DIETARY INTAKE OF COLLEGE ATHLETES DURING TRAINING IN TERTIARY INSTITUTES IN THE NORTH RIFT REGION OF KENYA

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DECLARATION

Declaration by the Candidate

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This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

This work is dedicated to my late mother, Beth Wanjiku Waititu who always stood by me and believed in me. Gone now but never forgotten. I will miss you always and love you forever. Thanks for all you did; this work is dedicated to you.

ABSTRACT

Athletics is increasingly becoming a major pillar of sustainable national development in Kenya. It is therefore important for athletes to consider various aspects of good performance. The concept that athletic performance is enhanced by optimal nutrition is a widely accepted one. The aim of this study was to determine the dietary intake of college athletes in tertiary institutes in the North Rift region of Kenya and compare this with Recommended Dietary Allowances (RDA). A cross-sectional survey in the quantitative and qualitative paradigms was carried out in two technical institutes. A sample of 44 male and 27 female athletes, 18-26 years old was selected. Anthropometric measurements were taken to determine Body Mass Index (BMI) and percentage body fat. Macronutrient and micronutrient intakes were determined using the 7-day estimated food record. Food intake data was analyzed using Nutri-Survey (2007) software. Descriptive statistics including mean, standard deviation and percentages were used to describe the variables. Macronutrients intake was compared to the Acceptable Macronutrient Distribution Range (AMDR). One way analysis of variance (ANOVA) was used to analyze differences by gender of each nutrient while the paired samples t-test was used to analyze difference between nutrient intake and RDA. Based on BMI, all the athletes were classified as normal. Percentage body fat was 6% for male athletes and 11.7% for female athletes which was lower than the standard body fat for athletes of 6%-13% and 14%-20% for male and female respectively. Diets of both male and female athletes consisted significantly lower than recommended daily intakes of energy, fat and water and the athletes were in negative energy balance. The AMDR for male athletes was 74.1% and 13.1% for carbohydrates and proteins respectively and for female athletes 66.4% and 11.7% for carbohydrates and proteins respectively. This met the requirements of 45%-65%, 10%-35% for carbohydrates and proteins respectively. The AMDR for fat was lower than the recommended 20%-30% for both male and female athletes. Folic acid, potassium and calcium intake were significantly lower than RDA for both male and female athletes (significant at $P<0.05$). Females exhibited inadequate iron intakes at 70.6% of the RDA. Except for water, energy and vitamin C, the study found no significant difference in the intake of various nutrients by male and female athletes. The inadequate energy and micronutrient intake in the college athletes could put the athletes at risk of nutritional deficiencies and compromise their athletic performance and thus national development and fame. It is necessary for institutes running athletic programs to consider having qualified sports nutritionists to guide athletes in their choice of diet hence improve athletic performance. This will lead to optimum performance in athletics and therefore individual and national development of the athlete and country respectively.

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OPERATIONAL DEFINITION OF TERMS

Athlete: A person possessing natural or acquired traits such as strength and endurance necessary for physical exercise especially those performed in competitive contexts. In this study, an athlete refers to male and female college students participating in competitions in short, medium and long distance races.

Anthropometric Measurements: The science of measurement applied to the human body and includes height, weight body and limb girths. In this study anthropometric measurements taken were skinfolds, weight and height.

Body Mass Index (BMI): An index of a person's weight in relation to height determined by dividing the weight in kilograms by the square of the height in meters (kg/m^2). In this study, BMI was used to classify athletes as underweight, normal, overweight or obese.

Chapati: Flattened round bread made from wheat flour.

Energy Expenditure: The amount of energy measured in kilojoules that a person uses to breath, circulate blood, digest food and be physically active. In this study, energy expenditure refers to the energy athletes use during training and exercise.

Energy Requirement: Level of energy intake from food that will balance energy expenditure when the body has a body size and composition, and level of physical activity, consistent with long-term good health.

Githeri: Kenyan traditional meal made from maize and beans.

Physical Activity: Any bodily movement produced by the contraction of muscles and that increases energy expenditure. In this study, physical activity refers to running at different intensities and for varied lengths of time in preparation for competition.

Recommended Dietary Allowances (RDA): The average daily dietary intake that is sufficient to meet nutrient requirements of nearly all (97%) healthy individuals in a particular life stage and gender group.

Skin fold thickness: A measure of the double thickness of the skin and adipose tissue between the parallel layers of the skin. In this study, skinfold thickness measurements are used to determine body fat percentage.

Sports Nutrition: Study and practice of nutrition and diet as it relates to athletic performance. It is concerned with the type and quantity of fluid and food taken by an athlete.

***Ugali*:** A dish of maize flour cooked with water to a hick consistency.

LIST OF ABBREVIATIONS

ADA	American Dietetic Association
ANOVA	Analysis of Variance
ACSM	American College of Sports Medicine
AD	Activity Diary
BMI	Body Mass Index
BMR	Basal Metabolic Rate
DC	Dietitians of Canada
EE	Energy Expenditure
PA	Physical Activity
RDA	Recommended Dietary Allowance
SPSS	Statistical Package for the Social Sciences
TEE	Total Energy Expenditure

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Sports nutrition is the application of nutrition principles for the purpose of improving training, recovery and performance (Dunford, 2010). Athletes have always been advised about what to eat and the concept that dietary intake and athletic performance go hand-in-hand dates back as far as 532 B.C. Then, athletes took finely tuned athletic diet with meat as the staple food of their diet and alcohol was accepted for use during training and competition (Gill, 2012). Though these athletes may have performed well in the competitions, there was no scientific research to establish the nutritional content of their diet.

