THE STUDY OF THE EFFECTS OF AEROBIC TRAINING ON MIDDLE AND LONG DISTANCE ATHLETES' PERFORMANCE AT TIRUNESH DIBABA NATIONAL ATHLETICS TRAINING CENTER

BY

YIBELTAL MERSHA MELAKU

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENTS OF THE REQUIREMENT FOR THE DEGREE OF MASTERS OF SCIENCE IN ATHLETIC COACHING

October, 2012

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ACRONYMS

ANOVA	Analysis of Varians
N/A/T/C	National Athletics Training Center
SPSS	Statistical Package for the Social Science
VO_2Max	Maximum Volume of Oxygen
BMI	Body Mass Index
MHR	Maximum Heart Rate
RHR	Rest Heart Rate
SD	Standard Deviation
THR	Training Heart Rate

ABSTRACT

The main purpose of this study was to assess the effects of aerobic training to the performance of middle and long distance athlete. It was evaluated the training plan, examined the performance of the athlete, the improvement rate, and the gender difference of an athlete with the use of performance predictive (Balke) test, document analysis and observation check list techniques.

The research was used comparative study method with the purposive sampling technique, involved 10 male and 6 female athletes which were selected from middle and long distance events. The data gathered from this technique were analyzed and interpreted with percentage and SPSS one way ANOVA statistic method. The results of the findings it shows that the training plan was followed the principles indicated to the literature except the difference with increased volume. The findings also shows the performance predictive test result of group multiple comparisons indicated that there was a significant difference between test one vs. two, one vs. three and one vs. four and there was no a significant difference between test two vs. three, two vs. four and three vs. four. The results of male comparison indicated that there was a significant difference between test one vs. three, one vs. four, two vs. three, and two vs. four, but there was no significant difference observed between test one vs. two and three vs. four. The results of male comparison indicated that there was a significant difference between test one vs. two, one vs. three and one vs. four, but no significant difference observed between test two vs. three, two vs. four and three vs. four. Depending on their VO_2max level male has been showed average improvement of 0.91% and average mean improvement rate of female was 1.84%. Finally the research showed that there was a difference in level of VO_2max between male and female athlete.

Key terms: aerobic performance, maximum oxygen uptake (VO_2max), performance predictive test (Balke test), aerobic training, altitude.

CHAPTER I

INTRODUCTION

1.1 Back Ground of the Study

The performance of an athlete mainly depends on their physiological, psychological and technical abilities.

To enhance aerobic performance David E. M, and Peter N. C., (1997.) suggested that middle and long distance athletes needs to train under their training session or plan for the improvement of aerobic capacity. In order to bring endurance performance for competency an aerobic training for middle and long distance athletes is an essential content, even though other physical qualities are essential. Therefore, this aerobic performance can be achieved through a high degree of persistence at practicing the tasks required to improve.

According to Lorry G. S., (1981) the primary goal of aerobic training is to improve and increase the capacity and efficiency of the heart, vascular system, and lungs to provide oxygen and nutrients to the working tissue and to remove the west products of metabolism and as well as improves the heart rate recovery process.

Therefore, Peter JL Thompson, (2009) explained that the most important types of aerobic training to enhance the athlete's aerobic performance are continuous or repetition (interval) training.

Those types of training Peter JL Thompson, (2009) defines; continuous training simply means walking, running or doing whatever training activity without rest. It is used to develop general endurance, specific endurance and for recovery. It usually takes place away from or in the track and provides a variety of pace; runs can be short, medium or long. The other type of continuous training which may be used throughout the year is 'Fartlek' training, where the athlete 'plays' with a variety of running speeds or rhythms. And repetition training is breaking of a total distance or any training load into smaller units which are repeated. While running the pace, distance and rest/recovery intervals and activity are prescribed and this training usually done on the track.

In addition to the above essential components of aerobic training, hill training is an important content and should be included in a training program.

Therefore, David E. M., (PHD) Peter N.C., (1997.) advised a coach to apply hill training in a training program and categorized in to series of gentile up hills and down hills, a series of runs up a long and a speed session consisting of multiple repetitions up a short, steep hill. This different style is beneficial for improved racing athletes.

However, physical quality development alone is no guarantee of success in athletics even if athletes engage in an intensive work load. But an athlete must have the correct frame of mind. That means psychological preparation is as important as physical conditioning and a coach should consider the methods to his training program (Peter JL Thompson, 2009).

Planning a training program is vital to the development of top-class performance of any kind. It ensures progression; it enables players to assess their own performance objectively, and at the same time they are to understand why training and coaching is necessary for the improvement of the athlete performance, therefore, Mary Jo R., You-B., (1995-2008) developed a sound distance training philosophy of the concept of Periodization. Periodization is the division of a training year into a cycle of several phases—each phase devoted to different training methods and objectives. Those phases are Conditioning Phase or Base Period, Pre-competition Phase, Competition Phase and Transition Phase.

Based on the above information supported by different scholars it can be realized that applying of different contents and following an appropriate training principles to the training program is therefore an essential task to enhance the athletes' performance.

The former famous athletes of Haile G/silassie, Kenenisa Bekele, Tariku Bekele, Derartu Tulu, and Tirunesh Dibaba etc…are pioneers and models for all youth and people of Assela to engage in athletics and they considered as a cultural activity.

Due to this fact the FDRE sport commission has been opened athletics training center to this area and aimed at to securing the continuity of our athletics. The training center athletes were trained

under full supervision of their coach based on their talents in different athletics events. Depending on event specific to enhance their performance the trainees were engaged in 6 to 10 sessions per week.

The weather conditions of the training center existed in almost all seasons feels cold and it has the altitude of 2210m to 2700m above mean sea level.

Even though the objective benefits of altitude trainings are still controversial, but the training center is opened also with a belief of training at high altitude contributes to physiological advantage and enhancing the athletes' aerobic performance for sea level competition.

But according to Lorry G. S., (1981) investigation indicated that training at altitude may improve performance at sea level for the unconditioned nonathletic person, but because the training intensity and duration that is required for the highly trained athlete cannot be achieved at altitude the same as it can at sea level, this improved performance is not found for highly conditioned athletes.

And Phil (2007) identifies the major problem athletes living at altitude face is a significant reduction in training intensity. At 4000m (13,122 ft) athletes can only exercise at 40% of their sea level VO_2max compared to 80% at sea level.

In general a close monitoring of physical activity of an athlete during the entire training programs and applying field test was essential to study the effects of training and helpful to determine the performance level of an athlete.

Therefore, with this substantial information the researcher was initiated to carry out a research under taken, which focuses on the effects of aerobic training in middle and long distance athletes' on to the current aerobic performance of an athlete which is found at Tirunesh Dibaba National Athletics Training center. The athletes who take part in the study were trained at Assela town near to Chilalo Mountain an altitude of 2210m to 2700m above mean sea level.

1.2 Statement of the Problem

Aerobic capacity is an essential component of endurance athlete. This component can be developed with a systematic design of training plan enables to target improving aerobic performance or maximum oxygen uptake of an athlete.

From Mc Dougall et al., (1998) recent research study suggested, a form of interval training known as a high intensity intermittent training leads to rapid improvement in VO_2 max and endurance performance.

But Peter JL Thompson, (2009) indicated that aerobic capacity can be improved with the activity of continuous and repetition (interval) training.

Ekblom, (1969) described the outcomes of aerobic training causes changes in central factors such as the heart and blood volume, which result in a higher maximum oxygen uptake (VO_2max).

The changes should have been measured with test to provide useful information. At first it has to be identifies the types of test and then the components to be tested. Tests for aerobic performance must use the same type of exercise as the event in which the individual participated and should generally last in the region of 8-15 minutes.

As Baechle & Earle, (2000); Noakes, (2001); Wilmore & Costill, (1999) suggested regard to VO_2max as the single best measurement of cardio-respiratory endurance and aerobic fitness. While other factors are important to athletic performance, VO2max is accepted as the baseline predictor of endurance performance.

As Mary Jo R., You-B., (1995-2008) information before a training program, coaches should *"test for success"* and look past obvious, surface-level data to explore the depths of undiscovered potential.

Thus, scholars agreed that measuring the athletes' aerobic capacity or maximum oxygen uptake (VO_2max) by applying field tests is considered as an important means of checking the athletes' progress and assessing the effectiveness of the training.

Therefore, Terry M., & Tudor H., (2006) compared advances in electronics – e.g. polar heart rate monitors and portable lactate analyzers – have offered coaches additional useful information during training and even competitive events. However, these devices are more likely to be available in a laboratory rather than a field setting. But predictive tests can be used to estimate VO_2max most coach's want robust but uncomplicated ways of monitoring their athletes' progress. These must be administered within the training environment, thereby avoiding the costs in time, energy and finances associated with validated laboratory tests.

In this study the researcher preferred to apply Balke field test for the purpose of determining the effects of aerobic training and the VO_2max change of an athlete found at Tirunesh Dibaba National Athletic Training Center. And there was no any study done before in our country with this topic for Master of Science.

In the light of the things discussed above, one can raise the following questions

1.3 Research Questions

- Does trainings are appropriate and have an impact to the athlete performance?
- Does Balke test predict the athlete's aerobic performance?
- Is there a gender difference in level of VO_2max?
- Does each test result indicate improvement rate of an athlete?

1.4 Objectives of the Study

1.4.1 General Objective

The general objective of this study was tried to investigate the effects of aerobic training in middle and long distance athletes' performance at Tirunesh Dibaba National Athletics Training Center.

1.4.2 Specific Objectives

The specific objectives of the study are:

I. To evaluate the trainings to the performance of an athlete,
II. To assess the level of VO_2max of an athlete with the use of Balke test,
III. To assess gender differences in VO_2max, , and
IV. To assess improvements of an athlete by comparing each test result.

1.5 Significance of the Study

Athletics training now a day needs an application of scientific way of training and frequent follow up of the athletes' progress because if athletes treated in a meaningful way they could be competent to the athletics world.

Based on Ethiopia sport commission evidence there are five athletic training centers which is opened in different region for the purpose of assuring the continuity of our athletics. Tirunesh Dibaba National Athletics Training Center is one of them found in Assela town. To enhance the performance of the centers' athlete trainings were given to middle and long distance athletes.

To make reliable and valid suggestions about the athlete progress test is one of the means to determine the performance level of an athlete, assessing training loads, monitoring the effectiveness of trainings and to set goals.

Exercise professionals regard to VO_2max as the single best measurement of cardio-respiratory endurance and aerobic fitness. While other factors are important to athletic performance, VO_2max is accepted as the baseline predictor of endurance performance (Baechle & Earle, 2000; Noakes, 2001; Wilmore & Costill, 1999).

Hence, to understand the progress of an athlete, the researcher was interested to engage to this finding, therefore, the main purpose of this finding was to assess the trainings on to the contribution of the athletes aerobic performance, to understand the measurements of Balke test as a predictor of the athletes performance, to compared gender difference in aerobic performance based on their VO_2max level, and finally it was compared each test results to understand the improvement rate of an athlete.

1.6 Delimitations

The delimitations of this study were:
Due to the constraints of budget the numbers of participants were limited to 16. And also the research participants included only middle and long distance athletes as well as the test was held in Assela and Adama after four week trainings to four times.

1.7 Limitation of the Study

The tests held in Adama were interrupted due to constraints of money. So this might cause changes in analysis of test results.

1.8 Operational Definition of Terms as Used in the Text

The following key terms were used throughout this document and to ensure clarity of meanings and usages the terms are defined below:

Aerobic: refers to the utilization of oxygen.
Aerobic endurance: is characterized by moderate contraction of large muscle groups for an extended period of times.

Aerobic training: is a training to improve and increase the capacity and efficiency of the heart, vascular system, and lungs to provide oxygen and nutrients to the working tissue.

VO2max (Maximal oxygen uptake): refers to the highest rate at which the body can take up and consume oxygen during intense exercise.

Continuous training: means walking, running or doing whatever training activity without rest.
Repetition training: is breaking a total distance or any training load into smaller units.
Balke test: is a field test used to measure the level VO_2max of an athlete.

1.9 Organization of the Study

The first chapter deals with background of the study, statement of the problem, objectives of the study, significance of the study, delimitation, limitation and operational definition of terms as used in the research document. The second chapter contains related literature of the study. The third chapter organized with research methodology; study area, climate and temperature, method of the study, procedure of data collection and data analysis technique. The fourth chapter deals with data presentation, analysis and discussion of the findings and finally the fifth chapter deals with about summary, conclusion and recommendation.

