed training interventions was addressed for each group. Finally, anaerobic fitness post-testing measures was taken immediately after the end of training intervention and takes one-week period.

The training program was progressive, so that both new interval and repetition training groups utilize their training starting at 50% of their competition pace progressing to approximately 90% of their competition pace. All the training sessions was supervised in Tilili Athletics center. The training schedule was given three days per week i.e., Monday, Wednesday, and Saturday and hence, a total of 24 days was given for two months (February and March 2020) training sessions, one session had consists of 40-60 minutes progressively. The programs of each session plan has found in appendix‘F’ and all the

designed training program was adopted from IAAF CECS Level III for short and Middle Distance athletes. A timeline for the experimental procedures and overview of the experimental design has shown in the following table.

Table 2: Training Protocol Layout

Treatment	Anaerobic Exercise Program
Frequency	3 days per a week
Total duration	2 months (8 weeks)
Duration /session	40 - 60min
Intensity	Moderate (50-90) MHR
Exercise days	Monday, Wednesday and Saturday
Training Time	1stday morning, 2nd day morning, 3rd day morning
Mode of exercise	Running, and hill training

3.6 Sources of Data

The researcher had used primary and reference sources according to the nature of the study. The primary data has taken from pre-test and post-test measurements in the field at the beginning and at the end of the training program. The related reference were obtained from different sources such as different documents, like books, journals, articles, thesis work and internet sources were to get relevant and sufficient information regarding to the study area.

3.7 Data Collection Instruments

As data collection instrument the researcher used the following anaerobic fitness tests before and after training interventions to measure anaerobic fitness variables; anaerobic efficiency, speed endurance, maximum speed, average power and fatigue index.

- 400 meters Drop off Test,
- Running-based Anaerobic sprint Test (RAST), and
- 150 metres endurance test
- 30 metres flying test

The types of data source in the study were used pretest and posttests. The stated problem needs to measured anaerobic fitness variables to evaluate the comparative effect of repetition and new interval training. In the project level, field-based fitness tests are a practical and feasible option to assess physical fitness variable, field based fitness tests are easy to administer, involve minimal equipment, low cost and a larger number of participants can be evaluated in a relatively short period of time. The field tests had been consists of: 1) power and fatigue index (RAST test in watt/second), 2) anaerobic efficiency (400 meters drop off test in second), 3) maximum speed (30 meter flying test in second), 4) speed endurance (150 meters endurance test in second). In the procedure of the study pre- test and post- test was taken before and after 2 months repetition and new interval training program for repetition training group and new interval training group. Before test regarding to data collection all necessary track and field marking were done. All athletes may ask to go for proper warm up & exercise. The tests for anaerobic fitness variables were demonstrated and completed instructions regarding all tests were given to all selected project athletes. When all selected project athletes can ready for the test, the data was recorded by the administering the test.

3.8 Selection and Administration of Skill Tests

In constructing a test it is important to make sure that it really measure the factors required to be tested, and is thus objective rather than subjective. In doing so all tests should therefore be specific (designed to assess an athlete's fitness for the activity in question), valid (test what they purpose to test), reliable (capable of consistent repetition) and objective (produce a consistent result irrespective of the tester) (Mackenzie, 2005). Thus, the following tests were used for this study to assess an athlete's anaerobic fitness improvement following to training interventions.

3.8.1 400 Meters Drop Off Test

The objective of this test is to monitor the athlete’s anaerobic efficiency.

Required resources: To undertake this test a researcher required measuring tape, 400m track**,** Stop watch, whistle and Assistant.

Test procedures: The test was conducted as follows; The athlete was timed running at full speed over 100 meters**,** The athlete takes a five-minute recovery**,** The athlete was timed running at full speed over 400m**.** Then the time for the 400m was converted to 100m splits by dividing the time by 4**,** finally the 100 meters sprint time was then subtracted from the split-time, giving the drop off time.

Scoring: By subtracting time of 100 meter run from the split-time of 400 meters run, take the difference in second. The aim is always to reduce the 'drop off' time by increasing anaerobic efficiency. A top female 400m runner has a ‘drop off' time of around 0.7 seconds.

Reliability: Reliability would depend upon how strict the test is conducted and the individual's level of motivation to perform the test.

Validity: There are no published tables to relate results to potential performance in competition.

3.8.2 Running-Based Anaerobic Sprint Test

The Running-based Anaerobic Sprint Test (RAST) was developed at the University of Wolverhampton (United Kingdom) to test an athlete's anaerobic performance. RAST is similar to the Wingate Anaerobic 30 cycle Test (WANT) in that it provides coaches with measurements of power and fatigue index.

Required resourses: To undertake this test researcher required measuring tape, 400m track – with a 35m marked section on the straight, 2 cones to mark the 35m section, Stopwatch, Assistant, Calculator will be advantageous.

Test procedure: The athlete is weighted prior to the test, undertakes a 10 minute warm session, has a 5 minute recovery, completes six 35m runs at maximum pace (10 seconds rest allowed between each sprint for turnaround). The assistant records the time taken for each 35m sprint to the nearest hundredth of a second and makes appropriate calculations.

Calculations;

Power output for each sprint is found using the following equations:

- Velocity = Distance ÷ Time
- Acceleration = Velocity ÷ Time
- Force = Weight x Acceleration

- Power = Force x Velocity OR Power = Weight x Distance 2 ÷ Time 3.

From the six times calculate the power for each run and then determine:

- Maximum power – the highest value
- Minimum power – the lowest value
- Average power – sum of all six values ÷ 6
- Fatigue Index – (Maximum power – Minimum power) ÷ Total time for the 6 sprints.

Maximum Power: This is a measure of the highest power output and provides information about strength and maximal sprint speed. Research range is 1054 watts to 676 watts.

Minimum Power: This is the lowest power output achieved in the six 35 meters sprints and is used to calculate the Fatigue Index.

Average Power: This provides an indication of an athlete's ability to maintain power over time. The higher the score indicates the athlete's ability to maintain anaerobic performance.

Fatigue Index: Indicates the rate at which power declines for the athlete. A low value (<10) indicates the ability for the athlete to maintain anaerobic performance. A high fatigue index value (>10) indicates the athlete may need to focus on improving their lactate tolerance.

Target group: This test is suitable for sprint and endurance athletes and players of endurance sports (eg football, rugby) but not for individuals where the test would be contraindicated.

Reliability: Reliability would depend upon how strict the test is conducted and the individual's level of motivation to perform the test.

Validity: There are no published tables to relate results to potential performance in competition.

3.8.3 150 meters Endurance Test

The objective of this test is to monitor the development of the athlete's specific endurance for 100 meters.

Required resources: To undertake a test you required; 400m track – 150m marked section**,** Stopwatch**,** Assistant.

Procedure of the test: The athlete undertakes a 150m run from a standing start**,** the assistant records the time for the athlete to complete 150m.

Reliability: Reliability would depend upon how strict the test is conducted and the individual's level of motivation to perform the test.

Validity: There are no published tables to relate results to potential performance in competition.

3.8.4 Flying 30 Meters Test

The objective of this test is to monitor the development of the athlete's maximum speed.

Required recourses: To undertake this test required: measuring tape, 400m track – 60m marked section on the straight, Cone to mark 30m point, Stop watch, Assistant.

Test procedures: The test comprises of 3 x 60m runs from a standing start and with a full recovery between each run, The athlete uses the first 30m to build up to maximum speed and then maintains the speed through to 60m. The assistant should record the time for the athlete to complete the first 30m and whole 60m.

Scoring: To determine the athletes flying 30m time subtract the time for the first 30m from the time for the whole 60m.

Reliability: Reliability would depend upon how strict the test is conducted and the individual's level of motivation to perform the test.

Validity: There are published tables to relate results to potential level of fitness and the correlation is high with experienced athletes.

