ASSOCIATION BETWEEN PERFORMANCE AND INJURY WITH DIETARY INTAKE AND NUTRITIONAL STATUS AMONG ATHLETES: CASE OF ITEN TRAINING CAMP IN THE RIFT VALLEY OF KENYA

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DEPARTMENT OF FOOD SCIENCE, NUTRITION AND TECHNOLOGY

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DECLARATION

I, hereby declare that this dissertation is my original work and has not been presented for a degree in any other university or institution of higher learning.

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ABBREVIATIONS

ATP – Adenosine triphosphate

BMI – Body Mass Index

BMR – Basal Metabolic Rate

CHO - Carbohydrate

CP – Creatine phosphate

EE – Energy Expenditure

GI – Glycemic index

KDHS – Kenya Demographic Health Survey

SPSS – Statistical Package for Social Science

IAAF – International Association of Athletic Federation

Kcals – Kilocalories

KM – Kilometres

M – Meters

RDA – Recommended dietary allowance

Mins – Minutes

DEFINITION OF TERMS

Athlete is a person who competes in one or more sports that involves physical strength, speed or endurance

Common Injuries are those injuries suffered by the athletes during the training period and hence affected their performance or caused them to drop out of their competition.

Elite Athlete is a runner who has won two or more international competitions.

Endurance is the ability to withstand prolonged strain such as in long distance races (delayed fatigue).

Long Distance Runners are those athletes who run races of a distance between 1500m to a marathon which is a distance of 42km.

Middle distance runners are those athletes who run races of a distance between 800 to 3000meters

Marathon is a long distance running event with an official distance of 42.195 kilometres usually a road race

Nutritional status is the condition of the body in those respects influenced by the diet; the levels of nutrients in the body and the ability of those levels to maintain normal metabolic integrity

Poor Nutritional Status is where the nutritional status is below 18.5 as measured as BMI.

Athletic performance is carrying out physical routines or procedures by one who is trained in physical activity. This is influenced by a combination of physiological, psychological and socio-cultural factors.

Sports Anaemia is false or dilution anaemia, resulting from the acute increase in plasma volume followed by apparent decrease in haemoglobin that accompanies heavy aerobic training.

Sports Nutrition is the study and practice of nutrition and diet as it relates to sports performance.

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ABSTRACT

Kenyan athletes are renowned over the world for their endurance running in middle and long distance races. They have won approximately 40% of all major international long and middle races that they have participated during the last decade. However, athletes sometimes get injuries which affect their performance and as a result have dropped out of the competition. The injuries are presumed to be nutrition related and may result from a negative energy balance and inadequate dietary intake particularly the micronutrients iron and calcium. This study was therefore designed to assess the association of performance of athletes with dietary intake of energy, iron and calcium in a training camp setting. The study was cross sectional in design and was conducted in Iten training camp Elgeyo-Marakwet County of the Rift Valley of Kenya. A sample of 282 athletes was used for the study, consisting of 192 males and 90 females. Iten training camp was purposively selected because of the regularity of training. Proportionate to size sampling was used to select athletes according to their races. A pre- tested structured questionnaire was used to collect data on socio demographic and socio- economic characteristics, level of performance and frequency of injuries. A 24-hour recall was used to determine the dietary intakes of energy, iron and calcium. Anthropometric measurements of weight and height were used to determine nutritional status of athletes as BMI. Nutri- survey software and Kenyan National food composition tables were used to compute the energy, calcium and iron intakes by individual athletes. SPSS 20.0 software was used for analysis. Results were subjected to analysis as frequencies, percentages, chi – square, linear regression and logistic regression.

Results showed that majority of athletes have secondary education; males at 60.4% and females at 55.6%. Almost half of the athletes were middle class socio economic category with males at 48.9% and females at 44.4%. Most of athletes were self employed with a few of them being employed in the armed forces of Kenya. Male athletes dominated long distance races like

marathon and half marathon at 64.5% whereas most of the female athletes were in middle distance races at 47.8%. Dietary intake of female athletes was lower as compared to those of males whereby 34.8% of male athletes met the RDA for energy and only 6.3% of females met the RDA for energy. None of the female athlete met the RDA for iron. The average individual Dietary Diversity Score was 4.34 with most consumed food group being starchy staple. Nutritional status of athletes was poor, female athletes were more likely to be underweight than males. A chi square test was done with a P value of 0.047 indicating that majority of the female athletes were underweight compared to the male athletes. Injuries were also quite common and female athletes were 5.8 times more likely to suffer injuries than the male athletes.

Results concluded that there was a significant positive association between performance and dietary intake of energy, iron and calcium. Athletes experienced injuries, loss of breath and fatigue which were the major hindrances to performance due to inadequate dietary intake of energy, iron and calcium. It was established that athletes had inadequate dietary intake of energy, iron and calcium with more of the female athletes not meeting the recommended dietary intake. The overall nutritional status of athletes as measured as BMI was poor.

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUNDINFORMATION

Training and competing in sports involve a range of activities of varying energy demands. Athletes face two main challenges in balancing their individual energy needs. The first one is inadequate dietary intake, while the second one is the propensity to restrict energy intake to maintain a low body mass and body fat level (Burke, 2006). Therefore, diet has the biggest impact on training and a good diet will help support consistent intensive training while reducing the risk of illness or injury, improving recovery time and maximizing exercise performance. In addition well chosen foods will help athletes train hard, reduce risk of illness and injury, and achieve performance goals, regardless of the diversity of events, environments, nationality and level of competitors (IAAF, 2007).

Kenyan athletes are renowned over the World for their endurance running in middle and long distance races. They have won approximately 40% of all major international long and middle distance races that they have participated during the last decade (Fudge et al., 2006). However, athletes sometimes get injuries which affect their performance. Their injuries are suspected to be caused by nutrient deficiencies. Their dietary practices, nutritional status and training habits have not been adequately studied. Therefore there is no structured nutrition education program for them. Understanding of the required practice of sports nutrition would help develop sound eating habits for optimal athletic performance and provide lifetime health benefits for the athletes (IAAF, 2007)

In Kenya 46.1% of women are iron deficient (KDHS, 2014). Research indicates that most of the female athletes have a higher prevalence of iron deficiency with 19% of female swimmers and runners having a problem of iron-deficiency anaemia affecting performance.

Iron is an example of micro nutrient that has been shown to either decrease or improve endurance performance depending on athletes iron status due to its important roles in delivering oxygen in the body through haemoglobin and myoglobin and in energy metabolism. Inadequate iron supply leads to iron deficiency anaemia which is associated with fatigue due to insufficient production of ATP, loss of breath during strenuous activity and reduced ability to exercise. Athletes are more vulnerable to iron deficiency due to hemolysis (physical sheering of red blood cells),sweating, menstrual bleeding for females, intestinal bleeding and athletes seeking hypoxic conditions to increase red blood cells density to enhance performance (Beard et al., 2000)

Calcium is an important micronutrient in sports especially for athletes because they are more likely to lose calcium as well as other minerals through perspiration. The mineral is involved in muscle contraction, transmission of nerve signals, blood clotting, and bone formation among others. This is essential to athletes because it prevents muscle cramps, unexpected muscle twitching, fatigue, strengthening bones and is needed to activate enzyme lipase which breaks down fat stores to produce energy (Lorincz et al., 2009)

Protein is essential for repair and maintenance of exercise induced damage tissues and muscle fibres, facilitating the replenishment of depleted energy stores and boosting immunity. Carbohydrates is the main source of energy, it is important to maintain blood glucose level during exercise and replaces muscle glycogen used during exercise. Adequate intake of carbohydrates will preserve protein use, enhances performance by delaying fatigue and allowing athlete to compete at higher levels for longer period hence maximizing on optimum performance (Burke et al., 2006)

1.2 STATEMENTOF THE PROBLEM

Over the years nutrition has been identified as the key component to athlete's performance. It is believed that aside from the limits imposed by hereditary and training no single factor plays a greater role in optimizing performance than diet (Tipton, 2010). Unfortunately, the dietary intake of many athletes follows population trend rather than public health or sports nutrition recommendations. For the female athletes they struggle to achieve a lean body mass resulting to increased risk of amenorrhea, negative energy balance and eating disorders which may affect the performance negatively whereas, male athletes encounter negative energy balance and not meeting RDA of nutrients due to inadequate nutrient intake that cannot be replaced due increased demand of nutrients.

Majority of Kenyan athletes have experienced injuries, which are presumed to be nutrition related during practice prior to local and international competitions and as a result have dropped out of the competition. The injuries may result from a negative energy balance and inadequate dietary intake of iron and calcium and other nutrients. The dietary practices of Kenyan athletes consist mainly of their basic staple diets based predominantly on energy rich foods for example cereals and root crops. These have been presumed to provide adequate nutrition for efficient and effective performance if adequately consumed. However, the effects of these dietary practices on nutritional status and training habits have not been adequately studied. There is therefore no structured nutrition training program for them..Very few studies so far have been conducted on dietary intake of energy, iron and calcium in association with performance in spite of athletics playing a significant role in publicizing Kenya as a country.

1.3 JUSTIFICATION

Over the past 20 years research has clearly demonstrated the beneficial effects of nutrition on athletic performance. Understanding of the required practice of sports nutrition would help develop optimal athletic performance and provide lifetime health benefits. The runners would

acquire the desired quality of running if they had adequate nutritional knowledge to propel them to practice the required nutrition and dietary habits. Sports have become a job opportunity for many youths especially those from Rift Valley region, and yet sport nutrition is not well recognized in Kenya. The results of the study would help to develop guidelines and training materials in sport nutrition to enhance performance. Since energy is important in fuelling the body and maintaining endurance in running, while calcium is important in muscle contraction and preventing hormonal decline (female athlete triad) during intense exercise among the female athletes and iron is important in oxygen circulation. Intense exercise causes an accelerated haemolysis of red blood cells reducing iron status thus causing reduction in performance. Nutrition education to sports persons would therefore concentrate mainly on these nutrients. This undertaking would be easy because athletes have realized that success in distance running results in financial rewards and ultimately elevates them and their families to top rank in the society.

For 'The Athletics Kenya, the body that governs athletics in Kenya, this information on dietary intake of energy, iron and calcium in association with performance would be important to help formulate nutritional policy that support athletes for optimal performance. The information will also help to foster the mission of the ‘Ministry of Sports and Youth Affairs’ and that of the Government in general.

1.4 OBJECTIVES

1.4.1 Main Objective

The main objective of the study is to assess the association of performance and injuries of athletes with dietary intake of energy, iron, calcium and the nutritional status.

1.4.2 Specific Objectives

1. To determine the demographic and socio- economic characteristics of the athletes.
2. To determine the level of performance during training of the athletes.
3. To determine the type and frequency of injuries suffered by athletes
4. To determine the dietary intake of energy, iron and calcium of athletes
5. To determine the nutritional status of the athletes.

CHAPTER TWO: LITERATURE REVIEW

2.1 SPORTS NUTRITION

Sports nutrition is a specialization within the field of nutrition that partners closely with the study of the human body and exercise science. It is a marginalized area of study yet nutrition plays a major role in good sports performance. The goals of sports nutrition are: to maintain glycogen levels, preventing glycogen depletion and optimizing energy levels and muscle tone (Heather et al., 2013). Sports Nutrition focuses its studies on the type, as well as the quantity of fluids and food taken by an athlete. In addition, it deals with the consumption of nutrients such as vitamins, minerals, supplements and organic substances that include carbohydrates, proteins and fats.