CHAPTER II

REVIEW OF RELATED LITERATURE

In this chapter it is focused on reviewing various literatures and research findings, which is assumed to have relevance to the study. The organization of this chapter is based up on the following major topics:

2.1. Planning the Training Program

The precise details of training plan construction soon come to haunt any coach or athlete; these details are the keys to achieving meaningful long-term development. How do longer-distance running, all the various faster running session, and comprehensive conditioning fit into a given time frame that ensures complete development and adequate recovery without undue fatigue? The most important part of any training plan is designing its details to match the needs and abilities of each athlete. Changing abilities to tolerate training stress may cause microcycles to vary in length anywhere between one and two weeks (David E.M., (PHD) and Peter N. C., 1997.).

2.2 Periodization for Distance Training

Mary Jo R., You-B., (1995-2008) showed that periodization is the division of a training year into a cycle of several phases—each phase devoted to different training methods and objectives. Periodized training allows runners to emphasize a specific type of training during a phase within a year-long training program. Other types of training are not neglected during each training phase—they are simply less emphasized.

- **Conditioning Phase or Base Period**

Mary Jo R., You-B., (1995-2008) described it is important for a coach to understand during the initial development of the base period, the athlete will most likely be sore for a minimum of three weeks.

Training should begin easy and there should be gradual increases in the time or distance run during training sessions. All physiological gains are made during periods of recovery; therefore, it is important to build recovery or rest into this phase as well as every other training phase. In this training phase, specifically, planned recovery is extremely important since the intensity of single workouts may not be as great as it is in other phases; however, the volume of work and the

accumulative effect of that volume will take its toll (perhaps later in the competitive season) if proper recovery is not planned into the training.

All the basic principles of training come into effect during the base phase. Most significant are the overload principle, the law of accumulation and the principle of specificity.

An excellent guideline to follow in this phase is the "10% rule"– meaning after the initial three weeks of training, volume (miles or minutes run) should not increase much greater than 10% from one week to the next week.

In the base period, all facets of the training program are introduced. A week of training most likely would include a steady state (long run) day, a pace day, a tempo workout day, recovery days and a complete or active rest day.

A steady state day should be a continuous run accounting for up to 20% to 25% of the total weekly mileage or time run.

Pace day should include running at "race pace" or faster for segments of between two minutes to six minutes.

Tempo days could very easily be referred to as the oxymoron of workouts. That is because tempo pace is best described as "comfortably hard." A good guideline for the pace to be run during tempo work is one minute slower than three-mile race pace.

The tempo portion of the run should be between 10 and 20 minutes for most runners. The more experienced and more fit the runner, the longer the duration of the tempo portion of the run can be.

Recovery days are best described as easier runs done at a decent, comfortable pace. A good guideline for the pace to be run during recovery work is two to three minutes slower than three-mile race pace.

Along that line, one important aspect of recovery running a coach should monitor closely is recovery runs should not simply be slow jogging done at 10 minute or slower per mile pace. Even if athletes are doing a recovery workout, they can still make gains in cardiovascular fitness if the run is not done "too slow."

Recovery runs are usually placed in the overall training schedule immediately following hard training days—this follows the hard/easy principle first established by Bill Bowerman at the University of Oregon. This hard/easy principle allows time for the body to recover. It is not uncommon to plan for two easy recovery days in a row if the coach observes his or her runners are not sufficiently recovered from the previous hard workout.

Mary Jo R., You-B., (1995-2008) indicated the following session:

- A week workout during the base period follows this schedule:
  - Monday: Steady State (Long) Run
  - Tuesday: Recovery
  - Wednesday: Pace
  - Thursday: Recovery
  - Friday: Tempo
  - Saturday: Recovery
  - Sunday: Active Rest or Complete Rest

❖ Pre-competition Phase

Mary Jo R., You-B., (1995-2008) guided after creating the base, the athlete's training should transfer into the pre-competition phase. While this phase may actually include some early season competitions, the purpose of this phase is to physically and mentally prepare the body for racing on the track.

In this phase, aerobic capacity should continue to be enhanced. Weekly running time or distance should continue to be increased as the quantity and quality of pace segments and the length of the steady state run should also be increased; however, it is important to note that coaches should not increase intensity and duration on the same day. One week, there can be an increase in the

intensity of the workout and the following week, the distance of the segments run or the total workout can be increased.

Race pace workouts can be run using three speeds: date pace, goal pace and dream pace.
Date pace is the actual pace the athlete is running presently in races.

Goal pace is the realistic expectation for middle to late season race times.
Dream pace is the ultimate goal of the athlete for this season.
Both the coach and the athlete need to have input in determining the goal pace and the dream pace. While it is wise to be a tad conservative on these predictions, the enthusiasm of the athlete who is willing to do the work should never be stifled.

As the athlete becomes more fit, it is important for the coach to encourage negative split runs. Negative split means running the second half of the run faster than the first half. The purpose of this training is while many runners can perform extremely well early in the races, few athletes can maintain the same cadence during the middle or latter portions of a race. If athletes perform negative split runs, they will be teaching their bodies to run faster and more efficiently when the body is fatigued.

Another way to enhance the ability to run fast when tired is to do race pace or faster strides at the conclusion of the run or workout.
Mary Jo R., You-B., (1995-2008) indicated the following session:

- A weekly schedule during this period includes the following:
    - One steady state (long) run day
    - One pace day
    - One tempo
    - One race day
    - One pre-race day
    - Two recovery days

❖ The week might look like the following:

- Monday: Steady state (long) run
- Tuesday: Recovery day
- Wednesday: Pace day
- Thursday: Light hill day or recovery day
- Friday: Pre-race day or recovery day
- Saturday: Race day or tempo run
- Sunday: Active or complete rest day

❖ **Competition Phase**

Mary Jo R., You-B., (1995-2008) ordered as the athlete moves into the competition phase of the season, competitive success is emphasized. The length of individual workouts and the total weekly mileage or time is maintained or slightly decreased. Pace workouts should have achieved a load of race distance or slightly longer. The pace run should become faster and recovery time allotted between segments should be gradually reduced. The steady state run is still a staple of the program, but the distance is gradually decreased as the pace is increased.

❖ Competitive phase week;

- Monday: Steady state runs (during the competitive phase it may sometimes take 10 days to two weeks to schedule in the steady state run.)
- Tuesday: Moderate pace
- Wednesday: Pre-race
- Thursday: Race
- Friday: Recovery
- Saturday: Race
- Sunday: Active rest or complete rest

❖ **Transition Phase**

Following the end of the championship season, distance runners must transition from track to prepare for cross country. The first portion of the transition phase is a good time for athletes to take a complete break from running. Many athletes take 14 to 21 days off to allow the body and

mind to heal. Some do alternative forms of exercise such as cycling, swimming or various exercise machines. Others just rest Mary Jo R., You-B., (1995-2008).

2.3 Aerobic Endurance

Aerobic means 'with oxygen' and aerobic endurance means muscular work and movement done emphasizing the use of oxygen to release energy from the muscle fuels. We have seen how the absorption and transport of the oxygen to the muscles is carried out by the cardio-respiratory system. Aerobic training leads to both a strong cardio-respiratory system and an increased ability to use oxygen in the muscles. Aerobic endurance can be developed by continuous or repetition running. The longer the duration of an event the more important is aerobic endurance (Peter JL Thompson, 2009).

2.4 Types of Aerobic Performance Training

As Peter JL Thompson, (2009) aerobic training is a training to improve and increase the capacity and efficiency of the heart, vascular system, and lungs to provide oxygen and nutrients to the working tissue.

2.4.1 Steady State Training

Steady state runs are long runs that should be done at a pace that can be maintained for 40–60 minutes with relative ease. The ideal intensity for a steady pace run is a pace equivalent to 70% of the individual runner's VO_2 max (approximately one minute per mile slower than 10K race pace).

A 40–60 minute continuous run at this level of intensity has been found to be ideal for developing the cardiovascular system, improving the capillarization of muscles, and enhancing the body's efficient use of its energy sources (Mary Jo R., You-B., 1995-2008).

2.4.2 Tempo Pace (Threshold) Training

To Mary Jo R., You-B., (1995-2008) tempo pace (threshold) running is designed to train runners at their lactate threshold–the level of running intensity where lactic acid begins to accumulate

rapidly in the blood. Continuous running at tempo pace usually can be maintained for 20–30 minutes. Theoretically, regular threshold training will enable the runner to maintain a faster race pace with no greater accumulation of lactic acid.

Threshold training can be either continuous or segmented. Continuous threshold training is usually referred to as tempo running. Tempo runs are typically 20–30 minutes at a pace about 20 to 40 seconds per mile slower than 5K race pace, with warm-up and cool-down running included before and after the run. The purpose of tempo runs is to train at an intensity level just short of hard pace running time (Mary Jo R., You-B., 1995-2008).

Segmented threshold training is also referred to as tempo repetitions or tempo intervals. This training consists of a series of shorter segment runs, usually lasting 90 seconds o eight minutes, with short recovery periods of one-minute or less in between. Distances of 600–2000 meters are best used for tempo repetitions. A entire tempo interval workout could last as little as 30–40 minutes, including recovery time (Mary Jo R., You-B., 1995-2008).

2.4.3 Continuous Slow Running

Continuous slow running is a form of training that develops almost totally aerobic endurance. Some authorities also refer to this type of running as LSD (long, slow distance). It involves, running over long distance (somewhere between 3 and 20 miles and even further) at slow speeds (7 minute miles and slower). The amount of distance covered in this type of training is generally determined by the individual's competitive distance. For instance, a 6 miler might run between 12 and 18 miles, while a miler might run between 3 and 5 miles. This type of training is performed at a relatively low intensity (about 60 to 80% of the maximum heart rate), and is generally considered to be the best method for developing stroke volume and capillarization. Note that when this type of training is being used, the speed by which it takes to bring the heart rate up to between 60 and 80% of maximum heart rate will depend upon the ability of the individual athlete. For example, a 6 minute mile pace might be adequate for a world-class marathon runner (Lorry G. S., 1981).

The goal of this type of running is to achieve recovery and regeneration. And the pace could be easy rhythm without rest with the volume up to 30 minutes Harald M. R., (1996).

2.4.4 Continuous Fast Running

This type of training is more intense than the slow continuous running; it also develops mainly aerobic endurance. The distances covered in this type of training are often in excess of the competitive distance; however, they are usually not as long as those performed in the slow continuous running. For instance, a 6-miler, instead, of running 12 to 18 miles as we suggested under continuous slow running training might run 8 to 10 miles at a steady, but faster pace, while a miler might run 11/2 to 21/2 miles, and repeat the distance 2to 3 times, alternately walking and jogging for 5 minutes after each run. This type of training is performed at a relatively high intensity (about 85 to 90% of maximum heart rate) (Lorry G. S., 1981).

The goal of this type of running is to achieve general endurance. And the pace could be 10 km to half-marathon rhythm; without rest with the volume up to 10-45 minutes (Harald M. R., 1996).

2.4.5 Repetition Training

Mary Jo R., You-B.,,(1995-2008) repetition training can be defined as repeated running segments of varying distances with the rest periods between the segments being approximately twice the length of time as it took to complete the previous running segment.

Repeated segments of one to six minutes of fast running have been identified by exercise physiologists as ideal repetition training for distance runners. Repetition training is designed to increase running efficiency by decreasing the oxygen cost of running and to help the runner become more pace and rhythm conscious (Mary Jo R., You-B.,, 1995-2008).

The running intensity used for repetition training should be desired race pace. Repetition training allows the athlete to attain and sustain VO2 max repeatedly. Repetition training enables a runner to train at V02 max for a cumulative period of time greater than could be sustained in a single race. A total time of 20–25 minutes, not including recovery time, is a good upper limit for a repetition training session (Mary Jo R., You-B.,, 1995-2008).

All repetition training can be varied by:

- Repetitions: The total number of repetitions in a session – may be divided into sets.
- Duration: Length of time or distance of one repetition
- Intensity: Rhythm, pace, speed or velocity of the repetitions
- Recovery: Time of the intervals between repetitions and sets

- Recovery activity: From a walk to easy running or more active as in new interval training (Peter JL Thompson, 2009).