3.9 Methods of Data Analysis

Pre and posttest score was collected from randomly selected new interval training (n=15) and repetition training (n=15) groups of before and after 8 weeks of training intervention, and the scores were recorded. Both training methods was given for eight consecutive weeks and attendance was taken throughout the training. Power, fatigue index, anaerobic efficiency, speed endurance, and maximum speed were selected from anaerobic fitness parameters to be tested.

After collecting the reliable data through experimental method such as pretest and posttest of each variable, the researcher analyzed and interpreted it. All data was analyzed by using table and descriptive statements using SPSS version 23 at an alpha level less than or equal to 0.05. Thus, the collected data were analyzed using paired sample t-test to analyze pre-test and post-test results of both training methods and independent sample t test was used to analyze the comparisons between new interval and repetition training group. Unless this has been done very carefully, misleading conclusions may be drawn and the whole purpose of doing research may reduce the quality. In addition based on the analyzed and interpreted results and discussion, brief conclusions, finally recommendation have been obtained.

3.10 Data Quality Control

To ensure data quality, all the field test procedures, collection of data's and handling information was carried out in accordance with standard protocols and measurements. The researcher used assistants to collect data. In addition, in order to avoid error, Orientation had been given for assistant data collector on how to use data collecting instruments and measurements during data collection. Moreover, the researcher created awareness for subjects about test and recommended precondition which they tried to do prior to take a test. Additionally all the above mentioned tests were recorded and feed in to the software by checking twice with assistants to avoid errors in data feeding.

3.11 Ethical Consideration

The study was designed in such way that ethical issues were properly addressed to the subjects, so the coach and students were volunteer to participate in the study like during training, during testing and other activities. Moreover, privacy of the participants and confidentiality were strictly secured and maintained throughout the study.

CHAPTER FOUR

4 RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter deals with the analysis, interpretation and discussion of results collected through 400 meters drop off test, 150 meters endurance test, 30 meters flying test, RAST test from subjects of the study. Pre-test and post-tests were taken from both new interval and repetition training groups before and after 8 weeks of training intervention, and the scores were recorded. The collected data were analyzed using paired sample t-test to analyze pre-test and post-test results of both training methods and independent sample t test was used to analyze the comparisons between new interval and repetition training group.

After collecting the reliable data from pretest and posttest of each variable, the researcher analyzed and interpreted it. The data was analyzed by using table and descriptive statements using SPSS version 23. The tests were based on Brian Mackenzie (2005), performance evaluation test. This chapter reveals results, interpretation and discussion of the research under taken.

4.2 Results

Based on the results of pre and post athletes the following analysis was recorded:

Table 3: Demographic Characteristics of Participants of NTG and RGT

Group	N	Age		Weight		Training Experience	
		Mean	SD	Mean	SD	Mean	SD
New Interval Training	15	15.93	.884	45.033	6.778	4.27	.884
Repetition training	15	15.93	.961	45.810	6.451	4.20	.862

As shown from the above table, descriptive characteristics of 30 study participants from Tilili Athletics project were found in mean ± SD of age (NTG=15.93±0.884, RTG=15.93±0.961), weight (NTG=45.033±6.778, RTG= 45.810±6.451) and training experience (NTG=4.27±0.884, RTG=4.20±0.862). This indicates the subjects were relatively had the same age, weight and training experience.

Table 4: Descriptive Statistics of Anaerobic fitness test variables

fitness tests	Group			
	NTG		RTG	
	Mean± Std. Deviation		Mean± Std. Deviation	
	PT	POT	PT	POT
400m drop off test	3.784±1.244	3.482±0.682	3.409±1.737	2.675±1.054
150m endurance test	23.905±1.675	22.659±1.445	23.260±2.256	21.6140±2.303
30m flying test	4.4333±0.284	4.139±0.360	4.42±0.358	3.6907±0.486
Power	381.57±108.54	484.08±163.69	385.48±108.93	515.08±173.58
Fatigue index	10.304±4.704	7.080±3.968	9.864±4.166	6.986±2.896

NTG=New interval training group, RTG=Repetition training group, PT=pretest, POT=posttest,

NB: the unit of all scores is second except power and fatigue index (watt)

The above table shows the mean, and standard deviation of pre and posttest scores for the five anaerobic fitness test variables for both training groups (NTG and RTG).

The above table (4) displays the group statistics of the post-test results of anaerobic fitness test variables: 400m drop off test, 150m endurance test, 30m flying test and RAST test for both repetition training group and new interval training group. From the data, we can see that 400m drop off test score of the pre and post-test mean value of new interval training were found to be 3.784±1.244 and 3.482±0.682 second and repetition training group post-test mean value were found to be 3.409±1.737 and 2.675±1.054 second respectively. Therefore, the mean value score of 400m drop off test indicated that, after intervention of new interval training versus repetition training with selected exercise, the

subjects performed the given distance and there was difference between the two groups. Yet, we cannot determine here if this difference was statically significant.

In addition, Pre and post-test results of 150m endurance test for both new interval training group and repetition training group was displayed in table 4. As shown in the table the pre and post-test mean value of new interval training group were found to be 23.905±1.675 and 22.659sec±1.445sec and repetition training group post-test mean value were found to be 23.260±2.256 and 21.614sec±2.303sec respectively. Therefore, the mean value score of 150m endurance test indicated that, after exposed to new interval training group versus repetition training there was deference between pre and post and between the two groups. Despite one can see that there was still a difference, we cannot determine here if this difference was statically significant yet. Similarly, the table above (4) also showed us pre and posttest results of flying 30m test to measure the maximum speed of the athletes for both intervention groups. Thus, the pre and post-test mean value of new interval training group were found to be 4.4333±0.284 and 4.139sec±0.360sec and repetition training group post-test mean value were found to be 4.42±0.358 and 3.6907sec±0.48575sec respectively. Therefore, the mean value score of flying 30m test indicates that, after intervention repetition versus new interval training with selected exercise , the subjects were performed 30m running at maximum speed and there was deference between pre and post and between the two groups. However, it was difficult to decide whether the difference is statistically significant or not.

Finally, the above descriptive statistics table also includes, power and fatigue index of RAST test of pre and post-test results. The result showed that the mean value score of power and fatigue index for new interval training groups were 381.57±108.54sec pre and 484.076±163.691watt post-test result and 10.304 ±4.7038watt/sec pre and 7.080±3.968 watt/sec post-test results respectively. Moreover, the mean value of both power and fatigue index for repetition-training group were found to be 385.48±108.93 watt pre, 515.077±173.584watt post-test, 9.864±4.166watt/second pre, and 6.986±2.896watt /sec. post-test respectively. We can see that there was still a difference. However, we cannot determine here if this difference was statically significant. Therefore, to identify the

statistical significant difference, paired sample t-test and independent sample t test must be applied as follow.

Table 5: Paired Samples t-Test Results of NTG and RTG

Anaerobic fitness tests	subjects	Paired Differences					T	DF	P
		MD	SD	SEM	95% CI of the difference				
					Upper	Lower			
400m drop off	NTG PT-POT	.302	.756	.195	-.117	0.721	1.548	14	.144
	RTG PT-POT	.734	.814	.210	.283	1.185	3.493	14	.004
150mendurance	NTG PT-POT	1.246	.670	.173	.8751	1.617	7.205	14	.000
	RTG PT-POT	1.645	.770	.199	1.219	2.072	8.279	14	.000
30m flying	NTG PT-POT	.295	.257	.066	.153	.435	4.446	14	.001
	RTG PT-POT	.729	.461	.119	.474	.984	6.128	14	.000
Power	NTG PT-POT	-102.5	111.46	28.780	-164.23	-40.77	-3.561	14	.003
	RTG PT-POT	-129.6	116.64	30.116	-194.19	-65.02	-4.303	14	.001
Fatigue Index	NTG PT-POT	3.224	2.836	.732	-4.794	-1.654	4.403	14	.001
	RTG PT-POT	2.878	2.986	.771	-4.532	-1.224	3.733	14	.002

Key: - NTG=New interval training group, RTG=Repetition training group, PT= pre t test, POT=post-test, SEM= St. Error mean, MD= mean difference, df= degree of freedom, SD=Standard deviation, CI= Confidence Interval, P= Sig. (2-tailed**)**

NB: the unit of all scores is second except power and fatigue index (watt)

The above table shows the paired sample test of significance differences of the two experimental groups (NTG and RTG) of pre and post-test results. According to the data presented in the table, the pre and post-test result of 400m drop off test showed statistically a significant difference in RTG. The result suggested that RTG significantly improved anaerobic efficiency when measured in 400m drop off test (MD=0.734, SD=0.814, p=0.004) than NTG (MD=0.302 SD=0.756, p=.144). Hence, (P <0.05) Post-

test score of 400m drop off test was significantly improved than pre-test scores for the RTG. However, no significant improvement was observed in NTG ($p>0.05$).