2.2 ENERGY REQUIREMENT FOR ATHLETES

Meeting energy needs is a nutrition priority for athletes. Carbohydrates, proteins and fats are the major sources of energy in the body. Body composition is one of the many factors that contribute to optimal exercise, thus maintaining a good body composition will ensure that athletes don't use the muscle store for energy. Although, usual energy intakes for many intensely training female athletes might match those of male athletes per kg body weight, some female athletes may consume less energy than the expected. Low energy intake (e.g., <1800-2000 kcal/d) for female athletes is a major nutritional concern because of a persistent state of negative energy balance that can lead to weight loss and disruption of endocrine function thus compromising performance among the athletes (Burke et al, 2004) Specific measurement techniques are used to estimate athlete energy needs, these include; Harris Benedict equation and Dietary recommended intake (Wilkins et al, 2000)

BEE adult women= 65.5+ (9.6×weight in Kgs)+ (1.85×height)+ (4.7×age)

BEE adult man = 66.0+ (13.7× weight in Kgs) + (5.0×height) + (6.8× age)

2.3 ENERGY METABOLISM

It is a process of generating energy in form of ATP from nutrients. It comprises a series of interconnected pathways that can function in the presence or absence of oxygen. These energy pathways includes: phosphagen system, glycolysis and aerobic energy pathways. They work together to make sure that the output of metabolic factory is meeting the muscle cell demand for ATP at a given time. By working together they maintain the ATP pool for various activities from rest to fast movement. During exercise an athlete will move through these metabolic pathways. As exercise begins, ATP is produced via anaerobic metabolism, as the exercise increases with an increase in breathing and heart rate, there is more oxygen available and aerobic metabolism begins and continues until the lactate threshold is reached. If this level is surpassed, the body cannot deliver oxygen quickly enough to generate ATP and anaerobic metabolism kicks in again. (Jason Karp, 2009)

2.3.1 Phosphagen Energy System

Phosphagen energy system is an anaerobic energy pathway also referred to as ATP-CP energy pathway which supplies about 10 seconds worth of energy and is used for short bursts of exercise such as a 100 meter sprint among the runners. This pathway doesn't require any oxygen to create ATP and does not use carbohydrate nor does fat rather the regeneration of ATP come solely from stored creatinine phosphate (CP) which is stored in skeletal muscle. It donates a phosphate to ADP to produce ATP. However, since there is limited amount of stored creatine phosphate and ATP in skeletal muscle, fatigue occurs rapidly due to depletion (Dunford M, 2006)

2.3.2 Glycolysis Energy System

It is used for all – out exercise lasting from 30 seconds to about 2 minutes and it the second fastest way to re-synthesize ATP. During this process carbohydrate inform of either blood glucose (sugar) or muscle glycogen is broken down through glycogenolysis to form pyruvate.

For every molecule of glucose broken down to pyruvate two molecules of usable ATP are produced. This pathway produces energy for short, high-intensity bursts of activity lasting no more than several minutes before the lactic acid build-up and it reaches a threshold known as the lactate threshold resulting to muscle pain, burning and fatigue making it difficult to maintain such intensity without other pathways thus athletes can increase their lactate threshold through proper endurance training. Though, very little energy is produced through this pathway, the trade – off is that energy is re-synthesized quickly (Glaister, M. 2005)

2.3.3 Aerobic Energy System

Aerobic metabolism fuels most of the energy needed for long duration activity. It uses oxygen to convert nutrients (carbohydrates, fats, and protein) to ATP. This system is a bit slower than the anaerobic systems because it relies on the circulatory system to transport oxygen to the working muscles before it creates ATP. Aerobic metabolism is used primarily during endurance exercise which is generally less intense and can continue for long periods of time. Most of the races including 5Km race use the aerobic systems. This system includes Krebs cycle (TCA cycle) and electron transport chain. When using carbohydrates, glucose and glycogen are first metabolised through glycolysis with resulting pyruvate used to form Acetyl CoA. The electrons produced in Krebs cycle are then transported through the electron chain where ATP and water produced. Fat is the major fuel for aerobic system and is the largest store of energy in the body (Heather et al. 2013)

2.4 MACRONUTRIENT REQUIREMENTS IN SPORTS

2.4.1 Carbohydrates Requirement

Carbohydrate primarily serves as an energy fuel particularly during intense exercise. It is the most useful in strenuous exercise and intense training compared with fat and protein. Therefore, carbohydrate intake should be adequate for physically active people so as to maintain the body's glycogen stores. During intense training, carbohydrate intake should increase upto 70%

of total daily calories so as to reduce mental fatigue and maintain carbohydrate oxidation rates. As work intensity increases, carbohydrate utilization increases. Nutritious dietary carbohydrates sources consist of fruits, grains, vegetables and tubers among others (Karelis et al, 2010)

Carbohydrate loading

It involves increasing the amount of carbohydrates eaten and decreasing activity several days before a high-intensity-endurance athletic event. Carbohydrate loading helps maximize energy storage (glycogen) and boosts the athletic performance. Athletes who compete in events lasting longer than about 90minutes may benefit from carbs-loading for few days prior to the competition. This strategy involves meeting the highest target for carbohydrate intake 9-12g/kg/day for 24-48 hours while exercise intensity is reduced and allowing muscle glycogen stores to be super- compensated above normal levels. As a result, an athlete gains fuel to exercise longer at their optimal output before they face a performance decline (Rodriquez et al., 2012)

Sporting performance and glycemic index

Glycemic index reflects how the blood glucose level of an individual will change after the ingestion of a food, beverage or a meal. The GI has become an increasing area of interest to athletes in the field of sports nutrition (Walton et al.1997). Some studies suggest that foods with a high GI cause a greater change in blood glucose and insulin which results in greater glycogen replacement in muscles. Therefore, high GI foods should be consumed during exercise because such foods will ensure rapid digestion and absorption leading to elevated blood glucose hence avoiding cases of hypoglycaemia (Manore,2004).Moderate GI foods have been shown to be eaten before an endurance exercise helps prevents the fall in blood glucose which is observed mainly during 90 minutes exercise (Kirwan et al. 1998) Low GI foods may be useful before exercise to provide a more sustained energy release and it will therefore

decrease the likelihood of creating hyperglycemia and hyperinsulinaemia at the onset of the exercise while providing exogenous carbohydrate throughoutthe exercise(Jamurtas et al, 2011)

2.4.2 Protein Requirement

Endurance athletes require considerable amounts of proteins just above the normal adult RDA (0.8g/kg) for the maintenance, repair and growth of lean muscle mass and optimum immune system function. Exercise burns up to 15% of the total amount of calories from muscle tissue. Therefore if an athlete does not provide enough protein as fuel thus more muscle tissue will be sacrificed through gluconeogenesis to provide fuel and preserve biochemical balance. A proper balance of plant and animal protein helps the body to maintain proper enzymes and hormones necessary for intense exercise (Philips et al., 2013).

2.4.3 Fat Requirement

Fat is stored as triglyceride in the adipose tissue and is the major source of energy in the body. Fat is an important fuel for runners and depending on the exercise intensity, may contribute more than half of the energy to fuel muscle contraction (Burke, 2004).Dietary recommendation for active individual like runners have typically focused on getting adequate intakes of carbohydrates, proteins and keeping fat intake to 25-30% of total energy intake per day. Fat is a necessary component of a normal diet since it provides high energy dense, essential element for cell membranes and is associated with intakes of fat soluble vitamins (ADEK). However, the type of fat consumed is important since long-term negative effects of high saturated fat diets on health are well known (Horvath et al., 2000).

2.5 MICRONUTRIENT REQUIREMENTS

2.5.1 Calcium

Calcium is an important element for athletes since they are at high risk of losing calcium as well as other minerals through sweat. The functions of calcium are; bone formation and teeth calcification, blood clotting, transmission of nerve signals and muscle contraction hence

preventing osteoporosis. Recommended dietary calcium for athletes ranges from 1000 to 1500mg/kg body weight per day. Good dietary sources of calcium includes; milk and milk products, leafy green vegetables, soy and tofu, fish, nuts and seed and calcium fortified foods(Zemel, 2000). Female athletes are more at risk of calcium deficiency than male athletes because of inadequate dietary intake of nutrients especially energy, calcium among other nutrients. Endurance exercise among the female athletes may cause hormonal declines than can stop menstruation (amenorrhea). This hormonal decline also compromises bone formation possibly leading to irreversible osteoporosis. For male endurance athletes inadequate dietary intake of calcium may result to testosterone deficits that also causes osteoporosis (McClung et al., 2014)

Female athlete triad

This is the combination of eating problems, menstruation problems and weak bones. Eating problems occurs when an athlete eats fewer calories than the RDA for calories. Some choose to limit their calories to improve appearance while others are unaware that they are not eating enough calories to meet their daily energy demands. This is also referred to as "disordered eating". Menstrual problems result from inadequate intake of calories and calcium causing menstrual period to become irregular a state called oligomenorrhea or causing menstrual period to stop a condition referred to as amenorrhea. Weak bones occurs when an athlete does not meet the recommended daily requirements of nutrients especially calcium and energy. Therefore, the combination of the three interferes with normal growth and development, increased risk of injury and loss of strength and endurance hence poor performance. (American academy, 2015)

2.5.2 Iron

Iron is a mineral found in small quantities (3-5g) in the body. This mineral plays a vital role in the transport of oxygen and carbon dioxide in the body. Most of the iron about two third is

found in haemoglobin with smaller amounts found in myoglobin, the cytochrome and other iron contained enzymes.RDA 18mg/day as the amount needed by females and 10mg/day for males. Iron sources are divided into heme and non – heme sources. Heme iron includes red meat, poultry, fish (meat factor). Non-heme iron includes spinach, broccoli, dried fruits, whole grain products and cereals. Heme is most readily absorbed by the body vary by 10 – 37% while non – heme absorption rates are 3 – 10 % (Alaunyte et al., 2014). Iron enhancers include meat factor, Gastric factor, ascorbic acid, malic acid, poultry and fish. Iron inhibitors include phytates, calcium and phosphate binding's agents, tea, coffee, soy proteins and excess bran/fibre. These are shown in Table 1.

Table 1: Dietary factors that affect iron absorption in the body

Enhancers	Inhibitors
Meat factor	Phytates
Gastric acid	Calcium and phosphates binding agents
Ascorbic acid(vitamin C)	Antacids
Malic acid	Tea (tannic acid)
Citric acid	Coffee
Poultry	Soy proteins
Fish	Bran /fibre

Sources; (Suedekum, 2005)

Stages of Iron Deficiency

Stage 1: **Pre latent iron deficiency**

Characterized by decreased or absent storage of iron. Levels of ferritin are considered low in this phase might be 60ng/dl and below while other iron parameters are normal

Stage 2: Latent iron deficiency

Characterized by decrease in iron supply to the developing cell as a result iron deficiency erythropoeisis occurs. Serum ferritin continues to decrease as well as other indices such as serum iron and transferring saturation. Haemoglobin may decrease slightly but it is still considered to be normal.

Stage 3: **Iron deficiency anaemia**

This results when serum ferritin falls below 12 g/dl and haemoglobin level below 15g/dl.