2.4.6 Interval (High Lactate) Training

Mary Jo R., You-B., (1995-2008) suggestion the interval is the recovery period between bouts of running. In a repetition training session, the objective is to run specific segmented distances repeatedly at race pace, so the recovery ratio is approximately 1:2 run to recovery time. In an interval training session, the objective is to run specific segmented distances repeatedly at a high lactate blood level, so the recovery ratio is 2:1 run to recovery—in other words, the time rested (interval) between running segments is half the time it took to run the previous segment.

Interval training should be included more often in the training of 800m and 1600m runners than 3200m runners because those races are 30–50% anaerobic (Mary Jo R., You-B.,, 1995-2008).

2.4.7 Slow interval training

This type of training causes the heart to beat approximately 180 times per minute during the work phase, and develops mostly aerobic endurance. It is generally restricted to distances up to 880 yards. Note that these would include repetitions of 110, 220, 440, and 880 yards. The speed by which this type of training is carried out is somewhat faster than in continuous fast running training, but at the same time, slower than the athlete's normal competitive speed. For example, an athlete who is capable of running the mile in 4 minutes might be as follows; running 220-yd intervals in a time of 33 seconds each with each run followed by jogging 110 yards in 30 to 45 seconds each. Complete recovery is usually not experienced by the athlete during the between runs. Generally, when the recovery heart rate reaches 120 beats per minute, the athlete starts the next work bout (Lorry G. S., 1981).

2.4.8 Fartlek

Fartlek is a Scandinavian term roughly translated as speed-play. It consists of runs over mixed terrains at varied paces. In the past, it was part of Sweden's military training. The Swedish coach Gosta Holmer applied this concept of "go-as-you-please" training to the development of distance runners. On first consideration it sounds delightful. Training out in the forest, on wooded trails, and on back roads, runners who combine inventiveness, motivation, and self-discipline can run

together or alone, changing pace at various points determined by arrival at some selected object(such as a telephone pole or large rock or tree). The constant pace changing, varied terrain, and soft footing provide quality fitness development in the natural beauty of the wildness (David E. M., (PHD) Peter N.C., 1997.)..

Although this may be a good training system for experienced athletes, younger and less experienced runners may require more structured assistance to achieve proper value from this style of training. Also, there is a risk of some problems if fartlek is carried out with a group of runners of mixed athletes. Some will tire less quickly than others and push the pace, leaving those less fit hanging on for dear life. For the tiring runners, this is not training; it is hell and a risk for injury, overtraining, and negative mental attitudes. Unless the coach of such a group is out on the course, he or she will most likely not learn who has profited well by the training and who has suffered until it is too late. We wonder whether the benefits of such an unstructured session outweigh the potential hazards (David E. M., (PHD) Peter N.C., 1997.)..

A controlled version of fartlek training can be done in a park that has loops within earshot of a centrally placed coach. A grassy terrain with some hilly slopes and a quality running surface is really best. After an adequate 15-to-20-min warm-up, the athlete immediately quickness between 75% and 90% of maximum for between 30 s and 2 min, until the next whistle blast signals a slowing to ongoing running pace. The emphasis is on maintaining excellent running mechanics and successfully negotiating hills or obstacles, despite these widely different running paces. The athlete is strongly controlled by the coach in this situation. The training load must be adjusted closely to the athlete's fitness level. If long sprints with short recoveries are demanded, then the session cannot last very long. Whether short or long, fast runs are stressful and must be appropriate to the total training load of that microcycle (David E. M., (PHD) Peter N.C., 1997.).

David E. M., (PHD) Peter N.C., (1997.) explained the advantages of fartlek training are:

- Can take place away from the track over pleasant landscapes and terrain
- Can be done over a variety of terrain
- Programmes can be very flexible

- Rest period can be included or the session can be continuous with intermittent hard and easy running

- It is suited to most games

2.4.9 Hill Training

Three kinds of hill running are described by David E. M., (PHD) and Peter. N.C., (1997) it's use for distance runners. One is a series of gentile up hills and down hills as part of a road or cross-country distance run. Another is a series of runs up a long but manageable hill. The third is a speed session consisting of multiple repetitions up a short, steep hill. Not only does hill running increase the stress at any given pace because of the increased work necessary to counter the elevation change, but it also requires the use of arms, legs, and trunk musculature in ways that are different from level training. This different style is beneficial for improved racing athletes. For hilly, long-distance courses it is most beneficial to run steadily on the flat portion and vigorously up the hill. This optimizes the benefits of including the hills in that particular training session. The vigorous arm, shoulder, and trunk muscle activation from hill running just cannot be duplicated on flat surface. It closely mimics the muscular activity that occurs when a runner changes pace suddenly; thus hill running is akin to an exaggerated pace-change session.

Attacking hills during a long run provides a constantly recurring challenge. Each hill is a fresh obstacle to be overcome, testing an athlete's resolve and building mental toughness. Distance racing requires a similar resolve to counter other runners' attempts to break away from the field. In road and cross-country races some competitors will make a strong surge forward specifically at a hill to initiate the break. Hill training thus conditions the mind the body in a specific and practical manner. Of course, not all distance runs should be on hilly courses run in the manner described. A session emphasizing hill running is just that; a specific kind of training stimulus to be used judiciously (David E. M., (PHD) Peter. N. C., 1997).

As Dr. Jose M., B., (1992) Coaching Manual indicated the scheme of training is as follows:

Table 2:1 Training Scheme

BRIEF SCHEME OF TRAINING FOR THE LONG DISTANCES			
Basic	1	20%	General conditioning in gymnasium, Running drills (maybe with weighted jacket), circuit training, light weight training with many repetition, total

			training
	2	40%	Steady, Aerobic runs -12-16km
	3	10%	Extensive interval training- 20-30x200-400m with jog recovery of 45-90 seconds.
	4	10%	Fartlek- one hour.
	5	20%	Pace endurance— 4-8 (2000-3000m) at 75% effort. Recovery 3-4 minutes. INCREASE OF SPEED ENDURANCE, (NO. 2, 3, & 5)
SPECIFIC	1	10%	Hills—a circuit of about 5km, with fast uphill and relaxed downhill runs and some medium paced running on the flat.
	2	30%	Steady running at the anaerobic threshold (12-15km).
	3	10%	Intensive interval training— 4-5x (5x200-300m) at 75% effort. Recovery jog; 1min between repetition and 3min between sets.
	4	20%	Easy, long steady run— 2 hour
	5	30%	Pace endurance— close to competition pace, 3-5 (1000-3000m). Recovery 4-6 min. specific adaptation. INCREASED OF SPEED ENDURANCE (NUMBERS 2, 4 % 5)
COMPETITION	1	20%	Regenerative runs for 30-45 min and stretching.
	2	10%	Progressive runs, varied pace or fartlek
	3	30%	Competition pace—2-4x1000-3000m. at speed of specialized race. Active recovery 6-12minutes.
	4	30%	Steady, medium pace runs—one hour.
	5	10%	Competition – sometimes at other distances. Acquisition of peak form. FOR IMPROVING SPEED AND GAINING PEAK FORM (important number 1, 3 & 5)

2.5 The Endurance Energy System

The aerobic system requires oxygen. This system is emphasized in lower intensity exercise and is the basic system which provides the energy for most human activity from birth to death. As such it is also important in recovery from exercise of all intensities. It is very efficient and does not produce waste products. The heart and lungs are important in aerobic activity as oxygen and fuel are carried to the muscles in the blood (Peter JL Thompson, 2009).

The aerobic system resists fatigue. It takes longer to overload than either of the other two energy systems. Training the aerobic energy system must be a minimum of a total of 20 minutes duration. The work load

for aerobic training can be either continuous or broken up into repetitions of harder and easier running or exercise. Correct aerobic training will improve aerobic energy production in the muscle and also improve the efficiency and function of the heart and lungs, the oxygen transport system (Peter JL Thompson, 2009).

2.6 Principle of Training

2.6.1 Overload Principle

Mary Jo R., You-B., (1995-2008) indicates the most important principle of training for athletics is that of overload. It should be the aim of coaches to improve their athletes' levels of performance and the capacity for work. In order to achieve this goal, a coach must cause his or her athletes to adapt to a higher level of physical and mental performance. Overloading is the essential mechanism, or tool, for creating this adaptation.

Any new type of training subjects the body to greater or different stress than that to which is has become accustomed. When the load is greater than the normal level of exertion, that load becomes a stressor and stimulates a general adaptation process within the organism (the athlete).
This process is explained in Hans Selye's concept of the general adaptation syndrome, which states that all organisms respond uniformly to stress. When confronted with a stressor, an organism will initially respond with alarm. As the stress continues, the organism will then resist in various ways. If the resistance is positive, the organism is said to have adapted. If, however, the resistance to the stress is negative or the stress is unchecked, the organism will degrade into a state of exhaustion (Mary Jo R., You-B., 1995-2008).

Selye's Theory of General Adaptation
Stress
Stage 1: Alarm
Stage 2: Resistance Stage
Stage 3: Positive Adaptation or Negative Exhaustion
The general adaptation process causes the body to react in a predictable manner to stress. This predictability allows coaches to plan positive adaptation to overload by their athletes. Conversely,

this process also explains the negative results that athletes experience when overload or stress is managed improperly.

The overload is can be created by either increasing:

- The intensity of the work within each workout;
- The frequency or number of workouts; or
- The duration of the workouts at a given intensity.

2.6.2 Principle of Progression

The logical consequence of adaptation to overload is progression. As an athlete adapts to a given training load, a progressive increase in load then becomes necessary to continue the process of adaptation to the next level of performance. In other words, as the system is capable of doing more, it requires progressive increases in training load for it to be stressed into a higher level of adaptation (Mary Jo R., You-B., 1995-2008).

For progress to be achieved, however, an accurate assessment of an athlete's capacity for training must be made. Athletes should be pre-tested and then periodically reassessed in terms of the physical requirements and skills demanded by their respective event(s).Some common measures of such testing are VO_2 max, muscular strength, muscular endurance, vertical jumping ability and flexibility. Such information becomes the foundation upon which a coach manages the progressive overload that improves his or her athletes. Without such knowledge, training becomes haphazard and often results in the frustration or injury of the athlete.

There are four important measures of progressive overload: intensity duration, frequency, and mode (Mary Jo R., You-B., 1995-2008).

2.6.3 Intensity

This factor is the most critical of all in developing cardiorespiratory endurance fitness. It depends upon an individual's percent level of fitness, their percent health condition, and the length or duration of the training. The intensity of work can be expressed in several ways including:

1. A percentage of maximum heart rate

2. A percentage of maximal oxygen consumption

3. Number of calories consumed, or

4. During submaximal or aerobic work, it has been well established that heart rate increases linearly with energy cost (or oxygen uptake) of the work. Because of this and for practical reasons, exercise heart rate has been used by many researchers for determining not only the physiological stress of the work, but also for developing various training programs (Lorry G. S., 1981).

As Peter J L Thompson, (2009) identified to his manual, the scale of intensity relative to best performance are:

Intensity	% of athlete's best Performance
Maximum	95-100
Sub Maximum	85-94
High	75-84
Medium	65-74
Light	50-64
Low	30-49

2.6.4 Duration

In training for cardiorespiratory endurance, it should be kept in mind that the duration and intensity of the work are interrelated. More recent research has shown that continuous training at a low-intensity (heart rate around 65 to 75% of maximum) level for duration of between 30 to 60 minutes per day will result in significantly greater improvements than training at low-intensity for short periods of time (Lorry G. S., 1981).

2.6.5 Frequency

In fact, studies shows that 3 to 5 days per week is an optimal number of workouts for developing cardiorespiratopy fitness. Once a regular exercise routine has been established and the workouts

have become enjoyable, then the frequency of workouts may be extended to more than 3 to 5 days per week (Lorry G. S., 1981).

2.6.6 Mode of Activity

Anyone who has ever worked in a fitness program knows that motivation is probably the most important factor of all in developing a successful program. Because of this, it is extremely important to remember that whatever mode of exercise is selected, it should be one in which the participant enjoys and looks forward to each day. One of the goals in constructing an individualized exercise program is to develop an appreciation for exercise and training to where it eventually becomes a part of your everyday routine and not something that you make up dreading each day (Lorry G. S., 1981).