The above table (5) also displays the test of significance differences of the two groups (NTG and RTG) of pre and post-test results of 150m endurance test, 30m flying test, power and fatigue index test. Thus, the pre and post-test result of 150m endurance test for both NTG and RTG showed statistically significant difference (MD=1.246, SD=0.670, p=.000) in NTG and (MD=1.645,SD=0.770, p=0.00) in RTG. Hence, ($P<0.05$) posttest score was significantly increased than pretest score for both groups. Similarly, the mean value of pre and post-test result of flying 30m test, which was used to measure maximum speed of both NTG and RTG showed statistically significant difference. The results indicated that for NTG (MD=0.295, SD=0.257, p= 0.001) and for RTG (MD=0.729, SD=0.461, p=0.00) is significant at 0.05 level of confidence. The RAST test of power test also showed a significant difference from pre to post-test in both groups (i.e. MD=-102.50, SD=111.46, p=0.003 for NTG and MD=-129.59, SD=116.64, p=0.001 for RTG) which is significant at 0.05 confidence. Hence, ($P <0.05$) Post power test result was significantly improved than pre-test scores for both training group.

In additions, RAST test of fatigue index result of pre and post-test showed significance difference. As observed in the above paired sample t-test table, i.e. in NTG (MD=3.224, SD=2.836, p=0.001) and in RTG (MD=2.878, SD=2.986, p=0.002). Hence, $p<0.05$ showed that there was a significant improvement from pre to post-test results of the test in both NTG and RTG. As discussed before in chapter 3, (3.8) Fatigue Index: Indicates the rate at which power declines for the athlete. A low value (<10) indicates the ability for the athlete to maintain anaerobic performance. A high fatigue index value (>10) indicates the athlete may need to focus on improving their lactate tolerance (Mackenzie, 2005). Generally, the results indicated that the applied repetition and new interval training protocol caused a significant improvement in all anaerobic fitness tests in both training group, except 400m drop off test result for NTG.

Table 6: Independent Sample t-Test of Post- Test Result Measured Between Two Group

Independent Samples Test

Anaerobic fitness test		Levene's Test for EOV		t-test for Equality of Means						
		F	Sig.	t	df	P	MD	SED	95% CI of the Difference	
									Lower	Upper
400m drop off	EVA	5.453	.027	2.489	28	.019	.807	.324	.148	1.470
	EVNA			2.489	23.98	.020	.807	.324	.138	1.475
150m endurance	EVA	12.455	.001	1.488	28	.148	1.045	.702	-.394	2.482
	EVNA			1.488	23.54	.150	1.045	.702	-.406	2.495
Power	EVA	.196	.661	-.503	28	.619	-31.00	61.604	-157.19	95.189
	EVNA			-.503	27.90	.619	-31.00	61.604	-157.21	95.208
fatigue index	EVA	2.961	.096	.074	28	.941	0.0940	1.268	-2.504	2.692
	EVNA			.074	25.61	.942	0.0940	1.268	-2.515	2.703
30m flying	EVA	1.170	.289	2.870	28	.008	.448	.156	.128	.767
	EVNA			2.870	25.80	.008	.448	.156	.127	.768

EVA-equal variance assumed, EVNA-Equal variance not assumed, EOV- equality of variance.

4.3 Figures of the Comparison between NTG and RTG

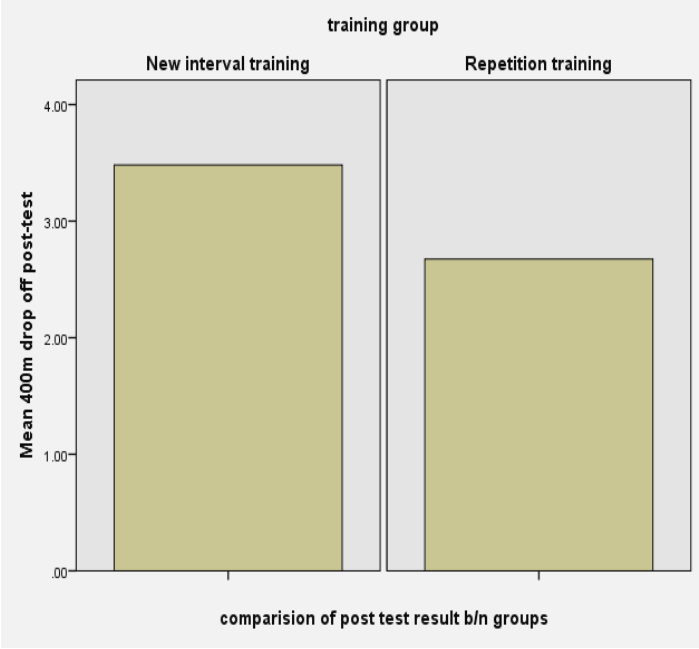

Figure 3: Graph of Mean Comparison of Anaerobic Efficiency between Groups

Figure 4: Graph of *Mean Comparison of Maximum Speed between Groups*

Figure 5: Graph of Mean Comparison of Speed Endurance between Groups

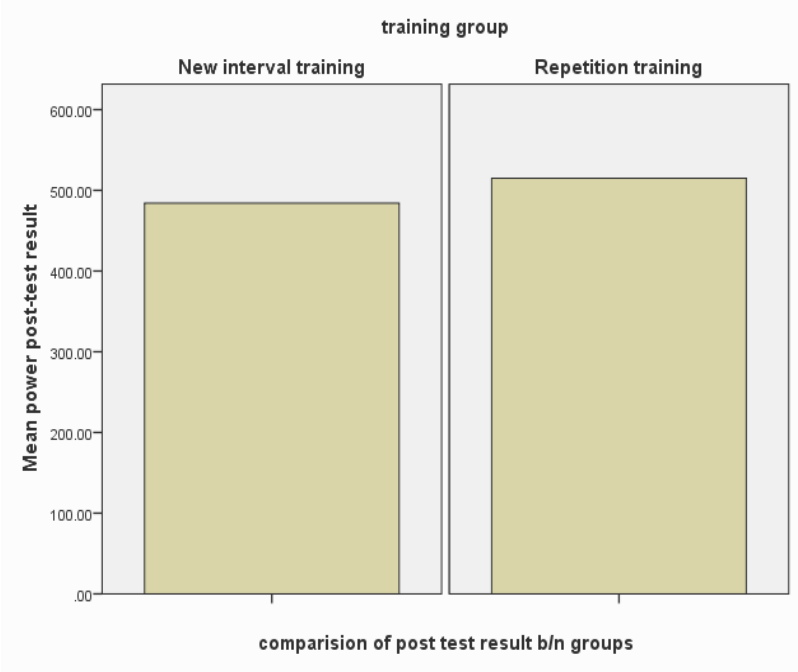

Figure 6: Graph of Mean Comparison of Power between Groups

Figure 7: Graph of Mean Comparison of Fatigue Index between Groups

The above table show us Independent sample t-test, which used to compare two different groups. So, the table and figures showed the comparison of the effect of NTG and RTG on anaerobic fitness and interpretation was drawn as the following.