Today, research has established that proper nutrition increases performance, allows for proper hydration and provides fuel to the body throughout the training period (Clark, Reed, Crouse & Armstrong, 2003). According to the International Association of Athletics Federations (IAAF, 2007), well-chosen foods for proper nutrition help athletes train hard, reduce risk of injury and achieve performance goals. This is in line with the Position of the American Dietetic Association, Dieticians of Canada and the American College of Sports Medicine (ADA, 2000) that physical activity, athletic performance and recovery from exercise are enhanced by optimal nutrition. On the other hand, suboptimal dietary intake has been found to result in persistent fatigue, poor exercise recovery and unwanted weight loss (Ray & Fowler, 2004). Adequate and proper nutrition of the college athlete is important to meet their energy, macronutrient and micronutrient needs.

College athletes have additional needs for macronutrients as well as micronutrients compared to their non-athletic peers hence it is necessary that their dietary intake be monitored. Their changing bodies and physical demands for training put them “at risk” for disordered eating and inadequate dietary intake especially for the female athlete. College athletes also encounter numerous barriers that can hinder healthy eating, including lack of time to prepare healthy foods (due to rigorous academic and training programs), insufficient financial resources to purchase healthy foods and travel schedules necessitating eating away from home (Malinauskas, Overton, Carpenter & Corbett, 2007). Furthermore wellness of the student athlete reduces the prevalence of injury and other health- related problems that impact performance and thus team competitiveness (Malinauskas et al., 2007).

An assessment of dietary intakes and practices of the college athlete is necessary as it will help them understand their intake. With the increase in the number of physically active women participating in athletics, there is also need to understand the dietary intake of the female athlete. According to Sungot-Borden (2004), eating disorders are higher in female than male athletes. Many female athletes have been found to have such low body weights that they cease to menstruate (Webb, 2007). Research has shown many college athletes to have diets that need change in order to promote health and support performance (Malinauskas et al., 2007). Their diets have been found to be low in fruits and vegetables and high in processed foods and fat (Clark et al., 2003). Though there has been an increased interest in nutritional information, there is no evidence that athletes are now more knowledgeable about the role of nutrition in athletic performance.

Studies have shown that athletes from a wide variety of sports do not have an adequate knowledge of the dietary requirements of the human body hence are not able to make proper food choices (Rosenbloom & Dunaway, 2007). Athletes can obtain nutritional knowledge from a variety of sources like, magazines, coaches, internet or parents. With adequate nutritional knowledge an athlete is likely to have control of what to eat and make decisions on his/her nutritional habits. It is therefore necessary to determine the nutritional knowledge of athletes with regard to caloric, macronutrient and micronutrient intake.

Studies have been carried out on elite Kenyan athletes to determine their dietary intake (Mukeshi & Thairu, 1993; Onywera, Kamplamai, Tuitoek, Boit, Pitsiladis, 2004). However, there is little documented evidence on dietary intake of college athletes showing differences between dietary intake of male and female college athletes in Kenya. It was therefore necessary that a study on the dietary intake of college athletes be carried out to establish whether it meets the Recommended Dietary Allowances (RDA) for athletes.

1.2 Statement of the Problem

Participation in physical activity increases the energy and nutrient needs of an athlete (Croll et al,2006).These needs are met through adequate intake of both macronutrients and micronutrients. However, the college athlete is sometimes not able to meet dietary requirements due to a myriad of factors. Some of these include tight academic programs leaving little time to prepare meals or go out to eat. Sometimes they may be faced by financial problems limiting them to taking cheap meals that may not be necessarily adequate for training and competition. Athletes and coaches may lack knowledge on what diet is appropriate for the athlete therefore making poor choices of food to be consumed during trainings and competition. An understanding of proper nutrition for the athlete is a major concern for athletes, trainers and college administration and nutritional deficiencies are a major concern for today's athlete. If inadequacy of dietary intake persist, the college athlete is likely to perform poorly in competitions and experience slow recovery from injuries. There was therefore need to assess the dietary intake of college athletes and use the results to propose appropriate interventions.

1.3 Purpose of the Study

The purpose of this study was to assess the dietary intake of male and female athletes and determine its relationship with RDAs. The study also sought to determine whether the college athletes possessed basic knowledge in nutrition that would help them plan for their

1.4.1 Objectives of the Study

1. To determine the dietary intake of college athletes and compare this with Recommended Dietary Allowances.
2. To assess nutritional status of college athletes using BMI and body fat percent.
3. To determine eating patterns and meal frequencies of college athletes.
4. To determine nutritional knowledge of college athletes.
5. To determine energy expenditure from physical activity patterns of college athletes.

1.5 Research Hypotheses

The following null hypotheses were advanced for this study:

H_{o1}: There would be significant difference between macronutrient and micronutrient intake of college athletes and Recommended Dietary Allowances..

H_{o2}: There would be no significant difference between dietary intake of male and female athletes.

1.6 Significance of the Study

Over the years, Kenya has enjoyed glory and fame due to the good performance of her athletes internationally. This has contributed greatly to its human and national development from the large sums of money athletes bring home from earnings in the competitions. Since optimum nutrition contributes to good performance and helps in recovery from injuries, this study can help athletes, coaches and college administrators to plan for nutrition programs. Determination of the adequacy of athletes' diet will help institutions of learning and coaches to plan diet so as to maximize performance. It can also help the coach and college administrators to identify those athletes on the verge of eating disorders and take precautions before it leads to health conditions. By identifying those with eating disorders, treatment can be sort early to enable the athletes remain healthy. If adequacy of the athletes' diet is not addressed, their performance and health would be at risk leading to poor performance and recovery from injuries. The findings of this study can be used as a basis for further research in the field of sports nutrition.

1.7 Theoretical Framework

This study was guided by the Food Choice Process Model developed by Long et al (2011) as the procedure used by athletes for making food choices. The model outlines the determinants of food choice in athletes including all factors that could influence the nutrient intake and nutrition knowledge of the athlete.