2.6.7 Specificity of Training

The principle of specificity states that the specific nature of a training load produces its own specific response and adaptations. The training load must be specific to both the individual athlete and to the demands of their chosen event or events. This may be obvious when comparing the demands of events such as marathon and shot. It is less obvious but just as important when planning the training of a 200 meter specialist compared with a 400 meter specialist. Or, a 100 meter hurdler compared with a 400 meter hurdler (Peter J L Thompson, 2009).

General training must always come before specific training in the long term plan. The general training prepares the athlete to tolerate the loadings of specific training. The volume of general training determines how much specific training the athlete is able to complete. The greater the volume of general training in an athlete's foundation the greater is the capacity for specific training (Peter J L Thompson, 2009).

2.6.8 Recovery and Restoration

All gains in training are achieved during periods of recovery. This fundamental fact of athletics is probably the most ignored. Recovery and restoration of the body are integral and active elements of training, not the absence of training. For the body to adapt positively to the progressive overload of training, it must be able to recover adequately from the applied stress. The mantra "no pain, no gain" all too often runs the very thin line between maximum beneficial training and overtraining. The volume of training is far less important than its intensity and intelligent

application. Training without proper rest yields poor results and, often, injury (Mary Jo R., You-B.,, 1995-2008).

Too frequently, coaches do not understand the physiological response generated by hard training. Generally, adequate recovery from a strenuous workout requires at least 48 hours. In any given week, no more than two or three intense training days are recommended. Moreover, days of total or active rest are needed to relieve the accumulated fatigue of exercise. Without such recovery, chronic overtraining with significant risk of injury becomes likely. Coaches often view rest as wasted time in which they might be able to squeeze more preparation. This commonly seems to be the case near the end of season when they should be doing just the opposite. Rest should be greatest during the championship phase of any season (Mary Jo R., You-B.,, 1995-2008).

2.6.9 Individual Differences

It is generally agreed among coaches and exercise physiologists that everybody does not respond to training in the same manner. That is; what may be a significant training intensity for one person may be inadequate for another person. Therefore, the physical educator or coach should not demand that everyone complete the same amount of work at the same rate. Individual differences are real among people and should be anticipated by the coach and physical educator in helping them structure their training and conditioning programs to meet the need of each individual (Lorry G. S., 1981).

2.6.10 Principle of Variety

Training is a long term process and loading and recovery can quickly become boring for the athlete and the coach. The successful coach will plan variety into the training program to maintain the athlete's interest and motivation. In training for athletics a change is sometimes better than a rest. This change and variety can come from such things as changing the nature of the exercise, the environment, time of day of the session and the training group. Variety is an area in which the coach can be at his most creative (Peter J L Thompson, 2009).

2.6.11 Principles of Active Involvement

The performance of an athlete is a result of the combination of an athlete's efforts and the coach's skill. The last principle we shall consider is perhaps the most important. Without it a successful

training program cannot be started. The principle of active involvement in training means simply that for a training program to be fully effective the athlete must want to actively and willingly participate. This participation and involvement should go beyond how an athlete behaves in the presence of the coach. It requires that the athlete's actions in all aspects of his lifestyle contribute to successful performance (Mary Jo R., You-B.,, 1995-2008).

2.6.12 Detraining

Terry M., & Tudor H., (2006) explained this principle, also known as reversibility, requires a grasp of the fact that what we can gain we can readily lose. An experiment conducted in 1968 examined the cardiovascular responses of young men to sub-maximal and maximal exercise following three weeks complete bed-rest. This extreme example of detraining may not be directly applicable to the over-trained athlete, but there are some useful pointers for athletes and coaches. For example, maximal oxygen uptake fell by an average of _27 per cent; the major contributory factor was a reduction of similar magnitude in maximal cardiac output through smaller stroke volume. Sub-maximal heart rate at a standard workload also rose markedly.

The interesting feature of the study relating directly to aerobic athletes is the finding that those with the highest VO2 max values at the start of the experiment not only lost a greater proportion of their aerobic power but also took longer to return to their original value during the recovery training programme. Subsequent research has confirmed that aerobic power and muscular endurance diminish following as little as 14 days of inactivity. Absolute strength and power appear to be less vulnerable to periods of reduced training; but even here, the research evidence points to an impaired power output during technical performance; this suggests that inconsistent practice leads quickly to a loss of precision in skills performance (Terry M., & Tudor H., 2006).

2.6.13 The Warm Up

Terry M., & Tudor H., (2006) indicated the first unit of every training session or preparation for competition should be the warm up. The warm up gradually and systematically prepares the athlete for the training or competition activity which follows.

This preparation is both physical and mental as the warm up:

- mobilizes the muscles and tendons
- heats the body, particularly in the muscles and joints

- concentrates thought and rehearses the skills of what is to follow

Individuals have different needs in a warm up, but if well planned and executed it will result in improved performance. An active, dynamic warm up usually consists of three parts and there should be no static stretching in the warm up.

The effective warm up should progress from

- slow to fast
- active to dynamic
- general to the specific and
- simple to more complex

2.6.14 The Cool Down

Terry M., & Tudor H., (2006) explained an effective cool down is as important as the warm up, but is frequently neglected by the inexperienced coach and athlete.

The cool down gradually reduces the body's temperature and heart rate and speeds up the recovery and adaptation process before the next training session or competition. During the cool down the coach can also go over with the athlete the session just completed and evaluate the performance.

2.7 Maximum Oxygen Uptake and Distance Running

Without oxygen, human life as we know it would not exist. The gas is the essential requirement for all of our cellular activity. The maximal rate at which we can consume oxygen (VO2 max) is the outcome of a chain of physiological mechanisms linking the delivery of atmospheric oxygen to skeletal muscle contraction. Maximum oxygen uptake (or maximum aerobic power) is defined as the greatest oxygen uptake attained by an individual while, breathing air at sea level during the performance of physical work, and it is considered by most exercise physiologist as the best single measure of an individual's cardiorespiratory capacity. Maximal oxygen uptake is sometimes expressed in liters per minute, because it is influenced greatly body size, it is better for comparative purpose to express it in terms of milliliters of oxygen per kilogram of body weight per unit of time (ml/kg/min). In response to the growing popularity of the athletic, exercise professionals have an opportunity to work with increasing numbers of

individuals interested in this emerging sport and to address the methods of testing their maximal volume of oxygen uptake (VO_2 Max). Previous studies have been performed on the testing of athletes, but not specifically with regard to sub-maximal testing VO_2. This raises the question of how well current sub-maximal tests work for athletes.

Exercise professionals regard VO_2Max as the single best measurement of cardio-respiratory endurance and aerobic fitness. While other factors are important to athletic performance, VO_2Max is accepted as the baseline predictor of endurance performance (Baechle & Earle, 2000; Noakes, 2001; Wilmore & Costill, 1999).

Direct measurement of VO_2Max requires special, expensive equipment and requires the athlete to perform until maximal exertion has been reached (American College of Sports Medicine, 2000). The time, performance, and equipment needed to perform measured VO_2Max testing are prohibitive for many athletes, making sub-maximal VO_2testing more attractive. Sub-maximal VO_2tests require less effort, time, and equipment, yet yield results that closely approximate VO_2Max. The concept of VO_2Max long has been regarded as the accepted measure of cardio-respiratory fitness. Knowledge of VO_2Max allows for the quantification of values for training and conditioning, as well as a prediction of performance.

While a higher VO_2Max does not guarantee a better athletic performance, it provides the possibility for a superior performance (Baechle & Earle, 2000; Noakes, 2001; Noakes, Myburgh, & Schall, 1990; Wilmore & Costill, 1999).

The term VO_2Max is understood as the value of the athlete's maximum oxygen consumption during the maximum rate of work and is considered a predictor of athletic performance (Baechle & Earle, 2000; Noakes, 2001). During a complex interaction between the heart and skeletal muscles factors combine to establish the maximum rate of oxygen use by the muscles at the maximum work rate, which results in the maximum work rate achieved. The measured peak rate of oxygen consumption is the result, not the cause of peak work rate achieved (Noakes, 2001).

As exercise intensity increases so does oxygen consumption. However, a point is reached where exercise intensity can continue to increase without the associated rise in oxygen consumption. To understand this in more practical terms, take a look at the diagram below:

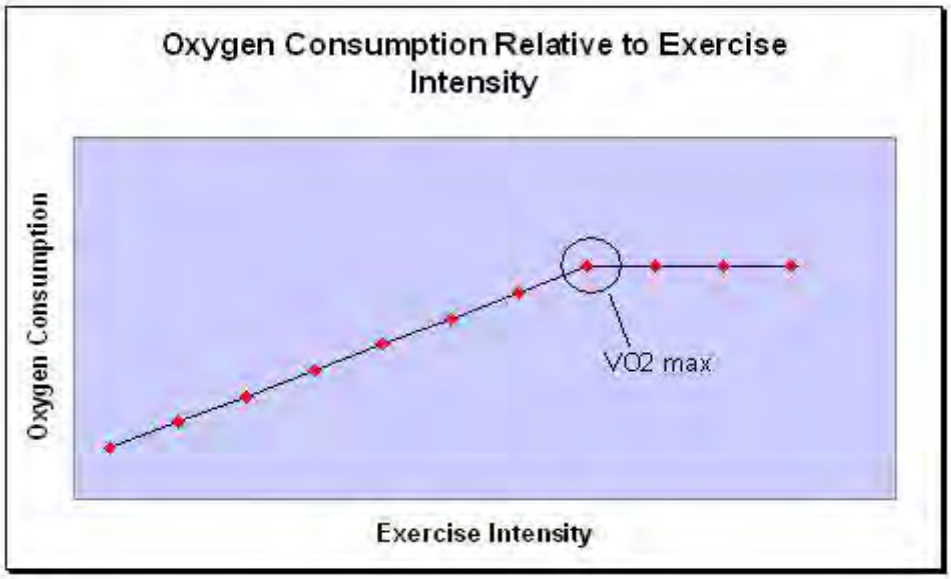

Fig.2:1 O_2 Consumption Vs Exercise Intensity

The above figure adopted from the work of Wilmore and costill, (2005).

The point at which oxygen consumption plateaus defines the VO2 max or an individual's maximal aerobic capacity. It is generally considered the best indicator of cardiorespiratory endurance and aerobic fitness. However, as well discuss in a moment, it is more useful as an indicator of a person's aerobic potential or upper limit than as a predictor of success in endurance events. Aerobic power, aerobic capacity and maximal oxygen uptake are all terms used interchangeably with VO2 max (Wilmore and costill, 2005).

2.8 Altitude Training

J. Appl. P., (1997) suggestion altitude training is frequently used by competitive athletes to improve sea-level performance. However, the objective benefits of altitude training are controversial. On one hand, acclimatization to high altitude results in central and peripheral adaptations that improve oxygen delivery and utilization. Moreover, hypoxic exercise may increase the training stimulus, thus magnifying the effects of endurance training. Conversely,

hypoxia at altitude limits training intensity, which in elite athletes may result in relative deconditioning.

The training program at altitude is similar to at sea level can be used for training at high altitude one should be aware that because muscular fatigue sets in earlier (lactate acid rises more readily and at lower work levels) at altitude (Lorry G. S., 1981).

Altitude, VO_2max decreases as altitude increases above 1600mt. (5249ft). For every 1000mt. (320ft) above that, maximal oxygen uptake decreases further by approximately 8-11%. The decrease is mainly due to a decrease in maximal cardiac output (the product of heart rate and stroke volume. Even though, altitude training is frequently used by competitive athlete for the purpose of improving sea level performance, but still the objective benefits of altitude trainings are controversial (Phil 2007).

According to Lorry G. S., (1981) investigation indicated that training at altitude may improve performance at sea level for the unconditioned nonathletic person, but because the training intensity and duration that is required for the highly trained athlete cannot be achieved at altitude the same as it can at sea level, this improved performance is not found for highly conditioned athletes.

And Phil (2007) identifies the major problem athletes living at altitude face is a significant reduction in training intensity. At 4000m (13,122 ft) athletes can only exercise at 40% of their sea level VO_2max compared to 80% at sea level.

2.9 Factors Influence Athletic Potential and VO2 Max

There are many factors it influences the performance of an athlete, among them some of are:

2.9.1 Age

Age; starting in the late teens for women and mid twenties for men, a decline of about 10% per decade is seen in measured VO_2max in those who remain relatively consistent in activity (Lorry G. S., 1981).