Exercise and iron status

Other than issues of inadequate dietary intake and increased iron loss due to menstruation, the most prevalent issues discussed as decreasing iron status are hemodilution, haemolysis and losses through GI bleeding and sweat. Hemodilution is an adaptation that occurs as an athlete begins an aerobic exercise program. As much as 15% expansion of plasma volume can be seen during the first 3 weeks of aerobic training (70% Vo2 max). The volume increases but there is no rise in the number of red blood cells therefore an initial decrease in haemoglobin value is seen. This is one of the factors behind sports anaemia. As an athlete becomes more conditioned there should be a levelling off of blood volume and haemoglobin values should return to normal. Hemodilution does not decrease iron stores but it is necessary to be aware of this adaptation when looking at an athlete's iron status. If the haemoglobin levels do not return to normal this can be an indication of possible anaemia. Evidence supported the idea that exercise cause an accelerated hemolysis or destruction of red blood cells affecting iron status and leading to increased iron requirement (Haymes et al., 1989). Values that can be affected by haemolysis include haemoglobin and hematocrit. The increased red blood cells destruction may be associated with a weakening of the cell membrane possibly due to the trauma of the raised circulatory rate, elevated body temperature compression of the red blood cells by muscular

activity. This could explain why runners are seen to be at high risk of anaemia than other sports. Hemolysis can result in increased iron excreted in urine and could be the primary cause of decreased serum ferritin found in athletes. The loss of iron through sweating must also be considered. Evidence suggests that women may lose up to 0.4mg Fe/litre of sweat while running (Andrews, 2000).

Sports anaemia

The term sports anaemia described in athletes is not considered as true iron deficiency anaemia. Sports anaemia is characterized by iron status measure such as serum ferritin, hematocrit and haemoglobin that are less than usual reference standards. In this condition red blood cells appear normal in size and colour. For some athletes, low values may be due to a physiological adaptation to exercise and therefore not representative to true iron deficiency anaemia. Although iron deficiency anaemia and sports anaemia share same characteristics like low haemoglobin, low hematocrit and low serum ferritin levels, sports anaemia differs in that there is insufficient iron present in the bone marrow to maintain the continuous production of haemoglobin (Papanikolaou et al., 2005)

2.6 Fluids Requirement for Athletes

It is important for an athlete to make sure that he/she gets the recommended amount of water before, during and after exercise so as to prevent dehydration. Benefits of good hydration are; enhancing performance, maintaining plasma volume, regulating body temperature and preventing thermal stress, promoting detoxification- flushing out bad toxin while bringing out good nutrients into the cells, keeping joints and muscles lubricated , keeping blood pressure in normal ranges, delaying fatigue and reduce injuries associated with dehydration. Both plain water and sport drink are good for hydration. Whereby, plain water alone is effective for fluid replacement especially in low intensity and short distance running. Sports drink is effective in long distance running and high intensity training. This is because sports drink contains added

carbohydrate and electrolytes. This will enhance performance because carbohydrate provides a muscle energy and electrolyte like sodium stimulate thirst mechanisms and fluid retention, maintaining plasma electrolyte balance, promoting both carbohydrate and water uptake in the intestines(Miller et al, 2015).Fluid lose is mainly through sweat and little loss faecal, urine and intestinal bleeding. Sweat loss ranges from 0.4-1.8 L per hour depending on individual athlete, intensity of exercise and weather. Therefore, it is essential that endurance athletes replace fluid loss via fluid intake containing about 4% to 8% of carbohydrate solution and electrolytes respectively. It is recommended about 500ml of fluid intake 1-2 hours before an event and continued intake of cool and cold drinks during the exercise for about 600-1200ml per hour for intense and prolonged exercise so as to replace fluid loss. There are factors that determine the quantity of fluids to be consumed, these includes; intensity of exercise, sweat rate, environment and duration of the exercise (Gleenson et al. 2013). Approximately 60% of water is from ingested fluids, 30% from ingested foods and 10% generated during metabolism that is 1 ml for every calorie consumed hence, the recommended amount of fluids for male athlete is 3.7 L/day and for the females athlete is 2.7 L/day. (Dellaville et al, 2010)

2.7 INJURIES IN SPORTS

Sports injuries are injuries that happen when playing sports or exercising. These can result from muscle imbalance, weakened muscle/bones/tendons, fatigue, hormone levels (females), dehydration, poor training methods, overtraining; poor playing equipment and above all poor nutrition (lack of specific nutrients). Injury is an inevitable part of training and competition irrespective of how diligent athletes are in preparation, conditioning and adherence to the sport's code of conduct and rules of participation. Ideally, a sports medicine professional would be in attendance at every event and training session. The most affected parts are muscles, tissues and bones, and the largest portion of muscle injuries occur during sports activities corresponding to 10 to 55% of all injuries (IAAF, 2013). The muscles most commonly affected

are the hamstrings, quadriceps and gastrocnemius. These muscles go across two joints and are more subject to acceleration and deceleration forces. One of the biggest fears for athletes, who engage in high-speed running, is the hamstring strain. Whereby, one study reported that hamstring injuries make up 26% of all injuries in athletics, with the majority being in sprint events (Hewett et al., 2005). Another study of university-level sprinters and jumpers in the USA found a hamstring strain incidence rate of 24% over a two-year period. The hamstring injuries present great variety of incidence and may correspond to 12 to 16% of injuries in sports like soccer, rugby and athletics (Monte, 2011). Most common injuries encountered by Kenyan athletes are hamstring, tendon, muscle cramps, ankle, fatigue, knee among others.

Fatigue has always anecdotally been connected to hamstring strains and other muscle injuries. Research has shown that there is a higher incidence of hamstring strains in the latter stages of competitions and training sessions. Fatigue can cause not only changes in muscle strength and durability, but also alter running mechanics in a manner that can make an athlete, while running at high velocities, more susceptible to hamstring strain (Drezner, 2005) Injury rates are higher in American runners than in Kenyan runners. This is evident in their running technique, which is a forefoot running style learned early in life, under barefoot conditions. Most Kenyan runners learned to run fore footed the correct way, without interference and it was barefoot running that was the basis for shorter Achilles tendon moments arm therefore certain modes of strength training appear to have little effect on injury prevention.

2.8 Assessment of Performance in Sports

Performance assessment is a valuable tool that provides quality information to structure and plan training more effectively. This is a method to assess an athlete's level of fitness in a controlled environment. Tests such as maximal oxygen uptake, pulmonary function and lactate threshold assessments are conducted using various measurement tools and equipment to

determine your fitness level. Athletes are tested for the following reasons: to provide accurate benchmark of training fitness that will allow determination of heart rate, lactate threshold and power training zones, to identify areas of strength and weaknesses that may need to be worked on and repeat testing provides valuable evidence of improved performance and quantifies potential to improve. These tests also allow precise analysis of the physiological changes that might happen to athletes as they exercise.(Atkinson et al., 2001)

The performance of athletes can be categorized into excellent, good, fair and poor. This may be established through ranking the best world record performance and the best performance achieved by individual athlete. Excellent performance can be measured as difference between the best world record and the best record achieved by individual athlete record achieved is less or equal to one minute, Good performance may be measured as greater than one minute and less than three minutes, Fair performance; greater than three minutes and less or equal to five minutes and Poor performance; greater than five minutes.

2.9 Nutritional Assessment for Athletes

Athletes are required to undergo a complete screening that includes a variety of medical, physiological, psychological and nutritional assessment regularly. A complete nutritional screening should include a dietary assessment, biochemical, anthropometric testing to assess body composition, and a clinical assessment of the athlete's appearance and well being. A complete evaluation of an athlete's dietary patterns is time-consuming and requires special trained expertise. There are a number of methods that can be used to monitor dietary intake of each nutrient and each has its merits and demerits which contributes to biases and errors to the information collected. This includes 24 hour recall, food records, food frequency questionnaire, individual dietary diversity score and food diary (Driskell, 2002; Wolinsky, 2002).

Therefore, it is important to get all the information provided by dietary assessment tools so as to obtain the information on: the athlete's lifestyle, nutrition knowledge, economic level, food availability& accessibility, social cultural factors, and time so as to determine the factors that will influence the athlete's present dietary patterns and their ability to make changes. The data collection process should include a thorough face to face interview with an athlete to obtain information such as location they live, who cooks their meals, the type of food they consume and the amount, how often they travel, how often they eat away from home, how and why they have chosen their present eating patterns, what supplements they take, and which kind of exercise they practice. Hence, the athlete's eating patterns can then be monitored and assessed by a specialist (Jonnalagadda, 2001).

2.9.1 Twenty - Four - Hour Recall

A 24 – hour dietary recall is a structured interview intended to capture detailed information about all foods and beverages (and possibly dietary supplements) consumed by the respondent in the past 24 hours, most commonly from midnight to midnight the previous day. This open – ended response structure is designed to prompt respondents to provide comprehensive report on all foods and beverage consumed, time of the day, preparation method, ingredients used and portion size (Subar et al., 2001)

2.9.2 Individual Dietary Diversity Score (IDDS)

Dietary diversity is a qualitative measure of food consumption that is a proxy for nutrient adequacy of diet of individuals and it also reflects household access to a variety of foods. ((Ruel, 2003)

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 STUDY DESIGN

The design of the study was cross sectional. This is a type of observational study that analyzes data collected from a population, or a representative subset, at a specific point in time.

3.2 METHODOLOGY

3.2.1 Study Setting

The study was conducted in Iten Elgeyo Marakwet County. It is located in the former Rift valley province and its capital is Iten town. Within the town is Iten training camp which accommodates around 1500 runners. The topography of the area consists of Kerio River binding the county on the eastern side. It also consists of Elgeyo Escarpment which is rugged giving more of relief difference. The area has a good climate with temperatures ranging from 14^0C - 24^0C. The rainfall is evenly distributed ranging from 400 -1400mm annually. Iten is at altitude of 2400m above the sea level making it the "home of champions" due to high altitude allowing athletes train in less oxygen and overtime the body will adopt to reduced oxygen and producing more red blood cells thus enhancing performance. The county has a population of 369,998 with a population density of 122 per km^2 and the tribes residing in the county are Keiyos and Marakwets (KNBS, 2009). The county has 373 primary schools and 75 secondary schools several health facilities including 3 District Hospitals, 2 Sub- District Hospitals, 5 Dispensaries, 89 Health Canters and 1 Medical Clinic. The economic activity in the county is characterized by mixed farming which consists mainly of livestock and subsistence farming. Other activities include small business, tourism, sports and fluorspar mining in Kerio Valley. The positioning of Iten is shown in the map in figure 1.