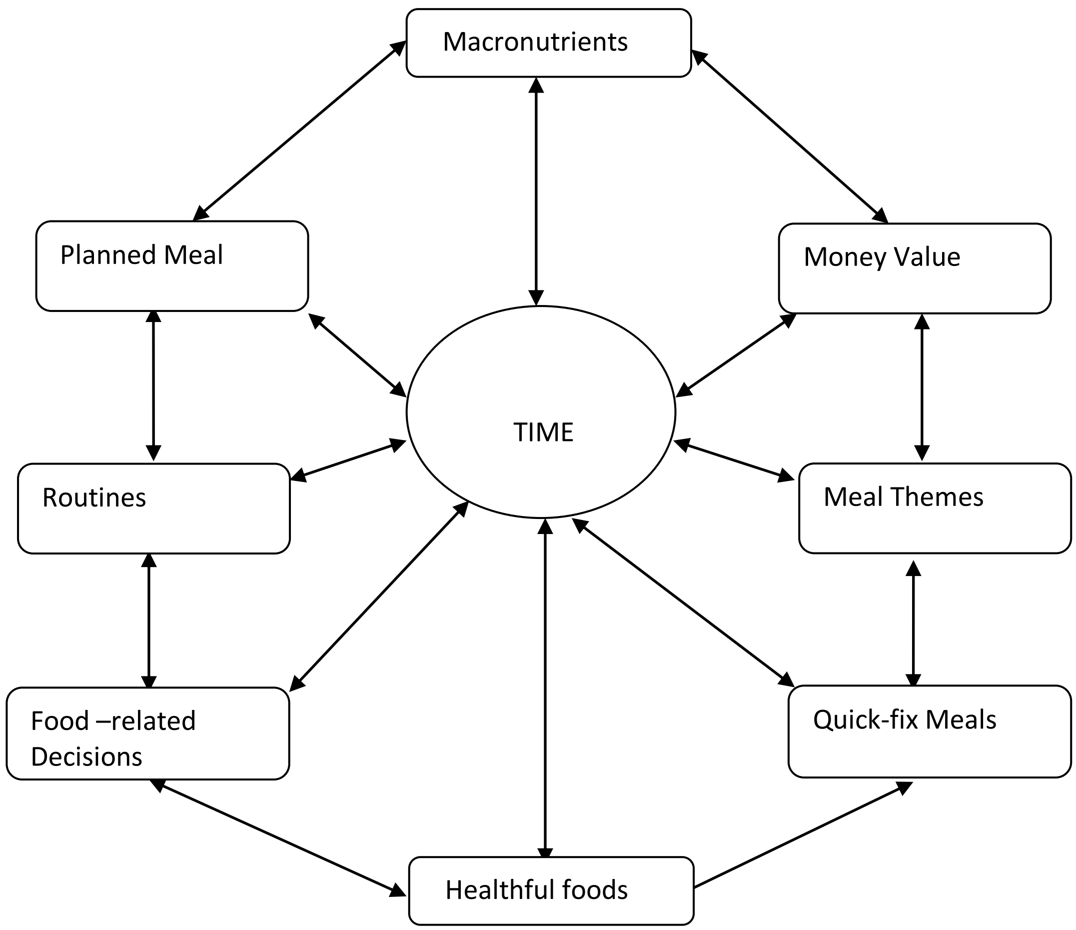

Figure 1.1: The Food Choice Process Model (Adopted from Long *et al,* 2011)

The choice that athletes make in food intake determines which nutrients enter the body hence influence food habits and patterns. When studying dietary intake of athletes, it is important to study factors that determine food choice, hence the appropriateness of this model for this study. The factors in this model interrelate and it is assumed that at whatever point an athlete enters the cycle, they can proceed around the circle clockwise, counterclockwise or straight across. Time was found to be the core category while all the other factors revolved around it. Hence, an athlete with an established routine will have to make food-related decisions on when and what to eat. These food-related decisions need to be balanced to maintain healthful food choices within the available time. Making decisions within the available time, may lead to the athlete opting for quick-fix meals which meet the definition of healthful food.

Additionally, athletes lack sufficient time to research what they should be eating and drinking and as a result are unable to make healthy choices during meal times (Barr et al, 1994). Monetary value of food was also found to affect food choices. College students in general will try to get the most from the money they have. This may result in the college athlete opting for a cheaper meal without necessarily considering the health aspect of the food resulting in inadequate intake of macronutrients. The social environment and availability, quantity, convenience and perceived healthfulness of the food are among the factors that affect an athlete's food choices (Bisogni *et al*, 2002). However, athletes will have different definitions of healthful foods depending on the sport. Teammates, peers and even family may influence what an athlete eats. Hausenblaus and Carron (2002) found that male athletes were influenced by teammates even though they did not eat together often. Though this food choice model was used in this study to establish determinants of food choice in athletes, some aspects may not apply as the model was developed based on male footballers in the United States of America. To understand fully what factors affect the dietary intake of long and short distance runners, it is necessary to develop a theoretical model to determine what influences their food choices. It is hypothesized that student athletes have a variety of influences on food choice; their knowledge, support (parents, coaches and teammates) and systems (educational programs). An understanding of these factors and how they influence the food choice of athletes can be used to improve food choice of the athlete and consequently give positive effects on performance. Insights into the food choice process used by athletes may allow athletic staff to provide nutritional guidance, enabling and encouraging athletes to make better food choices.

1.8 Scope of the Study

The study focused on registered students of Rift Valley Technical Training Institute and O'Lessos Technical Training Institute. The participants were drawn from male and female athletes participating in short, middle and long distance races. Those taking part in ball games were not included as they were found to have different schedules for training and competitions.

1.9 Limitations of the Study

The dietary food record method was a major limitation as respondents were likely to under-report or over-report dietary intake or change in dietary intake behavior. However the researcher minimized this by training the respondents before the survey and having the research assistants monitor the recording after the first day to ensure that respondents were doing the right thing.

Another limitation was in the use of Nutri-Survey software in data analysis as the data base of foods in the program lacked common local foods like *ugali* and *chapatti*. This was overcome by calculating the ingredients required and using the nutrient content of the individual ingredients.