2.9.2 Gender

Lorry G. S., (1981) described that when comparing aerobic endurance between men and women, there is only a small difference in light sub-maximal exercise, but considerable differences in heavy, maximal work. The maximum aerobic capacity (maximum oxygen uptake) is about 20 to 25 percent lower in women while the maximal pulmonary ventilation, stoke volume, cardiac output, a-vo_2 diff, and oxygen intakes are also higher in men. As Jensen and Fisher point out, there are several reasons why the female is limited in their cardiorespiratory endurance capacity when compared to the male. They are:

- a more rapid heart rate,
- a small heart with a smaller capacity to deliver blood
- Smaller chest cavity resulting in inferior lung capacity, and
- The blood of women is limited in oxygen-carrying capacity due to fewer red blood cells.

All the physiological factors limiting endurance exercise performance may be influenced by another factor—genetics. Various researchers have reported a genetically regulated upper limit to individual VO_2max values (Bouchard et al. 1999). These findings indicate that regardless of training volume or intensity, 10 to 30 percent of the variability in VO_2max is genetically determined. The genetic influence on VO_2max has been attributed to both central and peripheral factors, with the genetic effect on cardiac output reported as high as 50 percent (McArdle, Katch & Katch 1996). Similarly, training improvements in economy and lactate threshold are also genetically regulated.

Genetic differences in the proportion of muscle fiber types (slow twitch and fast twitch) are also common. Slow-twitch muscle fibers, characterized by more mitochondrial mass and higher enzyme levels than fast-twitch muscle fibers, have an increased capacity for mitochondrial respiration. Elite endurance athletes generally possess high percentages of slow-twitch muscle

fibers in muscles contributing to their respective exercise. In fact, some elite marathoners have been reported to have more than 90 percent slow-twitch muscle fibers in their leg muscles (Costill, Fink & Pollock 1976). The advantages of more slow-twitch muscle fibers include greater mitochondrial capacity and increased oxygen consumption, leading to improved performance. High correlations between slow-twitch muscle fibers and endurance performance have been reported in both running and cycling (Costill, Fink & Pollock 1976; Ivy et al. 1980). Individual fiber-type proportions also genetically regulate the training adaptability to the physiological parameters of VO_2max, exercise economy and lactate threshold (Robergs & Roberts 1997).

2.9.3 Heredity

Heredity is a major determinant of aerobic capacity, accounting for as much as half of the variation in VO_2Max (Wilmore & Costill, 1999). Interestingly, in studies of exercise programs with participants ranging from sedentary individuals to elite athletes, increases in VO_2Max have been found to range anywhere from 0% to 60%. It has been found that there is a genetic basis for these high and low responders to endurance training (Thomis et al., 1998). The low responders cannot improve with training, regardless of efforts, showing no adaptation to training (Lortie et al., 1984; Prud'Homme et al., 1984).

2.9.4 Injury

Athletics and injury are not separate each other because of his activity is not limited to a specific terrain. For this reason and other causes he is always in danger to expose for injury.

Christer R., (2007) explained about 'sports injury' can be defined as an injury that occurs during sporting activities or exercise. This can be broadened to include injuries affecting participation in sports and exercise and affecting athletes of all ages and all levels of performance.

Patients who seek medical attention at sports injury clinics represent the spectrum from top professional to recreational athletes. Even though we can identify the mechanism of an injury and its pathoanatomical correlate or diagnosis, its consequences may be very different for different athletes. If you are a professional player, there may be loss of earnings and the risk of losing your contract and even your career. If you are a club manager, it may mean losing an important player, perhaps at a crucial time, and the financial costs of a replacement player. If you are the team

doctor, physiotherapist, fitness trainer or coach, you will want to know how the injury will affect your plans for the players' ongoing dietary and physical training programmes. If you are the medic in charge, it will mean having to convince not only the player but also the club's other staff that you have the situation under control. The stakes are high. If a player goes back too early, they risk relapse or further injury but if they are held back, they might ask for a second opinion.

For younger athletes trying to establish themselves in their sport, an injury can result in major family-related conflicts. Over-ambitious or over-protective parents and pressure from coaches and team-mates can put stresses on to a young athlete not able to participate in their sport. For recreational athletes, injuries may mean loss of regular physical and social activities and problems with general health, such as blood pressure, insulin control or secondary problems to the lower back from limping. A shoulder injury from squash may cause difficulties for a builder or plumber with their own business or raise concerns about the safety of a police officer or firefighter. Completely irrational charity bets – 'I must run the London Marathon in a few months even though I have never run more than three miles because my honor is at stake' – are another issue.

As Peter JL Thompson, (2009) suggestion, "Prevention is better than Cure" is especially relevant to the athlete. Many preventive measures are very much common sense but specific precautions are still important.

As Peter JL Thompson, (2009) there are two ways in which injuries can occur. An injury may be caused by a particular traumatic incident, for example a fractured collar bone from falling in a race. On the other hand the injury may be caused by over-use, for example, Achilles tendon injuries in runners. Either may be caused by intrinsic factors, which are factors restricted to the participant, or extrinsic factors, when outside agents are involved. In sports requiring long periods of training the problem of over-use injuries may well be of equal, and often more, importance to prevent.

Fatigue also causes a breakdown of skill. This fatigue may occur in a single training session or result from training loads being too high or too close together. Whether overtraining is short term or long term a coach must be able to recognize the signs and symptoms of fatigue and reduce training levels before injury or illness occurs.

General symptoms of fatigue and stress:

- Listlessness, Lack of responsiveness and enthusiasm
- Loss of appetite
- Disturbance of sleep and waking up tired
- Raising of resting heart rate
- Possible loss of weight
- Incomplete recovery between sessions
- The skin and muscles may appear and feel ‘puffy’
- They express relief when a chance to ‘escape’ from training or competition presents itself.

CHAPTER III

RESEARCH METHODOLOGY

This chapter deals with method of the study, data gathering instruments and data analysis techniques.

3.1. Study Area, Climate and Temperature

As it mentioned earlier the training center is found at Assela with the altitude of between 2210 to 2700m above mean sea level, it has cool climate weather condition and its' 2004Ec annual highest average temperature was 17.3^{o}c and annual average minimum temperature was 10.5 ^{o}c.

3.2. Method of the Study

This study was tried to investigate and examine the effects of aerobic exercise training for middle and long distance athletes' performance which is found in the center of Tirunesh Dibaba National Athletics Training Center. Hence, a comparative study method was applied. The reason applying this method was comparing of each test held in at the end of every four week trainings and the trainings volume and intensities implemented to the center.

3.2.1 Source of the Data

The sources of data for this study were from middle and long distance male and female athletes; documents of the training plan gathered from the coach, from the test and observational check list while they are in training.

3.2.2 Population and Sampling Technique

Since the scope of the study was encompassed to middle and long distance athletes. Due to this to get tangible information the athlete was selected with the use of purposive sampling technique. Regarding to participants, they are well trained sixteen subjects (10 male and 6 female) with their consent recruited from each discipline.

3.3 Procedure of Data Collection

This study mainly used three types of data collection methods for the purpose of gaining appropriate information from the participants of the study. The instruments of data gathering techniques used by the researcher were it includes document analysis, performance predictive test (Balke test), and observational check list are applied.

Procedures:

Before the beginning of the research each athlete was informed about the study and they are asked their consent. Before and during conducting the study the athletes' Anthropometric Measurements (age, height, rest heart rate, training heart rate, training age and body mass index) were taken.

Rest heart rate of an athlete was taken while the athlete is awakening from the bed and counts their pulse with ten second and multiplies by six. The result was recorded with the average of four times. The training plans prepared by the coach were collected. The Balke test was applied to four times. The subjects were engaged the first test at the beginning of the main training. The tests were held in Assela Duna (a place used for training) and Assela stadium. Observation was held while the athletes are in training.

3.3.1 Document Analysis

Documents of four annual plan, weekly plan, session plan, attendances, and training profile which was prepared and collected by the coach were assessed and analyzed for the purpose of checking whether the plan contains goals, general and specific objectives, whether the weekly session plan drawn from the annual plan, the necessary training contents, an appropriate training volume and intensity, location of training venue and collection of attendance sheet. Evaluation checklist mark /√/ assigned under the column of 'Yes', 'No', and 'Not sure'.

3.3.2 Performance Predictive Test (Balke Test)

A 15 minutes track running was completed by each participant on four occasions. The subjects were informed about the tests which were held in after the end of four week training. Before a test commences prior a week each subjects were informed to prepare themselves. During the test each subjects was motivated to run as much as possible covering /completing the time based on their ability. The running track was divided into ten positions with cons. While the athletes are running they were informed the remaining time. At the end of 15 minutes run subjects were took their position with the blow whistle. The distance covered with a 15minutes run was recorded.

The test was used to collect data about the athletes' current aerobic performance conducted to the study. The result was recorded by computing with the formula of ((Total distance covered / 15)-133) x 0.172) + 33.3

Protocol:

This test protocol led to the following manner:

- the test requires the athlete to run in 15 minutes
- the athlete warm-up the body for 20 minutes
- informed the athlete to took their position at the end of the time
- gives command to start the test, starts the stopwatch and the athlete commences the test
- keeps the athlete informed of the time at the end of each 400m lap
- blows the whistle after 15 minutes
- Records the total distance achieved in 15 minutes to the nearest 10 meters.
- At the end of the test there was cool-down and stretching

Required materials:

- Track measured 400m.
- Stopwatch
- Whistle
- Notebook
- Pen/pencil
- Cones
- Assistant

3.3.3 Observation Check List

This data gathering method was designed to assess or examined to what extent the training implemented and assessed the factors directly or indirectly affects the trainings and the athlete's performance. Mainly it was focused on; the training designed on the paper and its implementation, the athletes' response of the training, aware the session objective, motivation of the athlete, safety/wellbeing of an athlete, idea and interest of the athlete and feedback about their training. During this the observation check list data was obtaining with a field note while they are in training.

3.4 Data Analysis Technique

The data gathered used through the method of document analysis, (Balke test) and observation check list were analyzed in chapter four. The test results and responses obtained from the above mentioned data gathering instruments were tabulated, interpreted and analyzed by using percentage method and with the formula of Balke VO_2max test and the result was interpreted by SPSS analysis technique. The interpretation, analysis and discussion were done based on the results obtained and literature guide.

CHAPTER IV

Data Presentation, Analysis and Discussion of the Findings

This chapter deals with presenting, analyzing and discussion of data obtained from the participants of the study by using different techniques of document analysis, performance predictive test (Balke test), and observation check list.

4.1 Data Presentation and Analysis

4.1.1 Background of the Participants

Below the table indicate that background information of the athlete sex and age structure, weight, height, training age, rest heart rate, training heart rate, body mass index and with the total number of ten male (from the alphabet A-J) and six female (from K-P) athletes was participated.

Table 4:1 Athletes Background

Subjects	Sex	Age	Weight in kg.	Height in cm.	Training age	RHR B/min.	THR B/min.	BMI W/m2.
A	M	23	65	172	7	43	180	21.97
B	M	21	54	170	5	44	184	18.69
C	M	23	57	164	6	43	178	21.19
D	M	23	56	171	6	47	188	19.15
E	M	21	60	175	5	46	180	19.59
F	M	22	57	168	5	48	190	20.20
G	M	22	65	174	6	44	180	21.47
H	M	20	69	172	5	46	182	23.34
I	M	22	56	170	7	44	178	19.38
J	M	22	59	169	5	46	180	20.66
K	F	19	50	158	4	60	204	20.03
L	F	19	46	154	5	62	206	19.40
M	F	17	52	162	4	66	216	19.18
N	F	17	48	155	5	64	210	19.98
O	F	19	49	166	4	60	200	17.78
P	F	18	55	165	4	60	210	20.20

Table 4:2 Information of Participant

Age	sex	Total Number	Avg. Weight Kg.	Avg. Height cm.	Avg. Training Age	Avg. RHR B/min.	Avg. THR B/min.	Avg. BMI W/m^2
23	M	3	59.33	169	6.3	44.33	182	20.77
22	M	4	59.25	170.25	5.75	45.5	182	20.43
21	M	2	57	172.5	5	45	182	19.14
20	M	1	69	172	5	46	182	23.34
19	F	3	48.3	159.3	4.3	63	203.3	19.07
18	F	1	55	165	4.5	60	210	20.2
17	F	2	50	158.5	3	61	213	19.58

Athletes who has age of 23(18.75%), age of 22(25%), age 21(12.5%), age of 20(6.25%), age of 19(18.75%), age of 18(6.25%) and age of 17(12.5%). Athlete developments are classified with stages based on the age of an athlete. Therefore, according to Peter J L Thompson, (2009) suggestion an athlete to reach their best performance should have to reach above 18 years of age with the above 10 years of training age. As Lorry G. S., (1981) heart rate increases linearly with increasing oxygen consumption and the resting heart rate in highly trained athletes may be as lower than 40 to 45 beats per minute and endurance training also lower maximal heart rate from about 200 to around 185 to 190 beats per minute as well as the minimum level of training heart rate should be 60% to a maximum of 90%.