Table 6 contains two sets of analyses: the first assumes equal variances and the second does not. To assess whether you should use the statistics for equal or unequal variances, use the significance level associated with the value corresponding to the heading, *Levene's Test for Equality of Variances*. It tests the hypothesis that the variances of the two groups are equal. A small value in the column labeled *Sig*. indicates that this hypothesis is false and that the groups do indeed have unequal variances (SPSS training manual, (2017), SPSS II or part II). In this research case (400m drop off test result indicated on the above table 6), the Levene's test for equality of variances shows that the calculated value of F = 5.453 with p-value =0.027. Therefore, we would reject the null hypothesis for equality of variance. Hence, we can assume that there is unequal variance between the two groups. Therefore, the results where equal variance not assumed can be used. The calculated value of t (23.98) is 2.489 and the corresponding p-value is 0.020. This indicates that there is a statistically significant difference between the two groups of means. A 95% confidence interval for the difference between the two groups means is [0.13772, 1.47561]. The confidence interval does not include zero. This indicates that there was a significant difference between the means of new interval and repetition training groups. Therefore, 8 weeks repetition training has better significant effect than new interval training because the mean value score of repetition training group is less than that of new interval training group (2.6753sec<3.4820sec) since the aim of the test is to reduce the time taken to cover a given distance.

Independent sample t-test was conducted as the result of mean of post-test to compare the time taken to finish 150 meters distance between two groups (NTG and RTG). As it was assessed by Levene's test for equality of variances (p = 0.001) homogeneity of variance was violated, so, equal variance not assumed was used; t (23.54) =1.488, P =0.150 two tailed, Mean Diff = 1.04467. The confidence interval does contain zero; this result does violate P value of the significant test. So, there was insignificant difference between two intervention groups (P >0.05) in speed endurance. Therefore, 8 weeks of both new interval training and repetition training had equal effect on speed endurance of athlete.

The other anaerobic fitness variable (power) was also tested using Independent sample t-test as the result of post-test to compare the RAST test score of the average power output

between two groups (RTG and NTG). As it was assessed by Levene's test for equality of variances (p =0.661) homogeneity of variance was not violated, so, equal variance assumed was used; t (28) =-0.503, P =0.619 two tailed, Mean Diff = -31.001. The confidence interval does contain zero; this result does violate P value of the significant test. Therefore, there was no significant difference between two intervention groups (P >0.05) in case of power test. Therefore, 8 weeks of both new interval training and repetition training had equal effect on average power improvement. Furthermore, Independent sample t-test was conducted as the result of post-test to compare the mean score of RAST test of fatigue index between two groups (RTG and NTG). As it was assessed by Levene's test for equality of variances (p =0.096) homogeneity of variance was not violated, so, equal variance assumed was used; t (28) =0.074, P=0.941 two tailed, Mean Diff =0.09400. Which does contain zero; this result does violate P value of the significant test. So there was no significant difference between two intervention groups (P >0.05) Therefore, 8 weeks of both new interval training and repetition training had equal effect on fatigue index improvement.

In addition, the above Independent sample t test table (6) indicated that the post-test result revealed that an average time taken to finished 30m distance to test the performance of athlete's maximum speed between new interval training group and repetition training group. As it was assessed by Levene's test for equality of variances (p=0.289) homogeneity of variance was not violated, so equal variance assumed were used; T (28) =2.870, P = .008 two tailed, Mean Diff = 0.448. The confidence interval does not contain zero; this result does not violate P value of the significant test. So, there is a significant difference between repetition training and new interval training groups (P <0.05) in case of maximum speed. Therefore, 8 weeks repetition training has better significant effect on maximum speed than that of new interval training.

4.4 Discussions

The purpose of this study was to compare the effect of 8 weeks of repetition training versus new interval training methods on anaerobic fitness variables among Tilili athletics project trainees. This topic acts as a link between the previous chapters and topics by discussing the findings in relation to the previous literature available.

The findings of the present study revealed that there were significance differences before the training and after 8 weeks of new interval training on athlete's speed endurance when assessed in 150m endurance test score by measuring the time taken to cover 150m distance running. The result suggests that NTG significantly improved speed endurance (MD=1.022, SD=0.756, p=.000). Hence, (P <0.05) Post-test value of speed endurance was significantly improved in 150m endurance test score than pre-test values for the NTG. As showed in the data (table 4) the mean values of 150m endurance test score were 14.8340 second in before new interval training, which was improved (reduced) to 13.8120 second after 8 week new interval training, this means the 150m endurance test score in speed endurance of NTG increased by 1.022 second after 8 weeks of new interval training. The increment of the rate of this score was one indicator of the improvement of the athletes' speed endurance. The reason behind this change was new interval training that they were engaged in. This finding is in line with the finding of Araujo, Gobatto, Marcos, and verelngia (2015) concluded that interval-training method with active recovery activities have been more recommended to promote anaerobic adaptation due to active roll on recovery period that enables the exclusion of elevated intensity. Another researcher which has relationship with the present study Tirkey (2014) also confirm that give an idea of nature of 200 meters sprint which require speeds, as well as speed endurance and might be improved by interval training method.

Another result obtained from the table of NTG revealed that there were significance differences before the training and after 8 weeks of new interval training on athlete's maximum speed when assessed in 30m flying test score by measuring the time taken to cover 30m distance running. The result suggests that NTG significantly improved maximum speed (MD=0.295, SD=0.257, p= 0.001). Hence, (P <0.05) maximum speed of NTG Post-test value was significantly improved in 30m flying test score than pre-test

value. As showed in the data (table 4), the mean values of 30m flying test score were 4.4333 second in before new interval training, which was improved (reduced) to 4.1387 second after 8 week new interval training, this means the 30m flying test score in maximum speed of NTG increased by 0.295 second after 8 weeks of new interval training. The increment of the rate of this score was one indicator of the improvement of the athletes' maximum speed. The reason behind this change was new interval training that they were engaged in. This finding agreed with interval training interspersed with active recovery between intervals above lactate threshold for short period has been found to be more beneficial than continuous training for improving muscular endurance physical fitness (Wilmore, Costilla, & Kenney, 2008). The finding of Billat (2001b) concluded that the supra maximal interval training might tax both the anaerobic and aerobic energy releasing systems at close to their maximal capacity.

Furthermore, as we have seen the above paired sample t test (table 5) there were significance differences before the training and after 8 weeks of new interval training on athlete's power when assessed in RAST test of power test score by measuring running based anaerobic sprint test (35m). The result suggests that NTG significantly improved power (MD=-102.50, SD=111.46, p=0.003). Hence, (P <0.05) Post-test scores of athlete's power was significantly improved in RAST power test score than pre-test values for the NTG. As the data (table 4) showed the mean values of RAST power test score were 381.575watt in before new interval training, which was improved to 484.076watt after 8 week new interval training, this means the RAST power test score in power of NTG increased by 102.50 watt after 8 weeks of new interval training. The increment of the rate of this score was one indicator of the improvement of the athletes' power.

This result disagree with the finding of Yüksel et al., (2014) displayed that interval exercises conducted for three days a week for eight weeks; interval exercises had **no** impact on body mass, body fat ratio and anaerobic power levels. On the other hand, the finding of Sözen and Akyıldız (2018) agree with the present result and it stated as it was observed that anaerobic interval training had a positive effect on anaerobic capacity, anaerobic power and the fatigue index.

Supporting with this, another result obtained from the present study, NTG revealed that there were significance differences before and after 8 weeks of new interval training on athlete's fatigue index when assessed in RAST test of fatigue index test score by measuring running based anaerobic 35m sprint. The result suggests that NTG significantly improved fatigue index of the athlete (=3.224, SD=2.836, p=0.001). Hence, (P <0.05) Post-training of athlete's fatigue index was significantly improved in RAST fatigue index test score than pre-test values for the NTG. As showed in the data (table 4), the mean values of RAST fatigue index test score were 10.304watt/sec before new interval training, which was improved to 7.08watt/sec after 8 week new interval training. This means the RAST fatigue index test score in fatigue index of NTG increased by 3.2240 watt/second after 8 weeks of new interval training. The increment of the rate of this score was one indicator of the improvement of the athletes' fatigue index (ability of resisting fatigue). Hence, the researcher accepted hypothesis H_A1.1 and rejected H_0.1 at 0.05 level of confidence. According to the finding result obtained from Sözen and Akyıldız (2018), it was observed that anaerobic interval training had a positive effect on anaerobic capacity, anaerobic power and the fatigue index. This present finding agrees with the finding of Tirkey (2014) stated that there has been a significant improvement on the performance of 200 meters sprint due to the effect of Interval Training Method Program. Even though they didn't consider active roll on recovery during their training intervention of interval training method, The other scholars (Majid, Seyyed . and Tahere (2013) also found that interval trainings can be used for increasing aerobic and anaerobic fitness of the athletes.