1.10 Assumptions of the Study

The study made the following assumptions:

- That the participants were honest in their reported intake without under- or over-reporting.
- That the weighing scales used were accurate as indicated in their calibration certificate.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This review of literature will discuss literature pertaining to sports nutrition: dietary intake, dietary habits and eating patterns and assessment of dietary intake of athletes. It is divided into five sections: 1) Overview of sports nutrition; 2) Macronutrient and micronutrient intake of athletes; 3) Nutrition knowledge of athletes and eating patterns; 4) Anthropometric characteristics of athletes; 5) Measuring dietary intake.

2.2 Overview of Sports Nutrition

Nutrition of athletes is the key not only for performance but also for injury prevention (Rodriguez, 1999). A study by Reid – St John (2003) examined eating habits and injury rates among female runners and established that 55% of the athletes polled reported injuries and those athletes also ate approximately 200 fewer calories per day. An athlete who is well nourished is not only healthy but also capable of training more intensely and being less susceptible to injury. In their position statement, The American Dietetic Association, Dietitians of Canada and the American College of Sports Medicine (2000) stated that physical activity, athlete's performance and recovery from exercise are enhanced by optimum nutrition. They also recommend appropriate selection of foods, fluids, timing of food intake for optimal health and performance in their diets. Research has shown that not ingesting a sufficient amount of calories and enough of the right type of macronutrients may impede an athlete's training adaptation, while athletes who consume a balanced diet that meets energy needs can augment physiological training adaptations (Hansen, 2010). Incorporating good dietary practices as part of a training program is one way to help optimize training adaptations and prevent overtraining (Rodriguez, 1999).

2.3 Dietary Intake of Male and Female Athletes

2.3.1 Energy Intake

The first component to optimize training and performance through nutrition is to ensure the athlete is consuming enough calories to offset energy expenditure (Leutholz, 2001). Athletes expend a high number of calories through training and competition and have greater dietary needs than the general population. Their daily intake therefore, has to be enough to provide for immediate energy needs such as body functions, activity and growth and to fuel and repair muscles.

According to the Nutrition Working Group of the International Olympic Committee (2010), energy intake influences the body's energy stores. The energy stores which include body fats and glycogen in muscle and liver play a number of important roles related to exercise performance since they, among other things, provide fuel for exercise as well as an athlete's size and physique. When energy intake is restricted, fat and muscle mass will be utilized for energy to fuel the body, and the loss of muscle will result in the loss of endurance for the athlete. Problems can occur when the athlete restricts energy intake to a level that interferes with the body's metabolic and hormonal function, for example, loss of menstrual cycle in female athletes.

Energy needs in individuals vary according to age, gender, body size, volume, intensity and frequency of physical activities. As a result, energy needs vary among athletes and it is important for each athlete to achieve a suitable intake by consuming the range of nutrients and food components that promote good health. In the 1989 Recommended Dietary Allowances (RDA), mean energy requirement for women and men who are slightly or moderately active and between 19-50 years of age were established as 9205kj and 12133kj per day respectively (National Research Council, 1989). However, these guidelines can only provide a crude approximation of the average needs of an individual athlete. The key formula in meeting energy needs of an athlete in competition, training and recovery is the combination and balance of carbohydrates, protein and fats. The Food and Nutrition Board of the Institute of Medicine provides recommendations on how much of these macronutrients an athlete should consume. The recommendations are given as ratios referred to as Acceptable Macronutrient Distribution Ranges (AMDR). The ranges represent the percentage of total calorie intake that should come from each nutrient. The AMDR for carbohydrates is 45%-65%, protein 10%-35% and fats 20%-35% (IOM, 2002).

Although the usual energy intakes for many female athletes may match those of male athletes per kg of body weight, some consume less energy than they expect. A study done at Ball State University in Muncie, Indiana by Beals (1994) and at Arizona State University by Monroe (1999) established that the average intake of the female athlete was 6280 Kj or less daily when their requirement was 9211 kJ- 12560 kJ per day. The study compared the eating habits of male and female athletes with those of non-athletes' gender. The result was that while athletic men ate as much as 150 percent more than non-athletic men, athletic women were eating significantly less than non-athletic women.

Low energy, menstrual dysfunction, loss or failure to gain bone density and increased fatigue, injury and illness may occur in low energy intake. These conditions constitute the female athlete triad (ACSM, 1997) which the female athlete may experience in low energy intake. Inadequate energy intake, relative to energy expenditure compromises performance and the benefits associated with training (ADA, 2009). A low energy intake or negative energy balance due to chronic dieting or under-eating may create a negative drain on energy which compromises performance (Jonnalagadda, 1998).

A study carried out on Kenyan athletes by Onywera *et al* (2004) found the energy intake of elite male athletes to be lower than recommended and below the energy expenditure putting them in negative energy balance. These results confirmed previous findings by Christensen and Hall (2002) on Kenyan athletes who were found to be in negative energy balance during periods of intense training. Chronically low energy intake usually results in poor nutrient intake, including carbohydrate, protein, vitamins and minerals.

2.3.2 Carbohydrate Intake

A high carbohydrate diet is thought to be the most important dietary recommendation for an athlete to follow (Grandjean, 1989). A diet richer in carbohydrates increases endurance performance because of the extra store of carbohydrates in the muscle referred to as glycogen. Carbohydrate is therefore an essential fuel for most athletes but since the body's ability to store it is limited, consumption is required to maintain adequate levels (Coyle, 1995). Carbohydrates are also the most efficient source of energy with athletes who train several hours a day requiring more carbohydrates (Zawila, Steib and Hoogenboom, 2003). The AMDR for carbohydrates is 45%-65% of daily energy intake with 1 g of carbohydrate providing 16.7 kJ. The higher end of this range is appropriate for athletes that train at moderate intensity. Recommendations of sports nutritionists are based on plentiful evidence that increased carbohydrate availability enhances endurance and performance during exercise sessions (Burke, Cox, Cummings & Desbrow, 2001). The recommendation for active individuals doing moderate, low-intensity and heavy endurance activity is 5-8g/kg body weight of carbohydrates (IOM, 2002). The American Dietetic Association recommends a range of 6-10g/kg body weight per day (ADA, 2002). However, the dietary recommendations for carbohydrates for the athlete will depend on the level of physical activity being performed. According to Srilakshmi (2007), for overall health, most dietary carbohydrate should come from refined grains, legumes and fresh fruits to ensure that the athlete also achieves requirements of fiber and micronutrients. In a study of Kenyan athletes, Onywera *et al* (2004) established that Kenyan athletes consumed a diet of 10.4g/kg body weight of carbohydrates per day translating to 600 grams per day. This showed that the athletes met daily requirements for carbohydrates.