4.1.2 Data Obtained from Document Analysis

To get tangible information the researcher was applied to a technique of document analysis. The table 4.3 and 4.4 showed below is a sample session which was prepared by the coach. The plan was used as a model among others middle and long distance training plan during general and specific preparation period.

Table 4:3 Sample Session Plan One

Session	Content	intensity %	set & rep.	rec. time	load	remark
1	Steady aerobic training 40'-90' (6'/km)		-	-	Easy	
2	Easy jog and circuit 50'	-	2x3	1'&30"		
3	Pace endurance M=6:30/2km, F=7:30/2km (2000m)	85-95%	3x	4'	Heavy	
4	One week=Gymnasium 90' Next week=theory class	-	-	-		
5	Fartlek 40'-60'	-	-	-	Medium	
6	Extensive interval training-400m	75-85%	20x	60"	Easy	
7	Easy jog and dynamic 50'	-	-	-		
8	Steady aerobic training 40'-90' (6'/km) (warm-up 20')		-	-	Easy	
9	Pace endurance M=6:30/2km, F=7:30/2km (2000m)	85-95%	3x	4'	Heavy	
10	Easy jog and stretching 50'	-	-	-		

The training plan contains the total of ten sessions with different contents to a week which were implemented until the end of the general preparation phase. From Monday up to Saturday except Wednesday and Friday all days have two (morning and afternoon) sessions but Sunday was a full rest.

At the beginning of the first session steady aerobic training was practiced, starting from 40 minutes and increased 10% volume in every week until the end of the phase. The intensity was presented in the form of estimated time per kilometer. A 20 minute warm-up and 5 minute cool-down activity in every session was included.

Pace endurance was implemented based on with the intensity of target pace and increased with by 2% after two weeks. Fartlek training was practiced to the area it has flat, small hill and road

without definite intensity and the volume was increased by 10% until it reached 60 minute. Extensive interval training was practiced with the intensity of aerobic pace increased by 1% after a week. The intensity was begun with 75%. The total volume increased in a week was reached to 30% and the total intensity was reached to 3%.

Table 4:4 Sample Session Plan Two

session	Content	Int.	Set & rep.	Rec.	Load	remark
1	Easy, long steady run 70'-50' (5'/km)	-	-	-	Easy	
2	Easy jog and stretching 50'	-	-	-		
3	Steady running at an aerobic threshold M=3:15/km, F=3:36/km (8km)	86%	-	-	heavy	
4	One week=Gymnasium 90' Next week=theory class	-	-	-		
5	Hill training (m=76",f=85")400m	90%	6x	3'	Medium	
6	Pace endurance M=5:30, F=6:40 (2000m)	97%	3x	4'	heavy	
7	Easy jog and dynamic 50'					
8	One week=Intensive interval training 300m(m=52", f=78") Next week= Easy, long steady run 70'-50' (5'/km)	101%	2x7	3' & 90"	Medium Easy	
9	One week=Steady running at an aerobic threshold M=3:15/km, F=3:36/km (8km) Next week=Pace endurance M=5:30, F=6:40 (2000m)	86% 97%	- 3x	4'	heavy	
10	Easy, long steady run 40' (5'/km)	-	-			

This training plan was implemented during the phase of specific preparation, it has also ten sessions and the rest program was similar to the above.

The first session training easy, long steady run was practiced throughout the phase with starting time 70 minute but the volume was decreased by 10% after it reached the middle of specific preparation period.

Steady running at anaerobic threshold was implemented based on with the intensity of target pace and increased with by 2% after two week and the volume was decreased after it reached the middle of specific preparation period.

Pace endurance was implemented based on with the intensity of target pace and increased with by 2% after two weeks training adaptation.

Intensive interval training was implemented based on with the intensity of target pace and increased with by 2% in a week. The total volume decreased in a week was reached in 20% and the total intensity increased in a week was reached 5%.

4.1.3 Document Analysis Check List

The table below presents an evaluation check lists used to evaluate the middle and long distance athletic training plan. The training plan document developed by the coaches was assessed regularly for the purpose of this study. The annual plan was seen one time; the weekly training plan was checked the total of four plans per week. This assessment was held until the end of this study.

Table 4:5 Document Analysis Check List

NO	Item	Yes		No		Not sure	
		NO	%	NO	%	NO	%
1	Does the annual plans contain SMART goal of the athlete?	1	100%				
2	Does the annual plan contain general objective?			1	100%		
3	Does weekly training plan emerged from the annual plan?	64	100 %				
4	Does weekly plan contain specific objective?	48	75%	16	25%		
5	Does the weekly training plan contain basic contents?	64	100 %				
6	Does the weekly training plan indicate the volume?	64	100 %				
7	Does the weekly training plan indicate the intensities?	64	100 %				
8	Does the coach have the training profile of the athlete?	4	33.33%	4	33.33 %	4	33.33%

As observed in table 4:6, the data obtained from the session document analysis checklist proved that, 1(100%) of the sessions the four annual plan have a clear goal. Whereas 1(100%) of the session the annual plan prepared without general objective. From those prepared weekly session plan 64(100%) have emerged from the annual plan. In the same way 48(75%) weekly session plan have clear objective but 16(25%) weekly session plan lack specific objective. 64(100%) of weekly sessions have basic contents. 64(100%) of weekly sessions have volume. 64(100%) of weekly sessions have intensities. 4(33.33%) of the sessions have training profile of the athlete, 4(33.33%) of the sessions do not have training profile of the athlete and 4(33.33%) of the sessions not sure to have training profile.

4.1.4 Data Obtained From Predictive Testing (Balke Test)

The raw data for each of the tests can be seen in appendix A and Table 4:15. After the raw data collected the results was computed with the formula of Balke test and put in to a meaningful manner. The measures of VO_2max are reported with a unit of ml/kg/min.

For standard descriptive statistics one way ANOVA method was applied. This method is used for comparing three or more means (David K. M., 1998). Standard description statistics were first determined the mean and standard deviation of the score.

Post hoc Bonferroni test result of one-way ANOVA

Table 4:6 Mean and SD of VO_2max Score

VO_2max score	N	Minimum	Maximum	Mean	Std. Deviation
Test1	16	55.14	67.76	62.1650	4.32365
Test2	16	56.86	69.48	63.6356	4.11410
Test3	16	58.58	76.00	66.0744	4.66743
Test4	16	58.39	70.74	65.3331	4.34376

The mean result indicated in test one shows the least value was found compared to others. The minimum score found in test score of one and the highest/maximum test score found in test three.

Post hoc Bonferroni test result of one-way ANOVA

Table 4:7 Groups Significant Level

Between Groups	Sig. at 0.05
	.000

The table above results of male and female group score has significance difference of .000

Post hoc Bonferroni test result of one-way ANOVA

Table 4:8 Groups Multiple Comparisons (Male and Female)

VO2max score(variable)	Test 1	Test 2	Test 3	Test 4
Test 1	X	.048	.001	.001
Test 2	.048	X	.770	.444
Test 3	.001	.770	X	1.000
Test 4	.001	.444	1.000	X

The mean difference is significant at the 0.05 level.

The above table shows the results of comparison of multiple variables (test scores). The statistical mean difference is significant at 0.05 levels.

The results of group comparison indicate that;

		Result
Test one compared to with	- test two	- the score is .048
	- Test three	- the score is .001
	- Test four	- the score is .001
Test two compared to with	-test three	- the score is .770
	-Test four	- the score is .444
Test three compared to with	-test four	- the score is 1.000

Table 4:9 Significant Levels (Male)

	Sig. at 0.05
Between Groups	.000

The table above results of male group score has significance difference of .000

Post hoc Bonferroni test result of one-way ANOVA

Table 4:10 Multiple Comparisons (Male)

VO_2max score	Test 1	Test 2	Test 3	Test 4
Test 1	X	.302	.000	.000
Test 2	.302	X	.090	.014
Test 3	.000	.090	X	1.000
Test 4	.000	.014	1.000	X

The Mean difference is significant at the 0.05 level.

The result of multiple comparison of male variables statistical significant difference result;

		Result
Test one compared to with	- test two	- the score is.302
	- test three	- the score is.000
	- test four	- the score is.000
Test two compared to with	- test three	- the score is.090
	- test four	- the score is.014
Test three compared with	- test four	- the score is 1.000

Table 4:11 Female Significant Level

	Sig. at 0.05
Between Groups	.000

The table above results of female group score has significance difference of .000

Post hoc Bonferroni test result of one-way ANOVA

Table 4:12 Multiple Comparisons (Female)

VO2max test	Test 1	Test 2	Test 3	Test 4
.Test 1	X	.048	.001	.001
Test 2	.048	X	.770	.445
Test 3	.001	.770	X	1.000
Test 4	X	.444	1.000	x

The Mean difference is significant at the 0.05 level.

The result of multiple comparison of female variables statistical significant difference result;

Result

Test one compared to with -test two - the score is.048

-test three - the score is.001

-test four - the score is.001

Test two compared to with - test three - the score is.770

- test four - the score is..445

Test three compared with - test four - the score is 1.000

Table 4:13 Coefficient of Determinations between Scores

	Test 1 and 2	Test 1 and 3	Test 1 and 4	Test 2 and 3	Test 2 and 4	Test 3 and 4
r^2	0.83	0.94	0.89	0.76	0.85	0.99

The statistical significance of correlation is important, but to better determine the relationship of two variables, the coefficient of determination should be utilized. The coefficient of determination is the square of the correlation coefficient (r^2) David K. Miller (1998).

The relations of two variables indicated above the table showed that each paired tests have strong relations. These mean that 83% of the variability of test one score is associated with test two. Or the two tests have common factors that influence the individual scores. And 94% of the variability of test one score is associated with test three. Or the two tests have common factors that influence the individual scores. 89% of the variability of test one score is associated with test four. Or the two tests have common factors that influence the individual scores. 76% of the variability of test two score is associated with test three. Or the two tests have common factors that influence the individual scores. 85% of the variability of test two score is associated with test four. Or the two tests have common factors that influence the individual scores. 99% of the variability of test three score is associated with test four. Or the two tests have common factors that influence the individual scores.

Table 4:14 VO_2max Scores

subjects	Sex	VO_2max score ml/kg/min				Average VO_2max
		Test 1	Test 2	Test 3	Test 4	
A	M	67.1	68.04	70.05	70.74	68.98
B	M	66.32	67.76	67.76	67.3	67.29
C	M	65.46	69.48	67.47	67.47	67.47
D	M	65.46	66.61	68.04	68.9	67.25
E	M	64.89	67.18	67.18	67.76	66.75
F	M	64.32	65.18	68.33	67.76	66.4
G	M	63.74	64.32	67.18	68.9	66.04
H	M	63.74	64.32	68.9	69.48	66.61
I	M	67.76	64.6	68.63	67.76	67.19
J	M	63.74	67.47	67.76	68.9	66.97
K	F	55.14	59.44	58.94	58.39	57.98
L	F	58.01	56.86	58.58	59.73	58.3
M	F	57.72	58.58	61.16	61.45	59.73
N	F	56.58	58.58	59.73	59.73	58.66
O	F	56.86	60.02	60.30	60.3	59.37
P	F	57.72	59.73	60.88	60.76	59.77

The above table contains the VO_2max scores of the athlete registered in each test. The data was compared to the normative data.

Based on Heywood (1998) normative data indicated to appendix B the scores of VO_2max listed above achieved by the athlete showed superior results of VO_2max level. Average male VO_2max level was 67.1ml/kg/min and average female VO_2max level was 58.97 ml/kg/min.