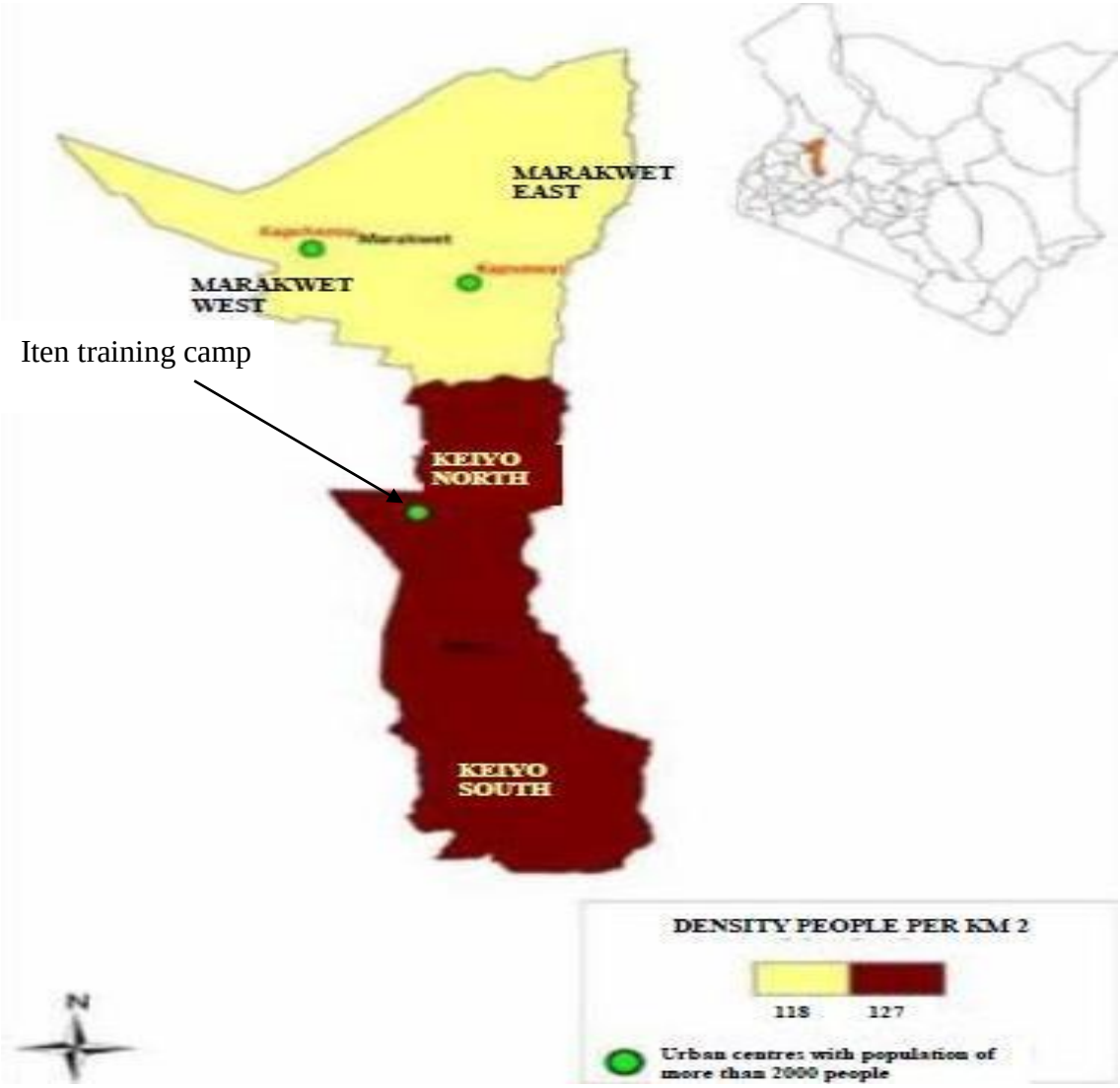

Figure 1: Map of Elgeyomarakwet County

3.2.2 Study Population

Study population comprises of athletes training in Iten training camp including both elite and amateur, also males and females. The population comprises of long distance athletes and middle distance athletes

Inclusion criteria

Middle distance (3000meters, 5000meters, and 10000meters) and long distance runners (21kilometers and 42kilometers) were included in the study. Both male and female athletes between ages 18 – 30years were included. The upper age of above 30 years was not included because of their small numbers in the camp according to training coaches from Iten camp

Exclusion criteria

All athletes training in other camps apart from Iten training camp were excluded from the study. Short distance (100meters, 400meters, and 800 meters) runners were excluded from the study. All the runners below 18years of age and those above 30yearsof age were excluded from the study. This is because majority of athletes training in Iten camp are between ages 18 – 30 years; this information was obtained from the training coaches from Iten training camp.

3.2.3 Sampling Frame

Athletes were selected according to the races they participated in. The two categories selected were middle distance running and long distance running. These are shown in Table 2.

Table 2: **Types of races**

Males	**Frequency**	**Females**	**Frequency**
Middle distances races			
3000meters	13	3000meters	9
5000meters	9	5000meters	14
10,000meters	46	10,000meters	20
Long distance races			
Half Marathon(21km)	61	Half Marathon(21km)	27
Full Marathon (42km)	63	Full Marathon (42km)	20

3.2.4 Sample Size Determination

Fischer's et al., (1991) formula will be used in calculating sample size as shown below;

$$n = \frac{Z^2pq}{d^2}$$

Where n=minimum desired sample size

Z= value for the chosen confidence interval 1.96=95% confidence interval

p= prevalence estimates.

q= 1 – p the estimated proportion

d^2= degree of desired accuracy/precision for the estimate (5% or 0.05)

$$n = \frac{(1.96)^2 \times 0.5 \times 0.5}{0.05^2}$$

$$n = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2}$$

=384

Since the population is less than 10000the following modified formula will be used

$$nf = \frac{n}{1 + (n/N)}$$

Where n = minimum desired sample

N= estimated population of the study (900)

$$\frac{384}{1 + (384/900)}$$

=269

Attrition level of 5% = 282

Iten training camp consist of around 900 athletes with 600 males and 300 females. It consists of all level of athletes; elite athletes and amateurs.

3.2.5 Sampling Procedure

A purposive sampling was used to select Elgeyomarakwet County, Iten training camp. Sampling scheme is shown in the figure below:

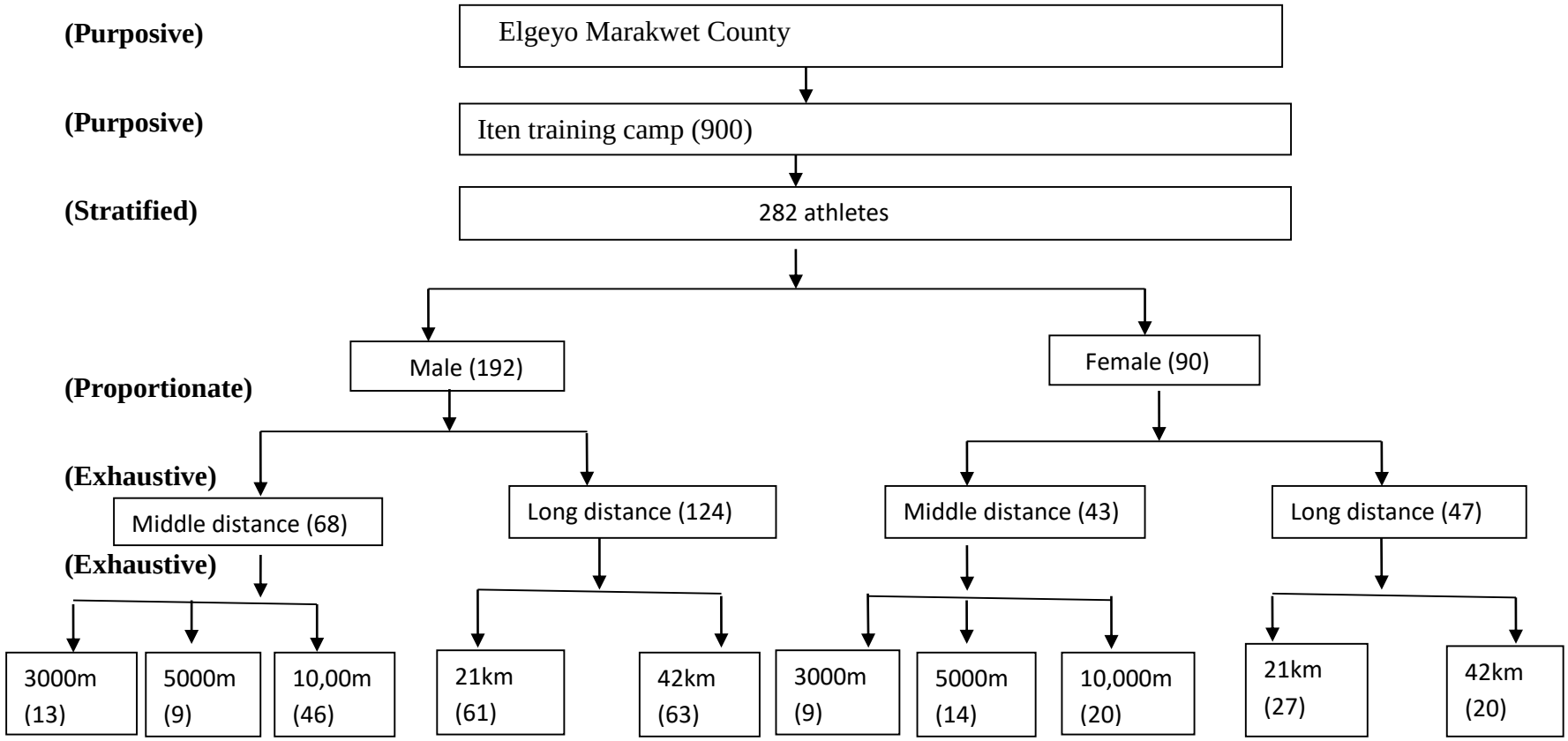

Figure 2: Sampling procedure

It was indicated by the coach that the ratio of male to female was 2:1. Out of 900 persons in the camp, there were 613 males and 287 females. Stratified sampling was done in accordance to age bracket of 18 – 30 years and middle and long distance runners and a sample of 282 was attained, whereby proportionate to size sampling was done to attain 192 males and 90 males. Exhaustive sampling was then done to get those in long distance races and middle distance race.

3.2.6 Data Collection Tools and Procedures

Data was collected using semi structured questionnaire, 24 hour recall, anthropometric measurements and individual dietary diversity score.

Questionnaire administration

A pre-tested semi structured questionnaire was used to obtain information on the socio-demographic and socioeconomic characteristics, type and frequency of injuries of the athletes and the type of race for each athlete. The questionnaire is structured to contain 24-hourr recall dietary diversity score and anthropometry. The questionnaire was administered and the respondents were expected to tick according to their corresponding category. Questions were coded for easier analysis.

Twenty – four -hour Recall

This is where an individual respondent was asked to list all the foods and beverages consumed during the last previous 24 hours. The respondent's had each portion of their food weighed before they ate. The leftovers from the amount served was weighed again and subtracted from the total amount served. The principal investigator got a detailed account of the amounts of ingredients used in food preparation, total food prepared and the amounts served for each athlete at every meal. The measures used in assessing the foods were included a diet scale to 1gm and a liquid measuring jar and model utensils (cups, spoons, plates, measuring jars,

sufurias). A list of conversion factors was determined and used to compute the total food consumed by the athletes. The national food composition tables (sehmi, 1993) for Kenya and a Nutri – survey software were used to compute the energy, calcium and iron consumed by an individual athlete in 24 hours.

Anthropometrical measurements

Weights and heights measurements were taken twice for each athlete included in the study population. The weights were taken using standard bathroom scale (Seca) in kilograms. In assessing the weights the respondents were requested to remove excessive clothing and shoes. The weighing scale was placed on a flat hard surface and calibrated using a known standard weight then the weights were recorded to the nearest 0.1kgs. The heights were measured using a stadiometers (seca). The respondents were requested to stand straight on the height board with their feet together, knees straight on the height board, buttocks and shoulder blades in contact with the vertical surface of the height board. The measurements were done to the nearest 0.1centimetre at eye level with the headboard. The height and weight were used to calculate Body Mass Index (BMI) using the formula: BMI= Weight (kg)/Height (m^2) and compare it with a reference population according to WHO (2006) reference standards. The results obtained were used to describe the nutritional status of athletes.

Individual dietary diversity score

The data collected using the mentioned tool was used to determine the diversity and adequacy of the athlete's diet. The athletes were requested to recall all foods they consumed in the past 24 hour period and each food mention as eaten are recorded by underlying and a score of one is given for every food group mentioned. The total score was then tallied and recorded as dietary diversity score so as to get individual's dietary diversity. 16 food groups were used according to FAO (2010).

Data on dietary diversity score was awarded to the individual respondent scores as follows: Less than 3 food groups shows low dietary inadequacy of the food groups taken, 4-7 food groups indicates moderate food adequacy and greater than seven food groups shows high dietary adequacy.

Performance measurement

The performance was categorized into excellent, good, fair and poor. This was established through ranking the best world record performance and the best performance achieved by each athlete. Since there were different races, the performance were graded in terms of time taken for each race. The reference was Rio Olympic time record. This is shown in Table 3.