2.3.3 Protein Intake

High protein diets among athletes have been popular throughout history (Grandjean, 2011). Exercise physiologists and sports nutritionists generally agree that exercise increases the need for protein (ADA, 2002). Protein is an essential nutrient in the diet, being used to manufacture body proteins that have important structural and functional roles, provide energy source during exercise and support gains in muscle mass that occur with exercise (Lemon, 2000). Research over the last decade has indicated that athletes engaged in intense training need to ingest about two times the recommended dietary allowances (RDA) of protein in their diet (1.5 to 2.0g/kg/day or 75-300g/kg/day) for a 50-150g kg athletes in order to maintain protein balance (Burke and Deakin, 2006). The AMDR for protein is 10%-35% of daily energy intake with 1 g of protein providing 16.7 kJ. If an insufficient amount of protein is obtained from the diet, an athlete will maintain a negative nitrogen balance, which can increase protein catabolism and slow recovery over time leading to muscle wasting and training intolerance (Leutholtz, 2001). An athlete should therefore ensure that they consume a sufficient amount of quality protein in their diet in order to maintain nitrogen balance. However, if higher protein intakes result in an insufficient carbohydrate intake, there is a likelihood of a negative impact on training capability (Broad and Cox, 2008).

Dietary intake surveys of athletes frequently report that protein requirement is adequately met (Burke *et al*, 2003).Those individuals at greatest risk for low protein intakes are active individuals who restrict energy intake for weight loss or follow vegetarian diets (Manore, 2002). In a study of Kenyan athletes (Onywera *et al*, 2004) and of Ethiopian athletes (Beis, *et al*, 2011), the athletes were found to meet the dietary recommendations for proteins.

2.3.4 Fat intake

Fat is important in the diet of athletes as it provides energy, fat-soluble vitamins and essential fatty acids. The dietary recommendations of fat intake for athletes are similar or slightly greater than those recommended for non – athletes in order to promote health. The increased tolerance of fat in athletes is based on the need to ingest adequate amounts of essential fatty acids (EFA) and their increased energy needs. Individuals that consume a low fat diet are at an increased risk of not getting adequate amounts of EFA (Grandjean, 1989).

The United States National Research Council suggests limiting dietary intake of fat to less than 30% of total calories mainly to minimize cardiovascular risk factors, obesity and diabetes (Lukaski, *et al*, 1984). On the other hand, athletes who take too little fat run the risk of lowering circulating levels of the hormones insulin and testosterone which are important in athletes that are keen to build lean body mass (Gibney *et al*, 2009). The recommendations for highly active individuals by the World Health Organization (WHO) are 20%-25% of total calories (Burke *et al*, 2004). Currently there appears to be no health benefits to consuming a very low fat diet (<15% energy from fat) in healthy individuals compared to more moderate fat intakes.

2.3.5 Water Intake

Proper hydration during exercise will influence cardiovascular function, muscle functioning, fluid volume status and exercise performance. Proper hydration during exercise enhances increased skin blood flow and sweating rate and helps sustain cardiac output. It is therefore necessary for all active individuals to attempt to remain well hydrated. The American College of Sports Medicine (ACSM) recommends athletes to maintain hydration before, during and after exercise (ACSM, 2000). According to the ACSM guidelines, athletes should maintain fluid and electrolyte balance to replace water and electrolytes lost in sweat. The greater the degree of hydration, the more negative the impact on physiological systems and overall athletic performance.

2.3.6 Micronutrient Intake

Micronutrients play an important role in energy production, hemoglobin synthesis, maintenance of bone health, adequate immune function and the protection of body tissues from tissue damage (Manore & Thompson, 2000; ADA, 2000). They assist with repair of muscle tissue during recovery from exercise and injury. The antioxidant nutrients such as vitamins A, E and C play an important role in protecting the cell membranes from oxidative damage (Watson *et al*, 2005). Vitamin C is a natural anti-oxidant which can help reduce exercise-induced oxidative stress and supports a healthy immune system by supporting white blood cell production. The B vitamins ensure optimum energy production and the building and repair of muscle tissue. The need for these vitamins increases proportionally with energy expenditure (Nande, Mudafale and Vali, 2009).

Vitamin D is required for adequate calcium absorption, regulation of serum calcium and phosphorous and regulation of bone health. The athletes at greatest risk of micronutrient deficiencies are those who restrict energy intake or consume high-carbohydrate diets with low micronutrient density. The primary minerals low in the diet of athletes is calcium, zinc and iron (Manore, 2000). Calcium is important for the building and repair of bone tissue and the maintenance of blood calcium levels. Inadequate dietary calcium increases the risk of low bone mineral density. Female athletes are at greatest risk for low bone density if energy intakes are low. Zinc is important in the functions of many enzymes and its role in the structural integrity of antioxidant enzymes systems may lead to an increased need in athletes who lose water in sweat and urine. Iron plays an important role in exercise since it is required for the formation of hemoglobin and myoglobin and for enzymes involved in energy production (Akabas and Dolins, 2005). The transportation of oxygen in the blood to the working muscle is important for aerobic exercise functions and this function is carried out by hemoglobin. Magnesium and potassium are important for energy production, muscle contractions, relaxation and muscle strength and healthy nerve endings. Studies on micronutrient of athletes show that where there is adequate intake of energy giving- foods like carbohydrates and fat, recommendations for micronutrients intake are met. A study done on Canadian athletes established that micronutrients intake of the major minerals and vitamins ranged between 120% and 366% of the recommended intakes (Lun, Erdman and Reimer, 2009).