Table 4:15 Athlete Improvement Rate

Improvement rate between Tests of VO2max ml/kg/mi

Athlete	Improvement rate			
	Between test one and two (%)	Between test two and three (%)	Between test three and four (%)	Average (%)
A	0.64	1.46	0.49	0.86
B	1.07	0	-0.34	0.24
C	2.94	-1.47	0	1.51
D	0.87	1.06	0.63	0.85
E	1.73	0	0.43	0.72
F	0.66	2.36	-0.42	0.87
G	0.45	2.17	1.26	1.3
H	0.45	3.44	0.42	1.44
I	-2.39	3.02	-0.64	-0.00
J	2.84	0.21	0.83	1.3
K	3.75	-0.42	-0.47	2.86
L	-1.00	1.49	0.97	1.46
M	0.74	2.15	0.24	2.63
N	1.74	0.97	0	1.55
O	2.70	0.23	0	1.13
P	1.71	0.95	-0.09	1.42

Between test one and test two except athlete *I* (-2.39%) and athlete *L* (-1.00%) all showed positive improvement.

Between test two and test three except athlete *B* (0%), athlete *C* (-1.47%), athlete *E* (0%) and athlete *K* (-0.42%) all showed positive improvement.

Between test three and four except athlete *B* (-0.34%), athlete *C* (0%), athlete *F* (-0.42%), athlete *I* (-0.64%), athlete *K* (-0.47%), athlete *N* (0%), athlete *O* (0%) and athlete *P* (-0.09%) all six male and two female athletes showed positive improvement. Except athlete *I* (-0.00%) all showed positive average improvement rate.

Average mean improvement rate of male was 0.91% and average mean improvement rate of female was 1.84%.

4.1.5 Data Obtained from Observation Check List

Data from this technique were obtained frequently while the subjects are in training. The data was taken by simply watching with the naked eye, and recording the data on an appropriate sheet based on below list of items for the total of fifteen sessions that means one session per week.

1. Are there relations of plan on paper and the training?
2. Is there any controlling mechanism of an athlete to stay his training?
3. Are athletes informed the session objective?
4. Are athletes motivated for training?
5. Are athletes able to respond the training?
6. Are the athlete practice with safety and well being?
7. Are the athlete listened their idea and interest?
8. Is there any feedback during and after the training?

During the training time the researcher was observed the process of the training based on the above list of items and assessed with subjectively. The overall view of the observation was:

The relation of plan on paper and training; from the sessions of observation mostly there were coincide but sometimes due to transportation problem they were changed the type and venue of training.

Controlling mechanism; sometimes coaches took attendance.

Information about session objective; throughout the observation almost all coaches were not inform their session objective.

Motivation for training; during training coaches were gives morale to their athlete and informed their test result.

The athlete response to training; during the first phase of pace work training all athletes were respond positively but after the intensity was increased some athletes face difficult to some extent.

Safety and well being of the athlete: some contents were practiced out of the track like forest training due to this some athletes complains injuries.

The idea and interest; athletes were raised ideas and interest about the training area, sport wears and nutrition. Coaches were to some extent tried to alleviate their interest.

Feedback during and after training: almost all coaches were comment their athlete while they are in training and at the end of their training some of the coaches were talk about the session.

4.2 Discussion of the Finding

The main objective of this research was to determine the effects of aerobic training in middle and long distance athlete's performance. Through a close observation in their setting between 4-week training to four times, testing their progress with Balke method the expectation for improvement was significant.

Evaluation the trainings, predict the progress, evaluate VO_2max level of male and female and analyzed the improvement rate were the primary focus of the research program.

The trainings were given with their setting without interference, but it was assessed continually. Necessary information was gathered before and after each phase of test.

Data were collected after each test and interpreted in a meaningful way because a row data does not give sense. But by using statistical analysis to determine the progress of performance it was helpful to put the tests in a realistic manner. The general test score was analyzed and its statistical significant difference was observed between the two sexes.

Evaluation of training plan

The training plan for general preparation which was prepared by the coach included all the contents of general conditioning (in gymnasium, running drill and circuit) accounts 20%, steady aerobic runs accounts 40%, extensive interval training accounts 10%, fartlek accounts 10%, and pace endurance accounts 20%, indicated to the literature review of Dr. Jose M., B., (1992) manual scheme. But the general conditioning was accounted to 40% and a steady aerobic run was accounted to 20% which was different from the literature review.

The training plan intensity (75%) was begun with the highest percent indicated to the literature review of Peter J L Thompson, (2009). In addition Phil (2007) identifies the major problem

athletes living at altitude face is a significant reduction in training intensity athletes can only exercise at 40% of their sea level VO_2max compared to 80% at sea level.

Mary Jo R., You-B., (1995-2008) suggest the guideline to follow "10% rule" or volume should not increase much greater than 10% from one week to the next week. But the training plan which were prepared by the coach was increased the total volume of 30% and 3% intensity per week.

The training plan for specific preparation which was prepared by the coach included all the contents of hill training accounts 10%, steady running at the anaerobic threshold 30%, intensive interval training 10%, easy, long steady run 20% and pace endurance 30% indicated to the literature review of Dr. Jose M., B., (1992) manual scheme. But steady running at the anaerobic threshold training were practiced 20% in one week and 10% another week and pace endurance were practiced 20% in one week and 10% to the other week. But the training plans which were decreased the total volume of 20% and increased by 5% intensity per week.

To interpret the general view of their plan all of the plans have SMART goal; which includes specific goal for each athlete and for group athlete it is expected to achieve at the end of the training year.

Regarding to general objective all plans were not constitute clearly. For their weekly training plan and all its contents were draws up from their annual plan.

In the same way all plans prepared by the distance coaches the volumes and intensities were indicated to their plan. Regarding to the training profile, there is a missing by some of them.

In general, from the above discussion regarding to general objectives there is a missing indicating to the annual plan.

Performance Predictive (Balke) Test

Group multiple comparison (female and male)

Test one and two

Performances were critically measured to evaluation and for judgment. For this particular study athletes were engaged to run 15 minutes. The results scored by each subject were compared each other. The degree of change within each test was fond statistically significant at the 0.05 level, though the difference between the two was sought a significant difference (.048), that means there is a change. And its coefficient determination r^2 indicates 0.83; therefore, there is a strong relation between the two scores. It means that 83% of the variability of test one score is associated with test two. Or the two tests have common factors that influence the individual scores.

Test One and Three

The statistical significance difference between the two scores was .001, it shows a change in value and its coefficient determination r^2 indicate a strong relation between the scores. 94% of the variability of test one score is associated with test three. Or the two tests have common factors that influence the individual scores.

Test One and Four

One way ANOVA a statistical significant difference was indicated .001 this it shows a significant difference between scores. And its coefficient determination r^2 indicates 89% of the variability of test one score is associated with test four. Or the two tests have common factors that influence the individual scores.

Test Two and Test Three

Multiple comparisons analysis of variance was .770, which means there were not a significant difference between the two scores but its coefficient determination r^2 indicates 76%, which means the variability of test two score is associated with test three. Or the two tests have common factors that influence the individual scores.

Although, the significance difference was not indicated the changes but there is a strong relation.

Test Two and Four

The two tests coefficient determination r^2 indicates 85% of the variability of test two score is associated with test four. Or the two tests have common factors that influence the individual scores. But the significance difference was .444, which means it was not indicated the changes.

Test Three and Four

The significance difference was 1.000, which means there was not indicated the change but the two tests coefficient determination r^2 indicates 99% that means the variability of test three score is associated with test four. Or the two tests have common factors that influence the individual scores.

Multiple Comparisons of Male

The significance difference between test one vs. three was (.000), one vs. four (.000), test two vs. test three (.090), and test two vs. test four was (.014) this result it shows there was a change. But test one vs. test two the result was (.302) and test three vs. test four was (1.000) this it was showed that there were no improvement.

Multiple Comparisons of Female

The significance difference between test one vs. two was (.048), one vs. three (.001), test one vs. test four (.001) this result it shows there was change. But test two vs. test three was (.770) test two vs. test four the result was (.445) and test three vs. test four was (1.000) this it was showed that there were no improvement.

Level of VO_2max Based On Gender

Heywood (1998) identified normative data for male the age of 20-29 should have VO_2max level of >52.4ml/kg/mi is a superior value and for female the age of 13-19 should have VO_2max level of >41.9ml/kg/mi is a superior value. Therefore, the average VO_2max level scored by male athletes was 67.1ml/kg/mi and the average VO_2max level scored by female athletes was 58.97ml/kg/mi. this value it showed that both males and females scored greater than the normative data, but the value of male athlete VO_2max was greater than the female athlete.

Improvement rate of an athlete based on test score

The table 4:16 indicate that the improvement rate between test one and two except athlete I and L all athletes showed a change. Between tests two and three except athlete B, C, E, and K the rest

athlete showed improvement. Between tests three and four except athlete B, C, F, I, K, N, O and P the rest athlete showed improvement. In general the average improvement of every individual athlete except athlete I the rest all were improved their VO_2max. Average mean improvement rate of male was 0.91% and average mean improvement rate of female was 1.84%.

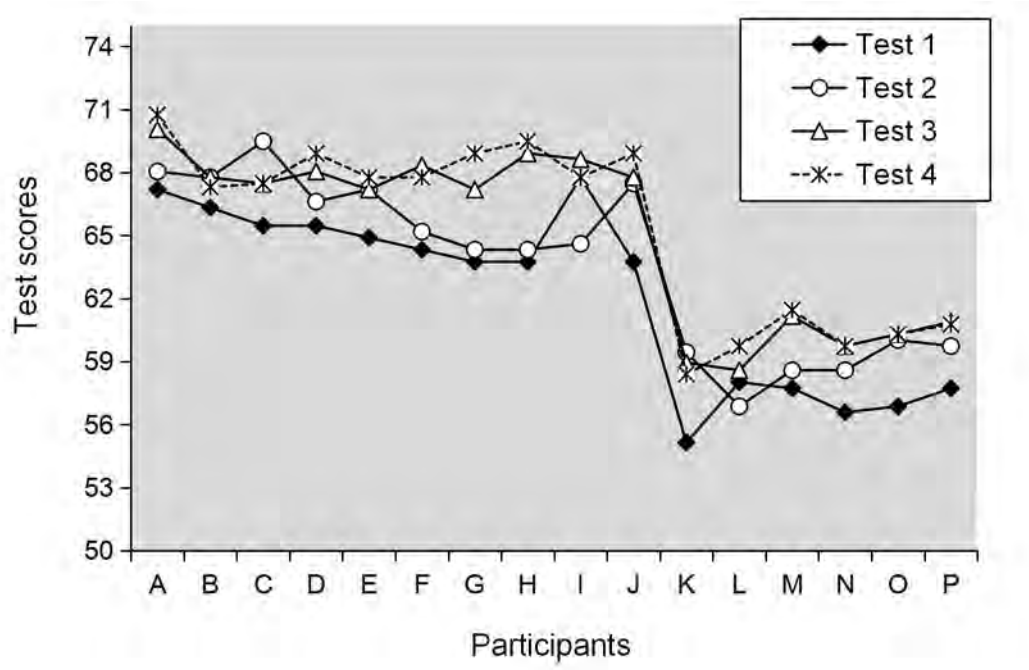

Fig 4:1 Test Scores Relation with Improvement

Key: from the **x** axis letter A – J scores of (Males) and K- P scores of (female)

The above figure indicates the graph of the improvement of VO_2max level of the athletes.

Observation Check List

The coaches mostly were trained their athlete they planned on paper, have training attendance, athletes were motivated by their coach if the task were in the track, the trainings were seemed appropriate to the level of the athlete because they were accomplished easily, and sometimes they were discussed each other about their trainings. But the result it shows that almost all coaches were not inform the session objective to their athlete.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter deals with summarizing the overall activities of the study and concluding the results obtained from the analysis of results and discussions section. Finally, recommendation was forwarded to alleviate the situation.

5.1 Summary

Long and middle distance athletes needs to train under their training session or plan for the improvement of aerobic capacity. In order to bring endurance performance of an athlete aerobic training is an essential content. The primary goal of aerobic training is to improve and increase the capacity and efficiency of the heart, vascular system, and lungs to provide oxygen and nutrients to the working tissue and to remove the west products of metabolism and as well as improves the heart rate recovery process. The purpose of this study was focused on the effects of aerobic training in middle and long distance athletes' on to the current aerobic performance of an athlete which was found at Tirunesh Dibaba National Athletics Training center.