Table 3: **Determination of Performance**

Type of race	**World Record Time**	
	Female	**Male**
3000m	8 mins	7mins
5000m	14mins	13mins
10,000	28mins	26min
21km	66mins	58mins
42km	138mins	122mins

Source: Rio Olympics, 2016

Performance Assessment

Excellent Difference between world record and the best record achieved by individual athlete record achieved is less or equal to one minute

Good Difference between world record and best record achieved by individual athlete is greater than one and less or equal to three minutes

Fair Difference between world record and best record achieved by individual athlete is greater than three and less or equal to five minutes

Poor Difference between world record and the best record achieved by individual athlete is greater than five minutes

Recruitment and training of field assistants/enumerators

Recruitment: Three field assistants were recruited according to the following criteria: completed secondary school education, must have a good communication in English and Kiswahili and Kalenjin, Good interpersonal skills with experience in community field work. The persons identified were interviewed and trained.

Training: Three selected enumerators were given a two day intensive training. Prior to the training, a training curriculum will be developed by the principal investigator and served as a guide during the training sessions (appendix 7). The training consisted of brief explanations of the study objectives, aim and purpose of the study. They were trained on how to use the study tools (questionnaire, 24 hour recall and anthropometric tools), a thorough review of the questionnaire, and role play of the interviewing techniques, taking anthropometric measurements and also training on the ethics during field work. Training for anthropometry included practical sessions of weight and height measurement and training on how to conduct a 24 hour recall using a diet scale.

3.3 DATA QUALITY CONTROL

Data quality control measures were employed throughout the data collection process.

3.3.1 Minimizing Bias

To obtain accurate and reliable results standardization tests was done on the bathroom weighing scale every time weighing is done. To assure validity of anthropometric measurements two recording were taken for each measurement. The respondents were informed of the study objectives and its purpose in the consent form in order to reduce the respondent bias.

3:3:2 Training of Field Assistant

For efficient and accurate data collection an educated and well experienced field assistant was recruited for the study. All the interviews were done by the principal investigator personally to improve the validity of the data.

3:3:3 Reviewing of the Questionnaires

Every completed questionnaire was cross-checked for any anomalies each and every day. The principal investigator examined the questionnaires to check for completeness, accuracy in recording the measurements, consistency of the answers as well as correct filling of the questionnaires. Any errors encountered during the cross checking of the questionnaires was corrected immediately.

3:3:4 Accuracy of Anthropometric Measurements

Accuracy of anthropometric measurements was ensured through proper training and supervision by the principal investigator during the measuring exercise. The height and weight measurements were taken twice and then averaged. This was helpful in improving the precision of the field assistance. The widest acceptable difference in height and weight was 0.1cm and 0.5kg respectively.

3:3:5 Supervision

All the activities during the study period were closely monitored and supervised. The presence of the principal investigator throughout the study, supervising and participating in all the activities such as taking anthropometric measurements, interviewing and conducting a 24hour recall improved the quality of data collected. The supervisors from the University of Nairobi supervised the field work data collection and provided technical assistance that would ensure high quality data

3.3.6 Pre – testing of tools and equipments

Pre – testing of the tools was conducted on 10 athletes in Chepkorio training camp before the actual study. This would ensure collection of the required data during the actual study and testing the applicability of the tools to be used. Relevant modifications to the tools (especially the questionnaire) were made prior to the actual study.

3.4 STATISTICAL DATA ANALYSIS

Data entry and analysis was carried out using statistical package for social science SPSS (20.0). Cleaning was done by running frequencies and using explores to check normalities, any missing data, outliers as well as consistency of responses between questions. Demographic and socio-economic data were analysed using descriptive statistics and simple frequencies, means, ranges, proportions and percentages. Chi-square test was used to examine association between variables. Chi–square was also used to determine the statistical significance concept. Linear regression was used to determine the association between variables in that it measures the extent to which two variables are linearly related and logistic regression was used to determine the strength of association and to predict the odds ratio. The results were presented in tables and figures like pie chart and bar charts.

3.5 ETHICAL CONSIDERATIONS

To gain legal grounds for undertaking the study, ethical and research clearance was sought from Kenyatta National Hospital/University of Nairobi ethics and research committee. A research permit was obtained from the National Council of Science and Technology in the Ministry of Higher Education, Science and Technology. The study proposal was approved by the Board of Post Graduate Studies (BPS) of the University of Nairobi. The permission was also obtained from Athletics Kenya Federation. Iten camp management was informed about the study purpose, objectives and methodology that would be applied during the study.

All the tools that were applied throughout the research such as questionnaire anthropometry tools, weighed food records were non-invasive. Informed consent was obtained from individual athletes before the commencement of the study. All the data collected were treated with utmost confidentiality and privacy throughout the process. No names/participant identifiers would appear anywhere be it in the questionnaires or the final report.

CHAPTER FOUR: RESULTS

This chapter presents findings of the study. This includes results of socio-demographic and socio-economic characteristics, performance, common injuries suffered by athletes' dietary intake of energy, iron and calcium and nutritional status. The results are presented in terms of narratives, tables and figures. The results are also presented in order of specific objectives.

4.1 SOCIO-DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

4.1.1 Socio Demographic Characteristics

A total of 282 athletes were assessed in the study with 192 males and 90 females. Most of male athletes were between ages 25 -30 years while most female athletes were between ages 18 – 24 years. Over 60% of both males and females were single. Majority of athletes (97.8%) had attained at least primary education with a small percentage having tertiary education. With regards to ethnicity majority of athletes were from the Kalenjin community. The results are shown in Table 4.

Table 4: Socio Demographic characteristics of athletes

Socio Demographic characteristics	Male (n = 192)		Female (n = 90)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Age of athletes (years)				
18 – 24	90	46.9	56	61.2
25 – 30	102	53.1	34	37.8
Marital status				
Single	121	63.0	55	62.1
Married	71	37.0	35	38.9
Education level				
Never attended school	1	0.5	2	2.2
Primary level	66	34.4	29	32.2
Secondary level	116	60.4	50	55.6
Tertiary level	9	4.7	9	10.0
Ethnicity				
Kalenjin	160	83.3	73	81.1
Kikuyu	4	2.1	7	7.8
Turkana	11	5.7	0	0.0
Masai	7	3.7	1	1.1
Samburu	6	3.1	2	2.2
Kisii	3	1.6	4	4.4
Kamba	1	0.5	3	3.4

4.1.2 Socio Economic Characteristics of Athletes

The athletes were placed into the three socio–economic categories of the country as follows: higher class (70,000 KShs per month), middle class (20,000 to 70,000 KShs per month) and lower class (below 20,000KShs per month). There were slightly more females in the lower class than males, slightly more males in middle class than females and slightly more males in the higher class than females. It was indicated that apart from athletics, majority of the athletes obtained their income from either farming or successful businesses. A small number were employees of the armed forces of Kenya. These results are shown in Table 5.

Table 5: Socio Economic characteristics of athletes

Socio Economic characteristics	Male (n =192)		Female (n = 90)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Socio Economic class				
Lower class	75	39.1	41	45.6
Middle class	94	48.9	40	44.4
Higher class	23	11.9	9	10
Occupation				
Farmer	58	30.2	19	21.1
Business	41	21.4	23	25.6
Casual labourers	74	38.5	38	42.2
Student	3	1.6	3	3.3
Armed force	16	8.3	7	7.8

1 KShs = $US 0.01

4.2 PERFORMANCE AND EXERCISE

4.2.1 Distribution of Athletes by Sex and Race

The races were grouped into two races; middle distance (3000m, 5000m and 10,000m) and long distance (21km and 42km also known as half marathon and full marathon respectively). In all the five races, by far men were the majority except in 5000m race. This was even more pronounced in the marathon races. These results are shown in Table 6

Table 6: Distribution of the Athletes by Type of Race

Type of race	Males (n = 192)		Females (n = 90)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Middle distance				
3000 m	13	6.8	9	10.0
5000m	9	4.7	14	15.6
10,000m	46	23.9	20	22.2
Long distance				
21 Km	61	31.7	27	30.0
42 Km	63	32.8	20	22.2

4.2.2 PERFORMANCE BY ATHLETES

The performance was categorized into excellent, good, fair and poor. This was established through ranking against world record for the event and the best performance achieved by individual athlete. Excellent performance was measured as difference between the best world record and the best record achieved by individual athlete record achieved is less or equal to one minute, Good performance; greater than one minute and less than three minutes, Fair performance; greater than three minutes and less or equal to five minutes and Poor performance; greater than five minutes.

Of the male athletes, 17.7% had excellent performance slightly lower than the female athletes with 21.1%. More females had poor performance as compared to male athletes as shown in Table 7.

Table 7: Distribution of athletes by sex and performance

Performance levels of athletes	Male (n = 192)		Female (n = 90)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Excellent	34	17.7	19	21.1
Good	107	55.7	44	48.9
Fair	32	16.7	13	14.4
Poor	19	9.9	14	15.6

4.2.3 Hindrance to Expected Performance

According to the athletes, major hindrances to expected performance were injury, running out of breath and fatigue. More male athletes experienced injury as a major hindrance to their expected performance compared to the female athletes. The hindrance to expected performance of most of the female athletes was running out of breath and fatigue as compared to male athletes. These results are shown in Table 8.

Table 8: Hindrance to expected performance by athletes

Hindrance to expected performance	Male (n = 192)		Female (n = 90)	
	Frequency	**%**	**Frequency**	**%**
Injury	147	76.6	32	35.6
Running out of breath	19	9.9	29	32.2
Fatigue	26	13.5	29	32.2

4.3 INJURIES SUFFERED BY ATHLETES

4.3.1 Common Injuries suffered by Athletes

Injuries that were common to athletes included hamstring, tendon, muscle cramps and ankle injuries yet majority of the athletes assumed that it was normal to suffer from this common injuries. There was a very small difference between female and male who suffered from common injuries that affected their performance. More males suffered from hamstring while more females suffered from muscle cramps. These results are shown in Table9.

Table 9: Common injuries suffered by athletes

Common injuries	**Male (n = 192)**		**Female (n = 90)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Hamstring	83	43.2	17	18.8
Tendon	32	16.7	19	21.1
Muscle cramps	37	19.3	39	43.3
Ankle	40	20.8	15	16.7

4.3.2 Association between Common Injuries and Sex

A chi square test and odds ratio was used to determine the association between sex and injuries suffered by athletes. From the chi square test, the findings indicated that more females were at risk of getting injured than males with a P value of 0.002.Odds ratio indicated that females were 5.8 times more likely to suffer from injury than male athletes. These results are shown in Table 10.

Table 10: Association between sex and injuries

Experiencing injuries					OR	95%CI	P value
	Yes		No				
	Frequency	%	Frequency	%			
Male (n=190)	160	83.3	32	16.7	5.8	1.726-1.9487	0.002*
Female(n=92)	87	96.7	3	3.3			

*Significant at <0.05
OR – odds ratio
CI – confidence interval

4.4 DIETARY INTAKE OF ENERGY, IRON AND CALCIUM

Significantly higher percentages of males met the RDA for the three nutrients than females. No female met the RDA for iron. The higher percentage that met the RDA for any of the three nutrients among males and females was about 35%. The results are shown in the Table11.