Hassapidou and Manstantoni (2001) investigated the dietary intake of elite Greek athletes using 7-day weighted dietary records and reported a lower than recommended intake of iron but a higher than recommended intake of the other micronutrients. An additional study conducted on female Greek athletes found out the athletes consumed less than recommended intakes for calcium, iron, zinc, folate, magnesium, vitamin A and the B vitamins (Papadoupoulou, Papadoupoulou and Gallos, 2002). Mullins, Houtkooper and Howell (2001) assessed the dietary intake and nutritional status of 19 female athletes during their training season and established that the athletes consumed more than 65% of the recommended intakes of all nutrients except vitamin E.

2.3.7 Dietary Assessment of Athletes

The primary purpose of dietary assessment is to determine what a given population is eating in terms of quality and quantity (Grandjean, 2004). Several methods are available for dietary assessment of individual and groups of athletes including retrospective (dietary recall, food frequency questionnaire, and diet history) and prospective (diet record, duplicate portion) techniques. The diet record method is the oldest and most common method of dietary assessment (Grandjean, 1989). The principle of the method is that the amounts of food consumed are recorded over a period of time in terms of estimated quantities and method of cooking. The method has been found to have the potential for providing quantitatively accurate information on food consumed during the recording period (Gibson, 2005). Recording foods as they are consumed lessens the problem of omission and the foods are fully described and methods other than the food diaries are rarely used in athlete populations (Heaney et al, 2010). It has been stated that the seven day dietary record increases the reliability of collected data (Magkos & Yannakoulia, 2003). However, a major disadvantage with this method is that it is subject to bias both in the sample selection and in the measurement of the diet. It also requires that the respondents be motivated and literate which is not always the case. Since the study was using college students, the problem of illiteracy did not arise hence the use of this method. Respondents in a study may find it difficult to record their intake for seven consecutive days hence not record accurately. Gersovitz (1978) reported poor compliance after four days of recording. However, even with these shortcomings, the dietary record method is said to remain the most efficient method of collecting dietary data on large numbers (Grandjean, 1989).

2.4 Nutrition Knowledge of Athletes

Nutrition affects almost every process in the body involved in energy production and recovery from exercise (Wardlaw and Smith, 2011). It is therefore an important component of any sportsman or woman. The main dietary goal of any athlete is to obtain adequate nutrition to optimize their training and performance (Jackbson and Aldana, 1992). To achieve this goal, some basic knowledge of nutrition for the athlete is necessary (Dunn et al, 2007). This includes knowledge of recommended dietary allowances, sources and role of nutrient and metabolism. However, studies on nutrition knowledge of athletes show that many college athletes do not understand basic nutrition concepts (Grandjean et al, 1981). Barr (1987) established that students with higher nutrition knowledge may obtain information to help increase performance or to recover faster from illness. This knowledge according to Rosenbloom et al (2002) can be acquired from magazines, coaches, parents or college lessons. However, many of these sources may not be suitable and at times are unreliable (Barr et al, 1997) contributing to the problem of athletes making poor dietary choices. To ensure that athletes receive adequate and accurate information, it is important that trainers, coaches and athletes receive nutrition education as part of sports training. Overall, proper nutrition education can work well not only for the athlete but for the whole team.

2.5 Nutritional Status of Athletes

Nutritional status is a critical determinant of athletic performance (Wan Nudri et al, 1996). Anthropometric parameters are useful in the evaluation of the nutritional status as they give a good estimate of the degree of dietary intake of athletes. Anthropometry provides information about body composition and can be used to design training and nutritional strategies for athletes. It provides data about major body components such as fat, muscle and bone that are important in sports performance. Anthropometry is preferred more than other methods since it is non-invasive, affordable and uses portable equipment to determine percent body fat, height and weight**.** Body composition and weight are two of the many factors that contribute to exercise and performance (ADA, 2000). The main reason for determining an athlete's body composition is to obtain information that may be beneficial in improving athletic performance (Barr et al, 1994). The skinfold measurements test is one common method of determining a person's body composition and body fat percentage. It estimates body fat percent by measuring skinfold thickness at specific locations on the body. Skinfolds are measured all over the body with the sum of more skinfolds being used to reduce the error in measurement and to correct possible differences in subcutaneous fat distribution (Gibney et al, 2009). Once the skinfold measurement has been taken, they are converted to percentage body fat. This method is subject to errors if the measuring equipment is poorly maintained and calibrated. However, according to the American College of Sports Medicine, when performed by a trained, skilled tester, skinfold measurements of body fat are up to 98% accurate (ADA, 2000).

Newer technology such as dual-energy X-ray and computerized tomography are more reliable than anthropometry but due to their cost they are only available in few research centers (Gibney *et al*, 2009). The American Council on Exercise recommends 14%-20% body fat for women and 6%-13% for men as appropriate for athletic populations (Jackson and Pollock, 1980). At the same time, extremely low body fat percent in athletes can be a health problem (Ode *et al*, 2007). The female athlete triad may occur especially when women lose too much fat and they risk injury and decreased performance. Studies on the anthropometric measurements and body composition of athletes have been carried out on Malaysian athletes (Ismail & Zawiah, 1989), American athletes (Fleck, 1983) and found that all groups of athletes were below the average values for percentage body fat of 14%-20% for women and 6%-13% for men.

The Body Mass Index, BMI, calculated as body mass in kilograms divided by height in meters squared is used in classifying fatness in athletes and non-athletic populations. According to the Expert Panel on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults (WHO Expert Consultation, 2004), a BMI of 25-29.9 kg/m^2 is considered as overweight while a BMI of 30 and above is considered obese. However, BMI alone has been found not to be an accurate measure of fatness in college athletes (Ode et al, 2007) and may classify over-fat individuals as normal due to its low sensitivity. Because of the larger muscle mass among the male and female athletes, BMI incorrectly classify normal fat athletes as obese. For this reason, BMI is used together with body fat percentage in order to give a more accurate measure of body fatness (Manila, 2007).