On the other hand, the findings of the study revealed that there were no significance differences before to after 8 weeks of new interval training on athlete's anaerobic efficiency when assessed in 400m drop off test score by subtracting the time taken to cover 100m running from 400m distance running. The result suggests that NTG did not significantly improved anaerobic efficiency (MD=0.302 SD=0.756, p=.144). Hence, (P>0.05) Post-training anaerobic efficiency didn't significantly improved in 400m drop off test score than pre-test values for the NTG, at 0.05 level of confidence . As showed in the data (table 4), the mean values of 400m drop off test of pre and posttest score of

NTG stay very close, 3.7840 second and 3.4820 second pre and post-test respectively. So, there was no significant difference between pre and post-test results of NTG due to engaging in new interval training methods. The other finding stated that interval training is based on the concept that a greater amount of work can be performed at higher exercise intensities with the same or less fatigue compared to continuous training, (Sá, Tenório, Freitas, Ruas&Câncio, 2012.

In case of RTG, The findings of the current study revealed that there were significance differences before the training and after 8 weeks of repetition training on athlete's anaerobic efficiency when assessed in 400m drop off test score by subtracting the time taken to cover 100m running from 400m distance running. The result suggests that repetition training group significantly improved anaerobic efficiency (MD=0.734, SD=0.814, p=0.004). Hence, (P <0.05) Post-test result of anaerobic efficiency was significantly improved in 400m drop off test score than pre-test values for the RTG. As indicated in the data (table 4), the mean values of 400m drop off test score were 3.4093 second in before repetition training, which was improved to 2.6753 second after 8 week repetition training, this means the 400m drop off test score in anaerobic efficiency of RTG increased by 0.734 second after 8 weeks of repetition training. The increment of the rate of this score in RTG was one indicator of the improvement of the athletes' anaerobic efficiency. The reason behind this change was repetition training that they were engaged in.

So this present finding in line somewhat with the concept of interval training can be traced back to at least the 1930s, when the famous German coach Woldemar Gerschler formalized a structured system of interval training. Interval training consists of repeated bouts of high- to moderate-intensity exercise interspersed with periods of rest or reduced-intensity exercise. Research has shown that athletes can perform a considerably greater volume of exercise by breaking the total exercise period into shorter, more intense bouts, with rest or active recovery intervals inserted between the intense bouts. (Wilmore, Costilla, & Kenney, 2012 p-220).

In addition, the findings of this study showed that there were significance differences before the training and after 8 weeks of repetition training on athlete's speed endurance

and maximum speed. The result suggests that RTG significantly improved speed endurance and maximum speed (MD=1.645, SD=0.770, p=0.00 for speed endurance and MD=0.729, SD=0.461, p=0.00 for maximum speed). Hence, (P <0.05) Post-test values of maximum speed and speed endurance was significantly improved than pre-test values for the RTG. As the data (table 4) showed the mean values of the time taken to run 150m distance was 23.2593 second in before repetition training, which was improved to 21.6140 second after 8 week repetition training, this means the 150m endurance test score in speed endurance of RTG increased by 1.645second after 8 weeks of repetition training. Moreover, the mean values of the time taken to run 30m was 4.4200 second in before repetition training, which was improved to 3.6907 second after 8 week repetition training, this means the 30m flying test score in maximum speed of RTG increased by 0.729 second after 8 weeks of repetition training. The increment of the rate of this score was one indicator of the improvement of the athletes' speed endurance. Supporting this results, Verkhoshansky (2015) stated that Experiment have shown that repetition training method is particularly effective for sprinters, this finding indicates that the training effect is achieved by varying the combination of runs; the combination 4-5-2-3 and the combination 5-2-3-4 favor for maximum speed, while the combination 3-4-5-2 favor for speed endurance.

Furthermore, the above paired sample t test (table 5) revealed that there were significance differences before the training and after 8 weeks of repetition training on athlete's power and fatigue index when assessed in RAST test score by measuring running based anaerobic 35m sprint. The result suggests that RTG significantly improved power (MD=-129.59, SD=116.64, p=0.001) and fatigue index (MD=2.878, SD=2.986, p=0.002). Hence, (P <0.05) the Post-training test result of athlete's power and fatigue index was significantly improved in RAST test score than pre-test values for the RTG. As the data (table 4) showed the mean values of RAST power test score were 385.478watt/sec in before repetition training, which was improved to 515.077watt/sec after 8 week repetition training, this means the RAST power test score in power of RTG increased by -129.59watt after 8 weeks of repetition training.

This finding directly in line with Behi, Amani, Fahey and Afsharnezhad, (2017)**;** Which was stated as the statistical analysis of the research has been shown that there is of current investigation indicated that compared to intensive interval exercise alone, attending intensive exercises is more effective on the highest anaerobic power (Wingate bike) and the lowest as well as the average of anaerobic power. In support, Gulbin (2014) also confirms that both training methods have similar effect on VO2max of individuals. In his study 15 subjects were divided into two groups (short sprint interval and continuous) according to their initial VO2max levels. Training programs were conducted 3 times per week for 7 weeks. The sprint interval program consisted of 4-6 Wingate anaerobic sprints with a 4.5 min recovery, while continuous program consisted of 30-50 min cycling at 60% VO2max. Results in this study showed similar benefits from SIT and from traditional CET. But, in this study the delivered sprint interval training intervention with passive recovery was highly lie on the anaerobic energy systems and the total number of subjects was small (n=15) which has its contribution to forward convincible conclusions based on the results. such results may due to the duration, intensity and recovery activity given for these training methods during the intervention may inappropriate and may not identical for the two groups. In addition, these studies were conducted on non-athletes which produce significant effect with minimal training stimulus for short period of time. Thus, the finding of this study is not applicable for athletes.

Moreover, the mean values of RAST fatigue index test score were 6.9860watt/sec in before repetition training, which was improved to 9.8640watt/sec after 8 week repetition training, this means the RAST fatigue index test score in fatigue index of RTG increased by -2.878watt/second after 8 weeks of repetition training. The increment of the rate of this score was one indicator of the improvement of the athletes' power and fatigue index (ability of resisting fatigue). Thus, the results indicate that the applied training protocol caused a significant improvement in all anaerobic fitness tests in repetition training group. Hence, the researcher accepted hypothesis $H_{A.2}$ and rejected $H_{0.2}$ at 0.05 level of confidence. So as to compare this finding with other finding, the finding of Dileep,T. (2014) found that there has been a significant improvement on the performance of 200 meters sprint due to the effect of Repetition Training Method Program. Lydiard's.A,

(1999) With anaerobic training, your objective is to create a big oxygen debt and lower your blood pH level so that your metabolism is stimulated to build buffers against fatigue. This is done with interval or repetition training. With anaerobic training, such as sprint training on the track or on a cycle ergometer, there are increases in both peak anaerobic power and anaerobic capacity. However, results have varied widely across studies, from those that showed only minimal increases to those showing increases of up to 25%(Wilmore, Costilla, & Kenney, 2012 p-273).