Table 11: Dietary Intake of Energy, Iron and Calcium

Nutrient intake	RDA for Nutrient	Range of RDA measured	% RDAs measured	% of sample meeting RDA	P value
Energy (Kcal)					
Male	2200 kcal	1800 – 2900kcal	81.8 – 131.8	34.8	
Female	2100kcal	1000-2200kcal	47.6 – 104.7	6.3	0.002*
Iron					
Male	10mg	7 – 11mg	70 – 110.0	21.7	
Female	14mg	6 – 9mg	42.9- 64.3	0.0	0.048*
Calcium					
Male	1000mg	700 – 1200 mg	70.0 – 120.0	30.4	
Female	1000mg	500 – 900mg	50.0 – 90.0	12.3	0.042*

***significant <0.05**

(Rodriguez, 2010)

4.4.1 ASSOCIATION BETWEEN PERFORMANCE AND DIETARY INTAKE OF ENERGY, IRON, CALCIUM AND NUTRITIONAL STATUS

Linear regression model was used to compute the association between performance and dietary intake of energy, iron, calcium and nutritional status. The findings indicated a positive association with a 2 tailed sigma of < 0.05. These results are shown in Table 12.

Table 12: Association between performance and dietary intake of energy, iron, calcium and nutritional status

	ß	R	r^2	Sig	Lower CI(ß)	Upper CI(ß)
Energy	1.186	0.611	0.373	0.002*	0.507	1.865
Iron	0.486	0.515	0.266	0.001*	0.224	0.748
Calcium	0.002	0.300	0.090	0.004*	0.057	0.064
Nutritional status	0.588	0.561	0.315	0.000*	0.486	0.690

***significance level<0.05

ß – Regression coefficient

r – Correlation coefficient

Sig – significance level

4.5 Categories of foods consumed by athletes

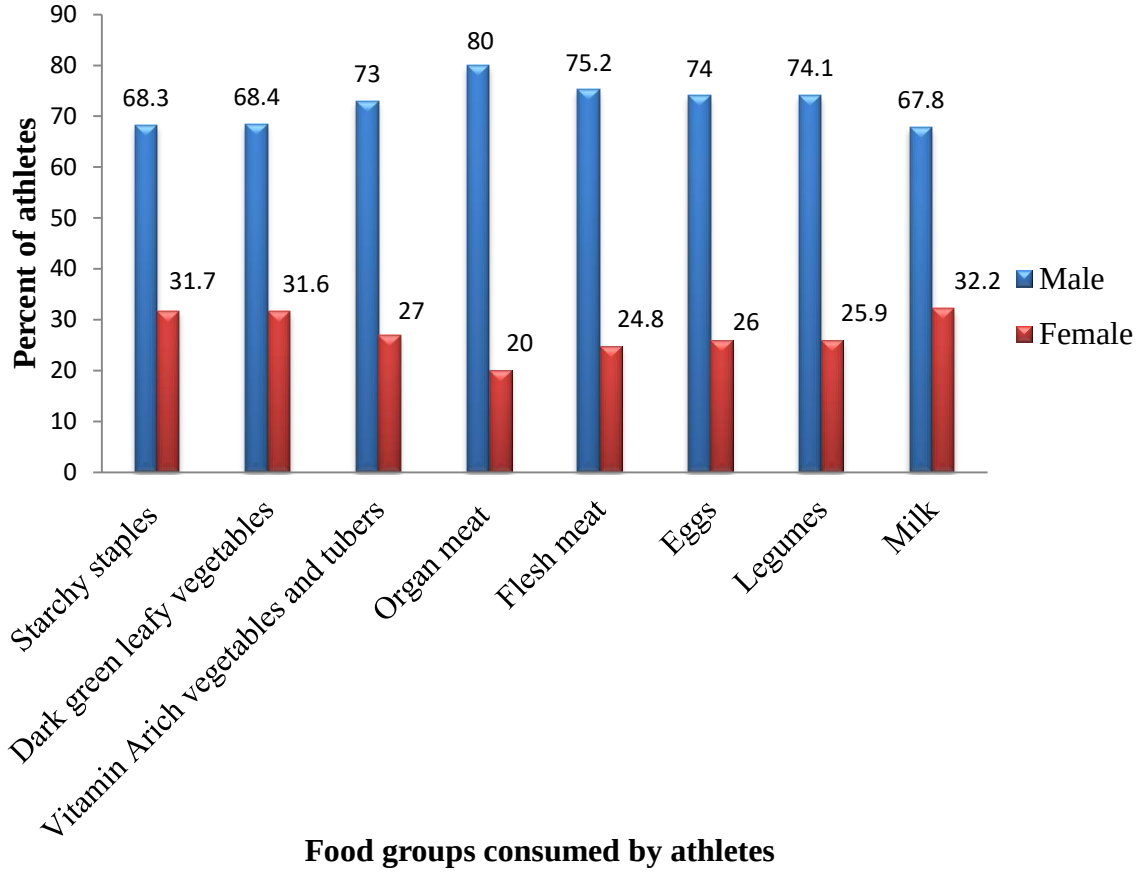

Figure 3: Categories of food groups consumed by athletes

Figure 4 shows the food groups as classified by FAO, (2010). From the study male athletes had the highest percentage in consumption of different food groups as compared to females with smaller percentage of consumption. Regression was used with a p value of 0.012 and odds ratio indicating males were 1.5 times more in consumption food categories than females. Starchy food had the highest consumption of 68.3% and 31.7% for males and females respectively. Consumption of milk and milk products which may have been consumed in tea, plain or fermented was also high. Fish, flesh meat, eggs and organ meat were the least among athletes.

4.6 INDIVIDUAL DIETARY DIVERSITY SCORE BASED ON 24 - HOUR RECALL

Individual dietary diversity score (IDDS) were used to evaluate the dietary practices in terms of the numbers of food groups consumed out of the FAO recommended. Dietary diversity scores were calculated as the number of food groups consumed over a period of 24-hours. FAO cut-off points were used to classify Dietary Diversity Scores. The mean IDDS for the athletes was 4.34 ± 0.45. Significantly higher percentages of males had higher IDDS than females while significantly higher percentages of females had moderate IDDS than males. No athlete from the two groups had low IDDS. These results are shown in Table 13.

Table 13: Dietary Diversity Scores of athletes

Dietary diversity score		**Males (n = 192)**		**Females (n = 90)**		χ^2	**P value**
		Frequency	**%**	**Frequency**	**%**		
1 – 3	**Low**	0	0.0	0	0.0		
4 – 7	**Moderate**	119	62.0	74	82.2	11.625	0.001*
8 and above	**High**	73	38.0	16	17.8		

χ^2 = Chi square ***Significant <0.05**

4.7 NUTRITIONAL STATUS OF ATHLETES

The nutritional status of athletes was measured as BMI. Almost 50% of the male athletes had normal BMI as compared to 31.1% of the female athletes. More female athletes at 5.6% were severely underweight compared to male athletes at 1.6%. None of the athletes was above normal BMI with the highest having BMI of 22Kgs/M^2. A chi square test was done with P value of 0.047 indicating that majority of the female athletes were underweight compared to male athletes. And odds ratio was done showing that female athletes were 0.701 times more likely to be underweight than male athletes. These results are shown in Table 14.

Table 14: Nutritional status of athletes measured as BMI

Nutritional status	Cut off BMI (Kg/M^2)	Male (n = 192)		Female(n= 90)		χ^2	P value
		Frequency	%	Frequency	%		
Severely underweight	<16	3	1.6	5	5.6		
Moderately underweight	16.0-16.99	33	17.2	21	23.3	7.958	0.047*
Mildly underweight	17.0-18.49	62	32.3	36	40.0		
Normal	>18.5-24.	94	48.9	28	31.1		

*significant at <0.05, χ^2 = chi square

4.8 ASSOCIATION BETWEEN DIETARY INTAKE OF CALCIUM, ENERGY AND IRON WITH INJURY

Logistic regression was used to show relationship between dietary intake of calcium, energy and iron with injury. Injury was statistically significant (P<0.05) in associated with dietary intake of calcium and iron but not energy. This indicated that insufficient intake of calcium and iron would make athletes more likely to suffer injuries during the event. The Exp (B) indicated that athlete's who had inadequate dietary intake of calcium and iron were about two times more likely to suffer injuries than those who had sufficient intakes. Inadequate dietary intake of energy was not significantly associated with injury. These results are shown in Table 15.

Table 15: Association between dietary intake of calcium, energy, and iron with injury

Energy and nutrient intake	ß	Wald	Sig	Exp (B)
Calcium	0.012	5.385	0.020*	1.989
Energy	0.003	3.521	0.061	1.003
Iron	0.682	5.495	0.019*	1.979

*significant at p<0.05 ß-regression coefficient
Wald- Wald statistics Sig – significance level Exp (B) - odds ratio

4.9 ASSOCIATION BETWEEN DIETARY INTAKE OF CALCIUM, IRON AND ENERGY WITH FATIGUE

Association between dietary intake of energy and iron was statistically significant with P<0.05 while association between fatigue and dietary intake of calcium was not statistically significant. The Exp (B) indicated that athletes with inadequate dietary intake of energy were 1.549 times more likely to experience fatigue during competition than those with adequate intake. Inadequate dietary intake of calcium does not predispose athletes to fatigue. These results are shown in Table 16.

Table 16: Association between Dietary Intake of Calcium, Iron and Energy and Fatigue

Energy and nutrient intake	ß	Wald	Sig	Exp (B)
Calcium	0.003	1.542	0.214	1.005
Iron	0.688	3.502	0.041*	1.003
Energy	0.002	1.243	0.048*	1.549

*significant at p<0.05

4.10 ASSOCIATION BETWEEN DIETARY INTAKE OF IRON, CALCIUM AND ENERGY WITH LOSS OF BREATH

Dietary intake of iron had a significant relationship with loss of breath (P 0.025) and the Exp (B) indicates that athletes who had inadequate intake of iron were two times more likely to experience loss of breath during intense exercise. These results are shown in Table 17.

Table 17: Association between Dietary intake of Iron, Calcium and Energy with loss of breath

Energy and nutrient intake	ß	Wald	Sig	Exp (B)
Iron	0.686	5.000	0.025*	1.985
Calcium	0.002	0.705	0.401	1.002
Energy	0.000	0.109	0.741	1.000

*significant at p<0.05 ß-regression coefficient Wald- Wald statistics
Sig – significance level Exp (B) - odds ratio

CHAPTER FIVE: DISCUSSION

5.1 SOCIO DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

5.1.1 Socio Demographic Characteristics

Kenyan athletes are renowned over the World for their endurance running in middle and long distance races. Successful athletes in Kenya have been found to span ages from 18 years up to about 40 years, for example a 35 year old Mary Keitany won the London marathon 2017. In this study however, the age span was between 18-30 years and it was purposively selected. More of male athletes were between ages 25 – 30 years while for the females most of them were between ages 18 – 24 years. This was similar to a recent study of the Ethiopian elite runners who were found to have majority between ages of 24-32 years (Scott, 2008). This is probably because after 30 years of age most female retire from sport and settle to other responsibilities including motherhood which reduce their time for active practice. Most of the athletes were single this could be because married athletes' especially female athletes have roles such as pregnancy, lactation and childbearing and caring for children, which reduces their commitment to athletics. A small percentage of athletes never attended school while most of them had secondary education with a few of them with tertiary education. These findings were similar to those by (Kibata, 2011) for elite athletes who were on practice to attend an international competition. Most of athletes achieved secondary education and turned to sports because of low employment rates in Kenya. Successful athletics is a personal initiative which does not require academic qualifications and earns income, most often even more than from employment. Majority of them were from Kalenjin community especially Nandi and Keiyo sub-tribe. The Kalenjin community have continued to dominate internationally middle and long distance racing, for reasons that are still not well explained. This has attributed to their body physical appearance, less mass for height, longer legs, slender limbs, shorter torsos and thin ankle describes a "bird like" trait (Pitsiladis, 2012).

5.1.2 Socio – Economic Characteristics

Most athletes were farmers and self employed in small businesses. Few were employed in the civil service mainly Kenya Army, Kenya police force and prisons. The economic class of most of them was second class with a small percentage in higher class level. This is probably due to low income from business and temporary employment. Employees of the disciplined forces routinely ran long distance each day in order to keep fit. Some will take advantage of this exercise and extend it as practice for athletics.