2.6 Eating Patterns and Meal Frequencies of Athletes

Assessment of meal patterns of athletes can facilitate the development of health promotion as well as provide information on desirable dietary habits. It can be used as an aid to nutritional counseling and in the assessment of eating disorders. Dietary guidelines for athletes require proper nourishment every day to provide energy from both macronutrients and micronutrients all of which are essential for good health and athletic performance (ADA, 2000). A study done by Burke et al (2003) on eating patterns and meal frequencies of elite Australian athletes established that the athletes ate approximately on five separate occasions each day with snacks and drinks consumed between meals. This was consistent with guidelines for sports nutrition that athletes consume snacks in between meals in order to meet energy needs (Kreider et al, 2010). However, student athletes are sometimes left with very little time to plan and prepare meals and usually take the easiest option for a meal (Paugh, 2005).

2.7 Physical Activity and Energy Expenditure of Athletes

In the body, food consumed is oxidized or combusted in the presence of oxygen to release carbon dioxide and heat (Gibney, Laham, Cassidy &Voster, 2009). When the ingested food is used for energy, the release and transfer of energy occur through a series of metabolic pathways in which the potential energy from food is released gradually over time (Wardlaw & Smith, 2011). This process ensures that the body is provided with a gradual and constant energy store rather than relying on a sudden release of energy from an immediate combustion of ingested food. It occurs continuously in the body and constitutes energy expenditure (Gibney et al, 2009). Gibney has further identified the major sources of energy expenditure in the body as thermic effect of meals, resting metabolic rate (RMR) and physical activity. Physical activity is a form of behavior (sports, leisure and general activities of daily living), whereas energy expenditure represents the total energy requirements of an individual that are required to maintain energy balance (Ekelund, 2002). Physical activity is quantified in terms of intensity, frequency and duration while energy expenditure is measured as the energy cost of a given form of physical activity (calories burned). For every physical activity, the body requires energy and the amount depends on the duration and type of physical activity. The cumulative total daily energy cost of physical activity is highly variable and depends on age, gender among other factors. This implies that physical activity provides the greatest source of flexibility in energy expenditure and is the component through which large changes in energy expenditure can be experienced (Gibney et al, 2009). Athletes therefore need to consume enough energy to maintain appropriate weight and body composition while training (Thompson et al, 1995). Energy expenditure can be measured using the Doubly Labeled Water (DLW) method, using heart rate monitors, diet records and activity diaries (Zhang el al, 2003). The former is more accurate and reliable but expensive requiring use of equipment that are not locally available. This study employed the use activity diaries where athletes recorded over a seven day period intensity and length of physical activities.

Energy balance occurs when energy intake equals energy expenditure. A negative energy balance compromises performance and negates benefits of training. Achieving energy balance on the other hand is essential for maintenance of lean tissue mass, immune and reproductive functions and optimum athletic performance. If energy intake does not cover the costs of energy expenditure, then weight and muscle mass are lost, and the ability to perform strenuous exercise declines. Weight loss in an active individual can decrease exercise performance and the health benefits associated with exercise training. It is therefore necessary that physically active individuals maintain energy balance by having adequate dietary intake.

2.8 Summary of literature

From the foregoing literature review, it emerges that studies on dietary intake of athletes have been carried out and especially so outside Kenya (Martin et al,2006; Noguera, 2005; Papadoupolou et al, 2002; Zawila et al, 2003 and Ziegler et al, 2002 among others). A few studies have been done on Kenyan athletes (Mukeshi & Thairu, 1993; Onywera et al, 2004). However, literature is lacking on dietary intake of both male and female college athletes in Kenya. This study therefore set out to assess the dietary intake of the Kenyan college athlete and compare the consumption of male athletes to that of the female athletes.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the research design and methodology used in the study. It is broken into the following sections: study design, study area, study population, sampling procedure and sample size determination, data collection and data analysis as well as ethical considerations.

3.2 Study Research Design

The study adopted a cross-sectional survey design and used both questionnaires and anthropometric measurements to collect data. A cross-sectional study is observational in nature and allows the researcher to record the information that is present in a population without manipulating variables (Gratton and Jones, 2004). This design was therefore found appropriate as it was employed in this study to gather data to support further research in sports nutrition.

3.3 Study Area

The study was conducted in Rift Valley Technical Training Institute (RVTTI) in Eldoret, Uasin Gishu County and Olessos Technical Training Institute (OTTI) in Nandi County. Both are tertiary institutions that offer courses in technical and business education. RVTTI is situated along Eldoret- Kaptagat road about 3 kilometers to the east of Eldoret town (Appendix 6). The institute sits on forty acres of land and currently has a student population of 2,200, a teaching staff of 105 and non-teaching staff of 55. OTTI is situated 50km from Eldoret town about 22km from the Eldoret-Kapsabet along Nabkoi road. They are among five such institutions in the north rift region. Others include: Rift Valley Institute of Science and Technology; Kaiboi Technical Training Institute and Kitale Technical Training Institute. Uasin Gishu and Nandi Counties are famous as home to international athlete. This has motivated many young people to venture into athletics and start training at an early age in the hope of making it to national then international competitions. It has also led to emergence of training camps within the region where international athletes from all over the country come to train. Since students cannot afford to train in the camps, the institutions provide opportunities for them to train and compete both nationally and regionally within the campuses

3.4 Target Population

The study targeted 150 male and 95 female college athletes aged between 18 to 26 years drawn from Rift Valley and Olessos Technical Training Institutes. The two institutions have many sports men and women who participate in local and national events. The study included all consenting bona fide students of the two technical training institutes and those currently registered for participation in athletic events. It however did not include those students training for sports like ball games and field events.