As we have seen the above explanation both groups were significantly increased in all anaerobic fitness test variables such as; 400m drop off test, 150m endurance test, 30m flying test, power and fatigue index RAST test. But, to answer the research question; which training method is better for the improvement of anaerobic fitness from both new interval training and repetition training methods; independent sample t-test was implemented. The results of this independent sample t-test indicated that in case of both in 400m drop off test and 30m flying test score; RTG had better significant effect than NTG. RTG Mean of post=2.67 second, NTG Mean of post=3.48 second in 400m drop off test and RTG Mean of post=4.14 second, NTG Mean of post=3.69 second in 30m flying test. These results indicate RTG score better than NTG score. According to the result obtained from table (6) revealed that, as it was assessed by Levene's test for equality of variances P = 0.020 two tailed, Mean Diff =0.80667 in 400m drop off test and P =0.008 two tailed, Mean Diff =0.448 in 30m flying test scores. Which means there was a significant difference between two intervention groups on anaerobic efficiency and maximum speed ($p<.05$). Therefore, repetition-training method is better than new interval training method to improve both anaerobic efficiency and maximum speed. So, the formulated hypothesis ($H_{O.3)}$ that, there is no significant difference between NTG and RTG in the effect on anaerobic fitness variables such as; anaerobic efficiency, speed endurance, maximum speed, power and fatigue index were rejected for only anaerobic efficiency and maximum speed at 0.05 level of confidence.

On the other hand, the results of independent sample t-test for speed endurance, power and fatigue index suggest that there was no significant difference between the two experimental groups of intervention. As recorded in the above table (6) as it was assessed

by independent sample t-test for equality of variances P = .150 two tailed, Mean Diff =1.04467 in 150m endurance test score; P =0.619 two tailed, Mean Diff =-31.001 in RAST of power test scores and P =0.788 two tailed, Mean Diff =0.440 in RAST of fatigue index test scores. Which means there was no significant difference between two intervention groups in the fitness of speed endurance, power and fatigue index ($p>.05$). Therefore, participating either repetition training or new interval training had been equally effective in improving anaerobic fitness variables (speed endurance, power and fatigue index). Therefore, the last formulated hypothesis ($H_{o.3}$) was fail to reject (accepted) for speed endurance, power and fatigue index at 0.05 level of confidence. This finding agree with the finding of Tirkey,Dileep, (2014) No significant difference has been found between two training program viz., Interval Training Method Program and Repetition Training Method Program for the improvement of 200m sprint performance. Another researchers Pandey.S.K, Verma.S. (2016) also confirm this finding as; when the analysis was done for finding out the effect of the two training program on performance of sprinters the interval group and repetition group were not shown any significance difference between them and both the training method were found to be equally effective in improving the performance of sprinting.

Alternatively, other study results show that there is no significant different between interval and continuous training methods on improvement of aerobic fitness associated with running economy. Smith et al. (1999); Billat et al. (1999) also found non-significant changes in 3km running performance after interval training intervention programs.

CHAPTER FIVE

5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The purpose of this study was to investigate the comparative effect of 8 weeks repetition training and new interval training on anaerobic fitness variables such as; anaerobic efficiency, speed endurance, maximum speed, power and fatigue index among contestant athletes of Tilili athletics projects trainee. In order to attain the general objective of the study, the following specific research objectives were formulated.

- Examine the effect of repetition training method on athlete's anaerobic fitness.
- Assess the effect of new interval training method on athlete's anaerobic fitness.
- Identify better training method for athlete's anaerobic fitness improvement from the two training methods and provide possible suggestions to improve anaerobic fitness of athlete's.

Based on the above specific objectives, the hypothesis was formulated. For this purpose, the researcher reviewed the available literatures in order to decide the focus of the study and methodologies. The reviewed literature contains the topics of; describing anaerobic fitness, factor affecting anaerobic fitness, effects of training on anaerobic fitness, benefit of anaerobic fitness, explaining new interval and repetition training methods, their benefit and their differences in relation with training variables and methods of doing these methods. In addition, types of repetition and interval training methods and their effect on anaerobic fitness was discussed and finally training variables of the two training methods was outlined.

In dealing with those basic objectives, the study conducted on contestant project athletes of U-17 trainees. Among the population of 40 U-17 trainees, the researcher selected 30 only short and middle distance runner athletes comprehensively (long distance runners were excluded) because of anaerobic nature of training intervention. Then all 30 athletes

were assigned to repetition training group (15) and new interval training group (15) through randomization. A researcher employed quasi-experimental approach. Training was done 3 times per week for 40-60 minutes per session. The selected anaerobic fitness variables anaerobic efficiency was tested by 400 meters drop off test, speed endurance was tested by 150 meters endurance test, maximum speed was tested by 30 meters flying test, power and fatigue index was tested by RAST test were taken from the participants at pre and post of training programs. Then to analysis and interpret the data, SPSS version 23 was employed. Independent sample t- test and Paired sample t-test was used to find out the significant difference between two groups and the post training result and pre training result of each variable respectively. In all cases, 0.05 level of confidence was fixed to test the significance, which was considered as appropriate. The result obtained in this study showed significant improvements in selected anaerobic fitness parameters in the participants of the study and significant difference between two groups, after analyzing the pre-post mean difference of each variable. Through paired sample t-test and independent sample t-test, the data was analyzed. Hence, the following findings were investigated:

1. The finding of this study indicated that improvement in anaerobic efficiency was observed. RTG had shown improvement as a result of the repetition training, anaerobic efficiency was improved from pre to post-test result. However, Even though there was an improvement between pre to post-test score of anaerobic efficiency in NTG, it is not significant. When we compare the two training group in case of anaerobic efficiency post-test score, RTG showed better significant improvement than NTG.
2. The finding of this study also revealed that speed endurance was significantly improved in RTG after 8 weeks of repetition training. Similarly, NTG also showed significant improvement after two month intervention of new interval training. As indicated in independent sample t-test there was no significance difference between RTG and RTG after 8 weeks training. This means both training method had equally effective to improve speed endurance of short and middle distance athletes.

3. Finding of this study indicated that there is a significant improvement of maximum speed in both RTG and NTG because of two-month training intervention. RTG show increased maximum speed with the consequence of repetition training than that of NTG. Thus, engaging in Repetition training is more effective than in new interval training.
4. The finding of this study showed both power and fatigue index were significantly improved in both RTG and NTG after exposed to 8 weeks training. However, significant difference between RTG to NTG of posttest scores was not observed. This means both training method had equally effective to improve power and fatigue index of short and middle distance athletes.

5.2 Conclusion

The present study was done to compare the effect of new interval training and repetition training methods on athlete's anaerobic fitness. Based on the major finding of this study, the following points were stated as a conclusion

- ❖ Implementing new interval training has a significant positive effect on anaerobic fitness variables such as; anaerobic efficiency, speed endurance, maximum speed, power and fatigue index as pre to post-test.

- ❖ Implementing repetition training has significant positive effect on anaerobic fitness variables such as; anaerobic efficiency, speed endurance, maximum speed, power and fatigue index as pre to post-test

- ❖ Repetition training method is better than new interval training method in improving maximum speed and anaerobic efficiency.

- ❖ Repetition training and new interval training methods has no significant differences on the effect of speed endurance, power and ability to resist fatigue (fatigue index).

5.3 Recommendation

In light of major finding, discussion and conclusions of this study the following recommendations are forwarded to investigate more on the effect of new interval training and repetition training on anaerobic fitness.

5.3.1 Recommendation for Practice

- ✓ Both repetition training and new interval-training methods are vitally important in short and middle distance since it leads to an improvement in anaerobic fitness. Therefore, it would seem highly advisable to implement both training programs in middle and short distance running training and in anaerobic fitness training, due to its influence on performance.
- ✓ The coaches should identify and understand clearly both new interval training and repetition-training methods and incorporates in to the actual training program based on scientific evidence.
- ✓ Coaches and athletes should have aware of both new interval and repetition training methods for performance improvement.
- ✓ As noted in the results of this study, both new interval training and repetition training methods are effective to improve anaerobic fitness variables and performance. So, athletes and coaches are highly recommended to include those training methods in their training session
- ✓ As noted in the results of this study, repetition-training method is more advantages than new interval training method to improve athlete's anaerobic fitness. So, athletes are highly recommended to use this training method for better anaerobic fitness improvement.
- ✓ Trainers should be concerned with developing; Anaerobic efficiency, speed endurance, maximum speed, power and fatigue index for their main role in enhancing performance of short and middle distance athletes.