5.2 PERFORMANCE AND EXERCISE

Kenyan runners, and especially those originating from the Kalenjin tribe, have dominated international middle- and long-distance running for over 40 years. Studies have been done on the factors that contribute to their success. Proposed explanations included anthropometric characteristics such as the low body mass index long and slender legs allowing Kenyan athlete to run with minimal energy and low energy consumption reduces the oxygen cost of running (Joyner et al., 2011). The athletes in the camp were training twice per day in the morning and in the evening and the types of exercises included tempo, track session, fartlek, hillrun, situps, stretching among others. According to trainers these exercises could help enhance and maintain performance. This is supported by (Billat et al., 2003) that the intensive training methods with consistent running at race pace contribute to the success of athletes' performance. It was reported (Onywera et al., 2006) that early introduction of children at early ages to running and extensive walking to and from school (about 5 – 20 kilometre). According to the Kalenjin, children usually stand as herders which give them practice in running as they chase the sheep across the countryside in high altitude and hilly regions of the Rift Valley. Another possible explanation to their outstanding performance is chronic exposure to high altitude whereby, Iten training camp is a high altitude about 2400 meters above sea level. These could help runners develop lungs capable of functioning in thinner air and can lead to superior levels of haemoglobin and hematocrit which in turn leads to an increased ability to transport oxygen to

the working muscles (Beis et al., 2011). Another possible reason for the outstanding performance is the motivation created the opportunity to achieve economic success. Since Kenya is among the developing countries and with unemployment rate among the youth. Running is perceived as employment opportunity which can considerably advance athletes position in the society (Onywera et al., 2006).

Most athletes participated in long distance running; marathon (42km) and half marathon (21km). In 10,000meters, half marathon and full marathon there were always more males than females. Kenyan male athletes have dominated long distance running for decades. It is only recently that females have emerged as participants in marathon and half marathon. Most of the male achieved at least good performance, with about 25% of them achieving excellent performance when rated against the performance of 2016 RIO Olympics.

5.3 INJURIES SUFFERED BY ATHLETES

The injuries that was common and frequent to athletes included tendon injury, hamstrings, muscle cramps and ankle injury. Athletes have a misconception that injuries are normal and cannot be avoided due to training on tarmac roads and worn out shoes among others. But evidence exist that most injuries occur due to nutrient deficiencies like calcium, energy and iron. Significantly more female athletes experienced injuries than male athletes. This is probably due to inadequate dietary intake of calcium, iron and energy due to fear of adding weight. For females also fatigue, female athlete triad may have hindered them from achieving good performance. During strenuous activities like running and exercising vigorously, there is increased need for macro and micro-nutrients and if these demands are not met then the risk of injuries such as stress fractures increases (Hedrick et al., 2013). Apart from poor diet, there are other contributing factors to injury such as environmental, anatomical, hormonal, biochemical and neuromuscular factors.

5.4 DIETARY INTAKE OF ENERGY, IRON AND CALCIUM

Diet may have its biggest impact on training and a good diet will help support consistent intensive training while reducing the risk of illness and injury. Good and balanced food choices and a regular meal pattern can also promote adaptations in muscles and other tissues in response to training stimulus (IAAF, 2007). Individual 24 hour recall was used to assess the dietary intake of athletes and thereafter Nutri-survey 20.0 software and (Sehmi, 1993) food composition table. The recommended dietary intake of energy for male athlete is 2200Kcals and that of females is 2100Kcals per day. Only 6.3% female athletes and 34.8% of males met the RDA for the energy. Carbohydrate intakes should be approximately 70% of the total daily calories and fats providing about 25-30% of total daily calories. It was not possible in the current study to partition the intake of energy into the two components.

Calcium is important for growth, maintenance and repair of bone tissue, maintenance of blood calcium levels, regulation of muscle contraction, nerve conduction, and normal blood clotting. Inadequate dietary calcium and vitamin D increase the risk of low bone mineral density, stress fractures and a contribution to female athlete triad. Female athletes are at greatest risk for low bone mineral density if energy intakes are low, calcium-rich foods are inadequately consumed and menstrual dysfunction is present (Rodriquez, 2016) Only12.3% of female athlete and 30.4% of males met the RDA for calcium. Most male athletes consumed foods rich in calcium such as milk and milk products and legumes, nuts and cereals compared to females with low consumption of the foods hence making the females be more susceptible to injuries than males.

Iron is required for the formation of oxygen-carrying proteins, hemoglobin and myoglobin, and for enzymes involved in energy production. Oxygen-carrying capacity is essential for endurance exercise as well as normal function of the nervous and immune systems. Iron depletion is one of the most prevalent nutrient deficiencies observed among athletes, especially

females. Iron deficiency, with or without anaemia, can impair muscle function and limit work capacity. Iron requirements for endurance athletes, especially distance runners are increased by approximately 70% RDA (>14mg and >10mg) for women and men respectively. The high incidence of iron depletion among athletes is usually attributed to inadequate energy intake. Other factors that can impair iron status are training at high altitudes, increased iron losses in sweat, feces, urine, and menstrual blood for females, intravascular hemolysis, foot-strike hemolysis and injury (Dellavalle et al., 2007) Findings from the study showed that none of the female athlete met the recommended dietary intake of iron while only 21.7% of male athletes met the RDA. This is evident with a smaller percentage of female athletes consuming iron rich foods such as dark green leafy vegetables, organ meat, flesh meat and eggs, as a result predisposing them to loss of breath, fatigue and exhaustion during competition thus obtaining poor performance. Similar results were published by (Kibata, 2011).

5.5 Dietary Diversity

Based on various food groups, consumption of starchy staples was highest at 99.6% closely followed by consumption of dairy products at 87.9% and consumption of dark green leafy vegetables at 75.2%. The least consumed food group was organ meat at 19.7% and fish at 12.1%. The staple food in the community is maize as ugali (paste from hot water and maize meal) and is mainly consumed with vegetables and milk (fresh milk and "mursik" traditional fermented milk). The findings of this study also agree with a study by (Onywera et al., 2006) that the common diet was mainly ugali. Starchy cereal staples were the most consumed food group, due to the easy availability. Moreover considering that most of the athletes were farmers and the most planted crop in Kenya is maize. Dark green vegetables such as kales were also consumed in plenty due to their availability. Milk and milk products were highly consumed too; this could be to the probable routine that individuals take either tea coffee or cocoa in combination with milk or plain milk with a meal. Cereals are the main sources of carbohydrates

energy while leafy vegetables are rich sources of iron and milk and milk products rich sources of calcium. The foods groups that were least consumed were organ meats, fish. Low intake of fish and organ meat could be due their prices at the market are high and also inadequate availability in the region. Most of the athletes were on moderate dietary diversity score with the mean dietary diversity score of 4 ± 1. According to FAO (2010), a DDS of 4 shows moderate intake of micronutrients. Since Individual dietary diversity scores aim to reflect nutrient adequacy, this would therefore imply that most athletes were taking adequate nutrients, which does not agree with the findings on the dietary intake of energy, iron and calcium which showed that maximum 30% of athletes met the RDA for nutrients. Such contradiction would arise in a situation where the athletes are not consuming the nutrient rich foods in sufficient amounts.

5.6 NUTRITIONAL STATUS

Nutritional status of athletes was calculated as BMI (Body Mass Index). From the study, most (57.2%) of the athletes were underweight (<18.5) with more females being underweight than males. This may be due to disordered eating resulting to female athlete triad which comprises of energy deficiency, menstruation dysfunction and low bone mass. This is due desire for body image and high thrive for thinness. Though Kenyan diet is perceived as adequate, general Kenyan diet consist of simple foods with high starch comprising maize and beans. Therefore, nutrition education and other contributing factors thus are not seen important since the performance has been outstanding for decades (Fudge et al., 2006)

These findings are supported by study of Kibata (2011) which showed that female athletes had lower nutritional status than males. The female endurance athletes reported experiencing amenorrhea with 79% experiencing changes in their menstruation cycle including skipping and missing for more than three month due to heavy training. This reflecting poor dietary intake and as a result poor nutritional status

5.7 ASSOCIATION BETWEEN PERFORMANCE AND DIETARY INTAKE OF ENERGY, IRON AND CALCIUM

Linear regression model was used to compute relationship between dietary intake of energy, iron and calcium and the performance of the athletes. There was a positive association between dietary intake of the three nutrients and the performance of athletes. The positive association between performance and energy intake is that when there is increased intake of dietary energy, the performance is increased and is similar to iron, and calcium hence an outstanding performance is achieved. This is simply because good dietary intake of energy, iron and calcium will eliminate injuries, loss of breath, fatigue and other hindrances to performance. The significance (2 tailed) value for energy was 0.000, for iron was 0.001 and that for calcium was 0.004. All these values indicates that there was a statistical significant between dietary intake and performance.

5.8 ASSOCIATION BETWEEN DIETARY INTAKE OF ENERGY, CALCIUM AND IRON AND INJURY, FATIGUE, LOSS OF BREATH

Logistic regression in this study was used to show the association between injury and dietary intake of calcium, fatigue and dietary intake of calcium and iron and lose of breath and dietary intake of iron. The result of regression is usually an equation model which summarizes the relationship between the dependent and independent variables.

Athletes with adequate intake of dietary calcium and energy were less likely to suffer injuries as compared to those consuming less calcium rich foods. This is probably because calcium plays an important role in maintenance and repair of bone tissue, maintenance of blood calcium levels, regulation of muscle movement and nerve conduction. Calcium deficiency acts as a resistance in successful training and competition because when calcium store is not adequate to be drawn upon by skeletal formation process, the athletes' bones will not be strong and supportive for endurance performance due to poor transmission of body's response signals.

Iron is important in transporting oxygen from ambient air into the working muscles. Athletes who had low dietary intake of iron experienced shortness of breath and fatigue, which as a result hindered them from achieving optimum performance. This is because inadequate iron stores causes sensation of shortness of breath during exercise ultimately due to decreased availability of oxygen to the working muscles. When oxygen is not transported effectively to the working muscle, it causes a build up in lactic acid in the muscle which as a result causes fatigue and soreness in muscles. More females experienced shortness of breath and fatigue as compared to males because the study established females consumed less iron rich food and low caloric dense foods and also loss blood from menstruation every month. The low consumption of energy foods was as a result of fear of adding weight and losing a smaller body mass for athletics.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

Most of the athletes were young; more of males were between ages of 25-30 years with more females between 18 – 25 years. Majority of the athletes had a secondary education with a small portion having tertiary education. Majority of them were from Kalenjin community due to their renowned outstanding performance for decades. Most of the athletes were farmers or self employed and the income from sports was to sustain their livelihood and boost their socio economic class. Most of the athletes were in the middle income class.

It was established that majority of athletes achieved good performance with more males running marathon and half marathon races and more female were running middle distances races.

Athletes experienced injuries, loss of breath and fatigue which were the major hindrance to performance due to inadequate dietary intake of energy, iron and calcium, with female athletes at more risk of getting injured than male athletes.

It was established that athletes had inadequate dietary intake of energy, iron and calcium with more of the female athletes not meeting the recommended dietary allowance (RDA).

The nutritional status of athletes as measured as BMI was poor. Significantly more women were underweight than men

6.2 RECOMMENDATIONS

Nutrition education should be incorporated into training activities of athletes. Athletics Kenya with other stakeholders should establish a structured nutrition training program and guidelines to be followed by all training camp coaches so as to promote nutrition education among athletes. Education strategies for sports professionals should focus on the roles of balanced diet

in sports so as to encourage athletes to practice sound nutrition rather than doping to maximize their performance.