Subjects were participated to the present research are:

- Sixteen in number ; well trained 10 male and 6 female athletes
- Males with average age of 21.9 and females are 18.7 average years old,
- The average training age; males has 5.7 and females 4.3.

The study was held in the selected center of Turnesh Dibaba N/A/T/Center. The sources of data were taken from document analysis, performance prediction test and observation check list.

The information gathered from documents was analyzed by using percentage and the result of the study shows the following findings.

- Evaluation of the training plan; contents for general preparation were included the same as referred to the literature, but the amount of general conditioning should be covered in training was increased and the amount of steady aerobic run should be covered in training was decreased. The amount of training volume was increased by 30% from one week to the next week, which is different from the literature guideline 10% rule.

- Evaluation of the training plan; contents for specific preparation were included the same as referred to the literature, but the amount of steady running at the anaerobic threshold training should be covered in training was decreased and the amount of pace endurance should be covered in training was decreased. The amount of training volume was decreased by 20% from one week to the next week, which is different from the literature guideline 10% rule. The training intensity was begun with 75%.

- The document analysis check list indicated that the SMART goals indicated to the annual plan.

- Regarding to setting objectives; according to different scholars one of the major components of a training plan is setting of objectives but the results which was obtained from document analysis do not indicate to the plan;

- As it was checked from the documents; the training contents, its training volume and intensities were drawn from the annual plan and indicated /presented in every weekly session plan,

- Documentation of the athletes profile; the check list result were not indicated except one of them.

The information obtained from performance predictive tests were analyzed with one way ANOVA multiple comparison techniques. The results of the findings it shows:

The raw data were obtained four times with Balke performance predictive test, after each test held in between 4 week training the data was put in to a meaningful way by computing with the formula of ((Total distance covered / 15)-133) x 0.172) + 33.3 with the unit of ml/kg/li. So to determine whether the test predicts the current performance of middle and long distance athletes or not statistical interpretation were taken.

- The performance prediction tests indicated that there was a performance improvement when tests are compared each other. This improvement was shown in the value of significance difference and line charts.

- The first or pre-test test compared to the second test the value it shows a significance difference and a strong relations of coefficient determination. This value it was also observed between test one and three.

- The test results of male athletes were statistically analyzed; therefore, the result shows between test one and two there is no significance difference. The results between the first and the third show a significance difference. The test result between one and four also shows a change, the results between test two with test three and four there was a change. But between test three and four there was no change,

- The test results of female athletes were statistically analyzed; therefore, the result between test one with test two, three and four it shows a change /improvement but test result of two; with three and four and between test three and four there was no improvement.. With coefficient determination all the tests have strong relations.

- The level of male athlete VO_2max was greater than the level of female athlete.

- There was an average mean improvement rate of VO_2max level indicated from the test result.
- Through observation check list; The coaches mostly were trained their athlete they planned on paper, have training attendance, athletes were motivated by their coach if the task were in the track, the trainings were seemed appropriate to the level of the athlete because they were accomplished easily, and sometimes they were discussed each other about their trainings. But the session objectives were not informed to the athlete.

5.2 Conclusion

To achieve the effects of aerobic training a systematic design of training program is mandatory. Based on the objective of the study the result of this research shows that the assessment of the

training plan follows appropriate principle and contributes the aerobic performance, but there was a difference to a guideline with increasing volume of training.

This study also measures the current performance of the athlete with performance predictive (Balke) test.

- The statistical significance difference test result of group comparison it shows that between test one vs. two, one vs. three and one vs. four have a significance difference. But test two vs. three, two vs. four and test three vs. four there was no significant difference.
- The statistical significance difference test result of male multiple comparison it shows that between test one vs. three, one vs. four, test two vs. three and two vs. four have a significance difference. But between test one vs. two and test three vs. four there was no significant difference.
- The statistical significance difference test result of female multiple comparison it shows that between test one vs. two, test one vs. three and test one vs. four have a significance difference. But between test two vs. three, test two vs. four and test three vs. four there was no significant difference.
- This research also indicates that there was a gender difference to the level of their VO_2max.
- The results also show that the average improvement of every individual athlete except athlete I the rest all were improved their VO_2max. Average mean improvement rate of male was 0.91% and average mean improvement rate of female was 1.84%.

5.3 Recommendation

Based on the findings of the study, the following suggestions are forwarded:

Appropriate aerobic exercise training is very essential for the improvement of the athletes' performance. This study shows that whether training brings performance change or not because one cannot simply justify the improvement, therefore, to understand the meaning of the change the subject should be measured /tested. For the purpose of this study 16 subjects were engaged to the study. From the documentation analysis there was a missing of objective and personal profile this two things are essential because without objective one cannot be successful so a coach should have been take in to account setting of objective while planning. From the observation session there were a missing to aware session objective this caused an impact to their motivation.

From the performance predictive test;

- The test result of group comparison between test two vs. test three, test two vs. four and test three vs. four it shows that there was no difference.
- male athletes were statistically analyzed; therefore, the result shows between test one and two there was no difference, between test three and four there was no change,
- The test results of female athletes were statistically analyzed; therefore, test result of two; with three and four and between test three and four there was no improvement.

In general this might be caused by the detraining effect to the athletes side, the lack of training adaptation and their psychology for test, might be the impact of training caused by change to their performance, might be caused by the decline of performance due the change of training phases and the shortest duration of the training between tests, the training duration might have an impact to the development of their physiology, might be caused by environment factor and due to the impact of intensity and duration caused by the altitude effect.

Therefore, all this factors can be a barrier to the improvement of the athlete performance, and the following points are helpful to alleviate the situation and provide as in response to the findings from this research.

- Setting general objective during annual planning is mandatory because it is a guide to understand the beginning and an end of the task.

- Organize athlete profile; it provides background information of the athlete and to determine the trainings.
- Athletes must know what they do and for what purpose. Before the beginning of the training the athletes have awareness the objective of the session training.
- The training terrain has selected properly to minimize injury.
- Psychology of the athlete must be developed.
- The increasing of volume must be following the training principles of the scientific guidelines.
- The intensity of the training must consider the training capacity and experience of an athlete and the area he lived and trained.

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Appendix A

ATHLETES VO_2MAX SCORES

Participant	Predictive test	1st test score	Vo2 max Score ml/kg/mi	2nd test Score	Vo2 max Score ml/kg/mi	3rd test Score	Vo2 max Score ml/kg/mi	4th test Score	Vo2 max Score ml/kg/mi
A	Balke test	4950	67.18	5025	68.04	5200	70.05	5260	70.74
B	Balke test	4875	66.32	5000	67.76	5000	67.76	4960	67.30
C	Balke test	4800	65.46	5150	69.48	4975	67.47	4975	67.47
D	Balke test	4800	65.46	4900	66.61	5025	68.04	5100	68.90
E	Balke test	4750	64.89	4950	67.18	4950	67.18	5000	67.76
F	Balke test	4700	64.32	4775	65.18	5050	68.33	5000	67.76
G	Balke test	4650	63.74	4700	64.32	4950	67.18	5100	68.90
H	Balke test	4650	63.74	4700	64.32	5100	68.90	5150	69.48
I	Balke test	5000	67.76	4725	64.6	5076	68.63	5000	67.76
J	Balke test	4650	63.74	4975	67.47	5000	67.76	5100	68.90
K	Balke test	3900	55.14	4275	59.44	4231	58.94	4183	58.39
L	Balke test	4150	58.01	4050	56.86	4200	58.58	4300	59.73
M	Balke test	4125	57.72	4200	58.58	4425	61.16	4450	61.45
N	Balke test	4025	56.58	4200	58.58	4300	59.73	4300	59.73
O	Balke test	4050	56.86	4325	60.02	4350	60.30	4350	60.30
P	Balke test	4125	57.72	4300	59.73	4400	60.88	4390	60.76

Appendix – B

Normative data for Male (values in ml/kg/min)

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<35.0	35.0 - 38.3	38.4 - 45.1	45.2 - 50.9	51.0 - 55.9	>55.9
20-29	<33.0	33.0 - 36.4	36.5 - 42.4	42.5 - 46.4	46.5 - 52.4	>52.4
30-39	<31.5	31.5 - 35.4	35.5 - 40.9	41.0 - 44.9	45.0 - 49.4	>49.4
40-49	<30.2	30.2 - 33.5	33.6 - 38.9	39.0 - 43.7	43.8 - 48.0	>48.0
50-59	<26.1	26.1 - 30.9	31.0 - 35.7	35.8 - 40.9	41.0 - 45.3	>45.3
60+	<20.5	20.5 - 26.0	26.1 - 32.2	32.3 - 36.4	36.5 - 44.2	>44.2

Normative data for Female (values in ml/kg/min)

Age	Very Poor	Poor	Fair	Good	Excellent	Superior
13-19	<25.0	25.0 30.9	31.0 -34.9	35.0 -38.9	39.0- 41.9	>41.9
20-9	<23.6	23.6 28.9	29.0 -32.9	33.0 -36.9	37.0 -41.0	>41.0
30-39	<22.8	22.8 26.9	27.0- 31.4	31.5- 35.6	35.7 -40.0	>40.0
40-49	<21.0	21.0 24.4	24.5- 28.9	29.0 -32.8	32.9- 36.9	>36.9
50-59	<20.2	20.2 22.7	22.8- 26.9	27.0-31.4	31.5 -35.7	>35.7
60+	<17.5	17.520.1	20.2-24.4	24.5-30.2	30.3-31.4	>31.4

Appendix – C

Improvement between Tests of VO2max ml/kg/mi

subject	Improvement rate			
	Between test one and two (%)	Between test two and three (%)	Between test three and four (%)	Average (%)
A	0.64	1.46	0.49	0.86
B	1.07	0	-0.34	0.24
C	2.94	-1.47	0	1.51
D	0.87	1.06	0.63	0.85
E	1.73	0	0.43	0.72
F	0.66	2.36	-0.42	0.87
G	0.45	2.17	1.26	1.3
H	0.45	3.44	0.42	1.44
I	-2.39	3.02	-0.64	-0.00
J	2.84	0.21	0.83	1.3
K	3.75	-0.42	-0.47	2.86
L	-1.00	1.49	0.97	1.46
M	0.74	2.15	0.24	2.63
N	1.74	0.97	0	1.55
O	2.70	0.23	0	1.13
P	1.71	0.95	-0.09	1.42

Appendix – D

ADDIS ABABA UNIVERSITYFACULTY

OF LIFE SCIENCE

DEPARTMENT OF SPORT SCIENCE

DOCUMENT ANALYSIS CHECKLIST

NO	Item	Yes		No		Not sure	
		NO	%	NO	%	NO	%
1	Does the annual plans contain SMART goal of the athlete?						
2	Does the plan contain achievable general objective?						
3	Does weekly training plan emerged from the annual plan?						
4	Does weekly plan contain specific objective?						
5	Does the weekly training plan contains basic contents						
6	Does the weekly training plan volume set based on the athlete's capacity?						
7	Does the weekly training plan intensities set based on the athlete's capacity?						
8	Does the coach have the training profile of the athlete?						

Appendix: E

Addis Ababa University

Faculty of Life Science

Department of Sport Science

Session Observation Checklist

The main purposes of this observation check list is intended to assess the trainings, controlling mechanism of an athlete, information about session objective, motivation and other factors…

PART –ONE

1. Observer Name ----------
2. place ----------
3. Session = morning ---------- After noon----------
4. Session length ----------
5. Number of athlete ----------
6. Number of coach ----------

Please write a field note you observe while the athletes are in training.

No	**Items**
1	Are there relations of plan on paper and the training?_____
2	Is there any controlling mechanism of an athlete to stay his training?_____
3	Are athletes informed the session objective?_____
4	Are athletes motivated for training?_____
5	Are athletes able to respond the training?_____
6	Are the athlete practice with safety and well being?_____
7	Are the athlete listened their idea and interest?_____
8	Is there any feedback during and after the training?_____

Declaration

I, the under signed, declared that this thesis is my own work and has not been presented of any other sources of materials used for the thesis have been fully acknowledged.

Name _____

Signature _____

Date _____

This thesis has been submitted for examination with my approval as a university advisor.

Name _____

Signature _____

Date _____