5.3.2 Recommendation for Further Study

- ✓ To make the finding of the study more convincing, similar studies should be conduct upon this issue using sophisticated equipment, facilities, and scientific tools of Measurement like Cunningham and Faulkner test, Wingate anaerobic test and the like.
- ✓ The study was conducted only to examine the effects of new interval and repetition training method on specific anaerobic fitness variables (anaerobic efficiency, speed endurance, maximum speed, power and fatigue index). So, it is recommended for other researchers to deal with other physiological fitness variables.
- ✓ This study was conducted only on short and middle distance runners, so it is recommended to conduct further researches to examine the effect of new interval training and repetition training on long distance runners, other events and sports.
- ✓ As a general, further studies should be conducted in the same area on various age categories, events, sophisticated equipments and modernized test tools and some more functional variables. Thus, these are other principal areas for further research.

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.

APPENDICES

Appendix A: Information Letter for Athletes

Research title: The Effect of repetition training Versus New-interval training method on athlete's anaerobic capacity

Researcher name: Birhanu Tebkew (MSc student)

Advisor: Zelalem Melkamu (Associate proffesor)

I am conducting a research study, which aims to evaluate the effect of repetition versus New-interval training methods on anaerobic capacity of athlete's. So, you are kindly requested to participate in this research study as described below.

This research study will be carried out and governed by the regulations for research on human beings. Because of the regulations require the agreement of the subjects; 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 procedures will be used, the potential benefits in this study. Thus, you are allowed to ask the researcher any questions that you may have about on the study. After discussion, if you agree to participate in the 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.

What is the study about?

The study will take place as follows.

Pre-Testing

You will undertake anaerobic capacity testing by……Then the results of the testing will help the researcher to describe the initial anaerobic capacity of the group. Pre testing for the whole group will take approximately 1 week.

Following pre-testing, you will be randomly divided into either from two intervention groups (repetition or New- interval training groups) or control group.

While intervention groups will undertake additional training sessions. The intervention will occur over an 8-weeks period, 3 times a week additional to the normal training sessions.

Post-Testing

The tests that will be used before the training program will be repeated at the End of the 8 weeks training intervention. The post-testing for the whole group will take approximately 1 week also.

Benefits to participation

Individuals participating in this study will receive a copy of all testing results and gain a better understanding of their performance in anaerobic capacity compared with the group average. In addition, you will also receive ongoing education and Coaching throughout the training intervention. Coaches will receive group results, but individual results will remain confidential.

At the end of the study if the designed interventions show significant result on athlete's anaerobic capacity, all athletes will have the opportunity to participate in this type of training in the future.

I ..... have read and understand the information provided in the Information Letter.

I understand the purpose of the study and I agree to participate in this study, realizing that I can withdraw from the study at any time.

Date.....

Signature …….

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: _____

Appendix B: Personal Profiles of the Participants.

Place –Tilili Town Zone-Awi

Training Type: repetition versus new interval training, Particular Training Time – 12: 00-1:00am Local Time

Age Category U-17; Number of player -30, Sex of trainees –12 Females and 18 males.

Table 7: List of Personal Profile of Participants for RTG

No	Code of the participants	Sex	Age (year)	Weight (kg)	Experience in athletics (year)
1	A	Male	14	47	3
2	B	Male	17	44	5
3	C	Male	16	56	3
4	D	Male	16	42.3	4
5	E	Male	17	51.5	4
6	F	Male	17	38	5
7	G	Male	16	43	5
8	H	Male	17	35.8	4
9	I	Male	15	39.3	6
10	J	Female	15	56.1	4
11	K	Female	15	39	4
12	L	Female	15	50	4
13	M	Female	16	52	5
14	N	Female	16	44.5	3
15	O	Male	17	48.65	4

Table 8: List of Personal Profile of the Participants for NTG

No	Code of the participants	Sex	Age (year)	Weight (kg)	Experience in athletics (year)
1	A’	Male	14	47	3
2	B’	Male	17	44	4
3	C’	Male	17	56	4
4	D’	Male	17	42.3	5
5	E’	Male	17	51.5	6
6	F’	Male	16	38	4
7	G’	Male	16	43	5
8	H’	Male	16	35.8	4
9	I’	Male	15	39.3	4
10	J’	Male	16	56.1	5
11	K’	Female	15	39	5
12	L’	Female	16	50	4
13	M’	Female	15	52	5
14	N’	Female	16	44.5	3
15	O’	Female	16	37	3

Appendix C: Anaerobic Fitness Variables

Table 9: Anaerobic Fitness Variables

No	Parameters	Type of test	Unit
1	Anaerobic efficiency	400m drop off test	second
2	Power and fatigue index	RAST test	Watt/second
3	Maximum speed	Flying 30m test	second
4	Speed endurance	150m endurance test	Second

Appendix D: Pre and Post-test Results of RTG

Table 10: Pre and Post-test Results of Anaerobic Efficiency and Speed Endurance for RTG

No	Repetition training group(RTG)	Age	Variables					
			anaerobic efficiency			Speed endurance		
			Test			Test		
			Pre	Post	Change	Pre	Post	Change
1	A	14	5.41	4.45	.96	25.84	23.45	2.39
2	B	17	2.20	1.56	.64	22.21	19.10	3.11
3	C	16	3.06	2.68	.38	21.58	19.12	2.46
4	D	16	1.66	1.89	-.23	20.11	19.26	.85
5	E	17	1.13	1.45	-.32	19.71	19.23	.48
6	F	17	2.41	2.10	.31	22.24	21.02	1.22
7	G	16	1.67	1.39	.28	22.45	20.23	2.22
8	H	17	1.32	1.34	-.02	21.58	19.78	1.80
9	I	15	4.69	3.65	1.04	25.59	24.56	1.03
10	J	15	3.16	3.04	.12	24.80	23.14	1.66
11	K	15	5.80	3.34	2.46	26.29	24.12	2.17
12	L	15	5.73	3.94	1.79	26.26	24.54	1.72
13	M	16	4.71	3.31	1.40	23.91	22.89	1.02
14	N	16	5.61	3.87	1.74	25.06	24.52	.54
15	O	17	2.58	2.12	.46	21.26	19.25	2.01

Table 11: Pre and Post-test Results of Power, Fatigue Index and Maximum Speed for RTG

No	RTG	Age	Variables								
			Power			Fatigue index			Maximum Speed		
			Test			Test			Test		
			Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
1	A	14	283.17	467.83	-184.66	5.99	7.51	-1.52	4.77	3.23	1.54
2	B	17	533.00	705.50	-172.50	15.02	14.50	.52	3.92	3.19	.73
3	C	16	530.50	772.83	-242.33	6.71	11.37	-4.66	4.13	3.45	.68
4	D	16	397.00	555.17	-158.17	9.06	16.14	-7.08	4.80	3.12	1.68
5	E	17	369.00	588.67	-219.67	7.05	17.89	-10.84	4.49	4.05	.44
6	F	17	383.33	727.83	-344.50	6.75	11.34	-4.59	4.19	3.65	.54
7	G	16	406.33	642.83	-236.50	8.16	9.89	-1.73	4.69	3.23	1.46
8	H	17	427.17	283.00	144.17	10.17	12.76	-2.59	4.50	3.65	.85
9	I	15	309.67	424.50	-114.83	5.45	7.13	-1.68	5.04	4.65	.39
10	J	15	305.00	398.00	-93.00	5.03	7.76	-2.73	4.02	3.56	.46
11	K	15	349.00	403.67	-54.67	6.47	5.90	.57	4.72	4.56	.16
12	L	15	299.17	309.00	-9.83	2.93	3.72	-.79	4.29	3.89	.40
13	M	16	280.33	390.50	-110.17	5.18	6.65	-1.47	4.45	4.00	.45
14	N	16	269.50	302.83	-33.33	3.86	5.03	-1.17	4.50	3.92	.58
15	O	17	640.00	754.00	-114.00	6.96	10.37	-3.41	3.79	3.21	.58