The government of Kenya should give support to the athletes; currently they depend entirely on themselves yet through their outstanding performance have made the country famous.

Further studies should focus on production of commercial foods for sports

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APPENDICES

Appendix 1: Informed Consent Form

Study Name: ***performance of athletes in association with dietary intake in Iten training camp in Rift Valley Kenya***

Introduction

Hello,I am a student at the University of Nairobi; I am pursuing my Masters degree in Applied Human Nutrition. I am conducting this research which will contribute to attaining my Masters degree. In order to get information about dietary intake of energy, iron and calcium and the performance outcomes of athletes, i kindly request you to be part of my study and help me fill in this questionnaire.

Purpose of the research

The purpose of the proposed study is to contribute to knowledge absence to nutritional requirements for optimal performance in sports to help in designing sports nutrition guidelines. The main objective of this study, therefore, is to assess the relationship of dietary intake of energy, iron and calcium on the performance of athletes. The specific objectives are: to determine the demographic and socio- economic characteristics of the athletes, to determine the dietary intake of energy, iron and calcium, to determine the nutritional status of the athletes, to determine the level of performance during training for the athletes and to determine the type and frequency of injuries suffered by athletes

Procedure

Upon your consent, individual athlete will be weighed and his height taken by a team of trained research assistants (RAs). You will also be interviewed on some areas such as socio-demographic characteristics, dietary intake, and your performance and the frequency and common injuries suffered during training and competition.

Your part in the research

You are requested to co-operate in this study by answering the questions in the questionnaire and providing any other information as pertains to the study. You are requested to be as honest as possible and the information collected will be treated with utmost confidentiality.

Possible benefits

It is my expectation that the study will be of benefit to you in terms of knowing your nutritional status and dietary practices. It is also expected to benefit the entire athletics team, Athletics Kenya and the camp management.

Possible Risks

There are no foreseen risks associated with the study. The measurements of height and weight do not pose any risk. Due care will be exercised during taking of the anthropometric measurements.

Compensation

Your participation is voluntary and therefore, you will not receive any form of compensation.

Your Rights as a participant

This study is protected and approved by human ethics committee (KNH/UoN) and Athletics Kenya Federation. In the event that you feel that you do not want to participate in this study you are free to do so without losing any benefits or entitlements (if any) that may/not have been specified earlier.

If you have any questions about your rights as a research participant, please contact: The Secretary, KNH/UoN Ethics Review Committee on P.O. BOX 1976/20723-00202 Nairobi, Kenya or Tel 254-020-2726300 Ext 44355 or Email: uonknh_erc@uonbi.ac.ke or by accessing their website at http://www.uonbi.ac.ke/activities/KNHUoN.

Volunteer Agreement

I have read the consent form describing benefits, risks and procedures for **"*Linkingperformance of athletes in association with dietary intake in Iten training camp in Rift Valley Kenya***

I voluntarily agree to participate.

Signature..... Date……/……/2016

Thumb print (*if participant cannot write***).....**

<u>For official use only</u>

I certify that the nature and purpose, the potential benefits and possible risks associated with participating in this study have been explained to the above individual.

Signature …… Date…….

Appendix 2: Questionnaire

Questionnaire No……

1: Demographic and socio-economic characteristics

Name of the respondent..... Date: .....

Name of Interviewer: ..... Date: .....

Age of the respondent..... Gender of the respondent.....

a. What is your marital status?
   1( ) single
   2( ) married
   3( ) others (specify.....)
b. What is your level of education?
   1( ) primary level
   2( ) secondary level
   3( ) tertiary level
   4 ( ) Never

c. what is your occupation

1( ) Farmer

2( ) Student

3( ) Business

4( ) Casual labourers

6( ) Armed force

d. Approximate how much do you earn per month in Kshs?

1( ) below 20,000

2( ) 20,000 – 69,000

3( ) above 70,000

e. To which ethnic group do you belong? .....

2: Appetite test

a. How would you rate your appetite?
   1( ) Good

2( ) Moderate
3( ) poor

b. How many times do you eat in a day?
   1( ) < 2
   2( ) 3 and above
c. Do you take snacks in between meals?
   1( ) yes 2( ) no
d. If yes, what kind of foods? .....
e. Do you drink water?
   1( ) yes 2( ) no

f. If yes how often do you drink water?

1( ) after every meal
2( ) only after exercise
3( ) once a day
4( ) others (specify)

3: Performance

a. How often do you exercise?
   1( ) once a day
   2( ) sometimes
   3( ) 3 times per week
   4( ) 2 times per day
   5( ) never
b. Which of the races below do you run?
   1( ) 3000meters
   2( ) 5000meters
   3( ) 10,000 meters
   4( ) 21km (half marathon)
   5( ) 42km (marathon)
c. List two kinds of exercise you do most often? .....

d. What has been your expected performance in the event(s) during the training?

e.What has been your best performance in the race(s) during the training so far?

f.Indicate what has been the hindrance to the expected performance

1( ) injury 2( ) running out of breath 3( ) exhaustion/ fatigue

g. Do you experience injuries during exercise?

1( ) yes 2( ) no

h. If yes list the kinds of injuries? .....

i. Do you seek help in case of injuries?

1( ) yes 2( ) no

j. If yes from whom?

1( ) hospital
2( ) coach
3( ) fellow athletes
4( ) nutritionist
5( ) others (specify)

k. Do you experience changes on your menses? (Females)

1( ) yes 2( ) no

l. If yes which ones? .....

4: Nutritional status

a. Weight of the respondent. weight 1 (.....kgs), weight 2 (.....kgs)
   Average weight (.....kgs)
b. Height of the respondent. Height 1(.....meters), height 2(.....meters)
   Average heights (.....meters)
c. Body mass index (.....$kg/m^{2)}$
d. What is the nutritional status of the respondent?
   1( ) severely underweight
   2( ) mildly underweight
   3( ) moderately underweight
   4( ) normal

Appendix 3: 24 HOUR RECALL

Dish			Ingredients			Individual consumption		
Time/meal	**Description**	**Amount**	**description**	**Amounts**	**source**	**Serving portion**	**Waste**	**Total/ amount**
Breakfast								
Snack								
Lunch								
Snack								
Super								
Snack								

Appendix 4: 24-Hour Individual Dietary Diversity Score

The interviewer should assess whether the previous 24 hour meal was either usual or normal diet.

Question Number	**Food Group**	**Examples**	**Yes = 1 No = 0**	**1= own 2= purchase 3= gift 4= other**
1.	CEREALS	Bread, noodles, biscuits, cookies, or any other food made from millet, sorghum, maize, rice, wheat + *local foods e.g. Ugali, porridge*		
2.	VITAMIN A RICH VEGETABLES AND TUBERS	Pumpkins, carrots, squash, or sweet potatoes that are orange + *any other locally available vitamin A rich vegetables*		
3.	WHITE TUBES AND ROOT	White potatoes, white yams, cassava, or foods from roots		
4.	DARK GREEN LEAFY VEGETABLES	Dark green/leafy vegetables		
5.	Other vegetables	Other vegetables, including wild one		
6.	VITAMIN A RICH FRUITS	Ripe mangoes, papayas +*any other locally available vitamin A-rich fruits*		
7.	OTHER FRUITS	Other fruits, including wild fruits		
8.	ORGAN MEAT (IRON RICH)	Liver, kidney, heart or other organ meats or blood-based foods		
9.	FLESH MEATS	Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds		
10.	EGGS			
11.	LEGUMES, NUTS AND SEEDS	Beans, peas, lentils, nuts, seeds or foods made from these		
12.	FISH	Fresh or dried fish		
13.	MILK AND MILK PRODUCTS	Milk, cheese, yogurt or other fermented milk products		
14.	OILS AND FATS	Oils, fats or butter added to food or used for cooking		
15.	SWEETS	Sugar, honey, sweetened soda or sugary foods e.g. chocolates, sweets or candies		
16.	SPICES, CONDIMENTS, BEVERAGES	Spices (salt, black pepper), condiments (soy sauce, hot sauce) coffee, tea, alcoholic beverages or local examples		
	Did you eat anything (meal or snack) or supplements outside home yesterday?			

Adapted from FAO (2010)

Appendix 5: Training schedule

Day /Time	Topic	Teaching method	Teaching Aids
Day One 8.30-10.30 AM	Workshop norms: • Introduction • Study objectives, aim and purpose • Activity matrix for data collection .	Lecture ,discussion, brainstorming and	Notebooks, handouts, pencils and flip charts
10.30-11.0	**TEA BREAK**		
11.00-1.00 PM	Study tools To go through the main tool(questionnaire) Translation of questions	discussion Taking notes Hand out	Flip charts Questionnaires Pencils, clip boards
1.00- 2.00 pm	**LUNCH BREAK**		
2.00-4.00	- To instruct on how to take anthropometric measurements: 1. Weight 2. Height	Demonstration and lecture	Bathroom scales stadiometers pencils and note books
From 4.00 pm	**DEPATURE**		
Day Two 8.00-10.30 AM	Dietary intake assessment -Instructing on how to use a 24 hour recall Review on how to conduct 24hour-recall	lecture demonstration discussion	24 hour recall Pencils Notebooks Diet scales
10.30-11.00	**TEA BREAK**		
11.00-1.00 PM	Pre testing the survey tools at Chepkorio training camp	demonstration	Questionnaire Bathroom scales Stadiometers
2.00-4.00	Pre testing the survey tools at Chepkorio training camp	demonstration	24 hour recall
From 4.00 PM	**DEPATURE**		

Appendix 6: Data acquisition matrix

Objectives	Variables	Data acquisition matrix	Activity	Instrument/tool	Equipments
To establish demographic and socio-economic characteristics of athletes	Age, sex, marital status, education level, occupation, income, ethnicity	Interviewing	Questionnaire administration by interviewing athletes	Semi structured questionnaire	Clipboards, Diary, pens/pencils, Erasers
To assess the dietary intake of energy, iron and calcium of athletes	Energy Iron Calcium	Interviewing	Weighing food	24 hour recall	Food scales Stationery
To assess the nutritional status of athletes	Weight Height BMI	Weighing	Measuring of weights, heights and calculating BMI	Bathroom scale for measuring weights Stadiometers for measuring heights	Anthropometric data sheet Stationery
To determine the performance of athletes	Best time record Types of races	Interviewing	Administering questionnaire and filling them	Semi structured questionnaire	Stationery
To establish the type and frequency of injuries suffered by athletes	Type of injuries Frequency, Management of injuries	Interviewing	Administering questionnaire and filling them	Semi structured questionnaire	Stationery

Appendix 7: Data analysis matrix

Outcomes	Variables/indicators	Descriptive statistics	Inferential statistics
Main objective	Performance, dietary intake of iron, energy and calcium, BMI	Frequencies, ranges, means, standard deviation	Chi square to test the association between nutritional status, dietary intake of nutrients demographic and socio-economic characteristics, injuries and the performance of athletes
Specific objective 1	Age, marital status, occupation, income education level, ethnic group	Frequencies, means	Odds ratio to measure association
Specific objective 2	Energy, calcium and Iron	Frequencies, means, ranges, standard deviation	Linear regression to test association between dietary intake of energy, iron, Calcium and performance
Specific objective 3	Weight, height BMI	Frequencies, means, percentages	Odds ratio to measure association of nutritional status between males and females
Specific objective 4	Type of race, level of Performance	Frequencies, percentages	Chi-square to test association between dietary intake of energy, iron, calcium and performance($P<0.05$)
Specific objective 5	Type of injury, Frequency of injury	Frequencies, means, percentages	Correlation to test the strength of association between injury and Intake of energy, iron and calcium