Appendix E: Pre and Post-test Result of NTG

Table 12: Pre and Post-test Results of Anaerobic Efficiency and Speed Endurance for NTG

No	NTG	Age	Variables					
			anaerobic efficiency			Speed endurance		
			Test			Test		
			Pre	Post	Change	Pre	Post	Change
1	A’	14	6.16	4.25	1.91	24.57	23.30	1.27
2	B’	17	3.11	3.04	.07	21.13	20.10	1.03
3	C’	17	3.21	3.13	.08	24.90	23.82	1.08
4	D’	17	2.90	3.03	-.13	23.54	22.76	.78
5	E’	17	3.02	3.01	.01	20.81	19.25	1.56
6	F’	16	2.23	2.76	-.53	25.16	23.54	1.62
7	G’	16	4.71	4.09	.62	23.25	22.00	1.25
8	H’	16	2.17	2.10	.07	23.01	22.23	.78
9	I’	15	4.50	3.78	.72	23.10	22.01	1.09
10	J’	16	3.87	3.45	.42	23.67	22.43	1.24
11	K’	15	2.82	4.02	-1.20	26.56	24.00	2.56
12	L’	16	6.17	4.55	1.62	24.11	22.67	1.44
13	M’	15	3.33	3.01	.32	23.06	23.56	-.50
14	N’	16	4.01	3.79	.22	26.73	24.67	2.06
15	O’	16	4.55	4.22	.33	24.97	23.54	1.43

Table 13: Pre and Post-test Results of Power, Fatigue Index and Maximum Speed for NTG

No	NTG	Age	Variables								
			Power			Fatigue index			Maximum Speed		
			Test			Test			Test		
			Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
1	A’	14	278.00	405.00	-127.00	4.58	9.50	-1.52	4.18	3.93	.25
2	B’	17	611.17	539.45	71.72	13.86	16.58	.52	3.90	3.34	.56
3	C’	17	478.12	695.52	-217.40	9.90	14.69	-4.66	4.17	3.89	.28
4	D’	17	405.00	550.67	-145.67	7.06	15.86	-7.08	4.42	4.34	.08
5	E’	17	512.00	819.00	-307.00	14.91	12.53	-10.84	3.89	3.78	.11
6	F’	16	429.00	655.00	-226.00	8.83	12.28	-4.59	4.74	4.56	.18
7	G’	16	482.00	429.00	53.00	9.18	11.29	-1.73	4.69	4.54	.15
8	H’	16	411.00	546.00	-135.00	8.14	15.25	-2.59	4.60	4.34	.26
9	I’	15	332.00	356.00	-24.00	4.92	10.12	-1.68	4.62	3.98	.64
10	J’	16	384.00	634.00	-250.00	9.14	13.90	-2.73	4.60	4.32	.28
11	K’	15	256.00	337.50	-81.50	2.55	4.67	.57	4.29	4.50	-.21
12	L’	16	355.50	382.00	-26.50	4.22	5.87	-.79	4.52	3.67	.85
13	M’	15	251.67	297.00	-45.33	2.02	3.26	-1.47	4.52	4.35	.17
14	N’	16	282.00	319.00	-37.00	4.05	3.62	-1.17	4.62	4.14	.48
15	O’	16	256.17	296.00	-39.83	2.84	5.14	-3.41	4.74	4.40	.34

Appendix F: Eight Weeks Training Plan for both RTG and NTG

Table 14: Two Months Repetition Training Plan

Place: Tilili town Age: 14-17 Periods: general preparation period

Objective: repetition training for the improvement of athletes' anaerobic fitness

Mesocycle 1

Days	Week 1	Week 2	Week 3	Week 4	remark
1	2 x4x400m (2000m pace) [1½' and 5']	2x10x100m slightly steep uphill run [<1' and 5']	2x4x300m (800m pace) [1½' and 5']	2x3x300m (1500m pace) [2' and 7']	
2	2x10x80m slightly steep uphill run [<1' and 4']	2x3x300m (800m pace) [1½' and 5']	2x8x80m fairly steep uphill run [<1' downhill jog and 5']	2 x 4 x 300m (800m pace) [2' and 5']	
3	2x3x400m (1500m pace) [1½' and 5']	2x3x300m (1200m pace) [1½' and 5']	2x3x300m (400m pace) [1½' and 5']	2x3x300m (400m pace) [3' and 7']	
Mesocycle 2					
Days	Week 1	Week 2	Week 3	Week 4	remark
1	2x4x300m (1500m pace) [1½' and 5']	2x6x150m very steep uphill run [<1' and 4']	2x4x300m (200m pace) [1½' and 5']	2x3x300m (800m pace) [1½' and 5']	
2	2x10x150m fairly steep uphill run [<1' down hill jog and 4']	2x4x300m (400m pace) [1½' and 5']	2x6x150m very steep uphill run [<1 and 6']	2x3x300m (400m pace) [1½' and 5']	
3	2x3x400m (800m pace) [2' and 6']	2x3x300m (800m pace) [1½' and 5']	2x3x300m (400m pace) [1½' and 5']k6	2x2x300m (200m pace) [2' and 5']	

Adopted from IAAF CECS Level III short and Middle Distance

Table 15: 8 Weeks New Interval Training Plan

Mesocycle 1

Days	Week 1	Week 2	Week 3	Week 4	remark
1	2x4x300m (2000m pace) [100m a.r.o. in less than 30'' and 5']	2x10x100m fairly steep uphill run [<1' downhill run and 5' a.r.o. running on leveled field]	2x3x300m (800m pace) [100m a.r.o. in less than 30''and 5']	2x3x300m (1500m pace) [100m a.r.o. in less than 30'' and 7']	
2	2x8x80m slightly steep uphill run [<1' downhill run and a.r.o. running on leveled field 3']	2 x 3 x 300m (800m pace) [100m a.r.o. in less than 30'' and 5']	2x8x80m fairly steep uphill run [<15'' down hill run and 5' a.r.o. running on leveled field]	2x2x300m (800m pace) [100m a.r.o. in less than 30'' and 5']	
3	2x3x400m (1500m pace) [100m a.r.o. in less than 30'' and 5']	2x4x300m (1500m pace) [100m a.r.o. in less than 30'' and 5']	2x3x300m (400m pace[100m a.r.o. in less than 30'' and 5']	2x3x300m (400m pace) [100m a.r.o. in less than 30'' and 7']	
Mesocycle 2					
Days	Week 1	Week 2	Week 3	Week 4	remark
1	2 x3x300m (800m pace) [100m a.r.o. in less than 30'' and 5']	2x4x200m fairly steep uphill run [<1' down hill jog and 4']	2 x3x300m (200m pace) [100m a.r.o. in less than 30'' and 5']	2x3x300m (200m pace) [100m a.r.o. in less than 30'' and 5']	
2	2x6x200m slightly steep uphill run [<1' down hill jog and 4']	2x3x300m (400m pace) [100m a.r.o. in less than 30'' and 5']	2x4x150m very steep uphill run [<1' down hill jog and 6']	2 x 2 x 300m (400m pace) [100m a.r.o. in less than 30'' and 5']	
3	2 x 3 x 400m (400m pace [100m a.r.o. in less than 30'' and 5']	2x2x300m (400m pace) [100m a.r.o. in less than 30'' and 5']	2x2x300m (800m pace) [100m a.r.o. in less than 30'' and 5']	2 x 2 x 200m (100m pace) [100m a.r.o. in less than 30'' and 5']	

Adopted from IAAF CECS Level III short and Middle Distance

Key: **a.r.o** is the acronym of active roll on

Appendix G: Map of Guagusa Shikudad Woreda (Study Area)