3.5 Sampling Technique and Sample Size

Stratified sampling technique was used in the study. Athletes were stratified into two categories men (82 from RVTTI and 68 from OTTI) and women (54 from RVTTI and 41 from OTTI). From the population of 245, a representative sample of 71 was selected based on the following formula by Nassiuma (2000):

$$n = \frac{Nc^2}{c^2 + (N-1)e^2} = \frac{245(0.2)^2}{0.2^2 + (245-1)0.02^2} = 71$$

Where	n	=	Sample size
	N	=	Population
	c	=	covariance
	E	=	standard error

Nassiuma (2000) asserts that in most surveys, a coefficient of variation in the range of 21%-30% and a standard error of 2%-5% is acceptable. The lower limits of the coefficient of variation and standard error were selected so as to ensure low variability in the sample and minimize the degree of error. Thereafter the proportionate stratification formula was used to allocate athletes into the two categories (male and female). The purpose of the method was to maximize survey precision and to ensure that each stratum had the same sampling fraction. The formula used was: $n_h = \left(\frac{N_h}{N}\right)n$

Where,

n_h is the sample size for stratum h,

n is total sample size,

N_h is the population size for stratum h,

N is the total population

Hence,

Table 3.1 Sample Stratification in Terms of Gender

Athletes	**Target Population**	**Sample Size** $n_h = \left(\frac{N_h}{N}\right)n$
Male	150	44
Female	95	27
Total	**245**	**71**

A sample of convenience of 44 male and 27 female athletes from both institutions was used. RVTTI had 82 male and 54 female athletes while OTTI 68 male and 41 female athletes. The sample stratification formula was applied to determine number of athletes per institute to take part in the study (Table 3.2).

Table 3.2 Sample Stratification per Institute

Athletes	**Sample Size**	
	Male	Female
RVTTI	24	15
OTTI	20	12
Total	**44**	**27**

3.6 Data Collection

The data examined in this study was collected using detailed self-administered questionnaires. In part I of the questionnaire, the athletes were required to fill in information on their demographic characteristics, dietary habits, nutritional knowledge, and their health status (Appendix 2).

3.6.1 Nutritional Status of Athletes

Height and weight of the athletes (taken barefoot and in light clothing) were measured to the nearest 0.1 cm and 0.1 kg respectively using a SECA weighing scale with height attachment (Vogel and Halke Hamburg, Model 7141014009). The measurements were taken twice and an average of the two recorded (Appendix 3). Skin fold thickness measurements were taken using a skinfold caliper (GIMA PLICOMETRO Model S.P.A Cod 70200) at different sites based on gender as described by Jackson and Pollock (1985) and ACSM procedures (Durnin and Rahaman, 1967). These sites for men included the chest, abdominal and thigh skinfolds while for females, the triceps, waist and thigh skinfolds were used. To take measurements, each skin fold was grasped firmly with the thumb and index finger holding the caliper perpendicular to the fold approximately one centimeter away from the thumb and finger. The sites were measured in succession to avoid experimenter bias and a complete data set obtained before repeating the measurements for the second time (Appendix 3&4).

All skinfold measurements were taken on the athletes' right side irrespective of their preferred side as per the guidelines of the American College of Sports Medicine (ACSM) 2000).The measurements were taken in the morning before training by research assistants who had been trained how to do this by the researcher. This ensured the reliability of the results as measurements taken after training, competition or showering may increase skin fold thickness since exercise, warm water and heat produced increase blood flow in the skin (Norton et al., 1996).

3.6.2.1 Measures of Dietary Intake

The seven-day estimated food record was used to record the time of consumption, identity and amount of food and beverages consumed for a period of seven days during the study period for both male and female athletes. Reporting over the seven-day period has been found to provide the best opportunity to collect valid information as it encompasses the potential diversity of diet and activity practices of weekends and weekdays (Martin, et al, 2006). Recording foods as they are consumed lessens the problem of omission and the foods are more fully described (Thompson and Subar, 2002). Furthermore, dietary intake records have been used to assess nutrient intake of college athletes (Clark et al, 2003). Household measures including cups, tablespoons and teaspoons were provided by the researcher to help respondents quantify food items. The quantities were further converted to grams and milliliters to enhance analysis. Items like eggs and soft drinks were taken as units. Apart from providing food intake data, this method also provided important information about eating habits of the respondents.

3.6.2.2 Activity Pattern

The athletes were instructed to accurately fill the activity diary for seven days in order to provide as detailed as possible information on their daily training pattern during the training period. Details of time, duration and intensity of the physical activity performed were recorded. Participants were trained to differentiate three categories of intensity: light, moderate and heavy.

3.7 Data Analysis

Data analysis is the process of computing certain measures along with searching for patterns of relationship that exist among data groups (Kothari, 2004). In this study, once the questionnaires were received, the raw data was edited to correct errors and omissions where possible. The responses were categorized based on themes and sub-themes. Means, percentages and standard deviations were computed to provide general view and trend of the variables**.** The weight and height measurements were used to calculate body mass index (kg/m^2) for each athlete and results presented as a mean. Skinfold measurement was used to calculate body fat as a percentage of body weight using a computer calculator downloaded from www.linear-software.com/online.html.

Dietary intake data was analyzed using Nutri Survey 2007 Program (Gibson, 2005) and the intake expressed as a percentage of the RDA. The Nutri Survey is the English translation of the German nutrition software, EBISpro. The software was downloaded (nutrisurvey2007.exe) and used to determine nutrient intake which was compared with RDA. This software was chosen for its efficiency since it contains the food databases of different countries, including Kenya. The macronutrient intake was compared to the Acceptable Macronutrient Distribution Ranges (AMDR) to determine the balance of macronutrients intake and the results compared with recommendations of the Food and Nutrition Board of the Institute of Medicine (FNB/IOM, 2002). The paired sample t-test was used to determine difference between nutrient intake and RDA. One way analysis of variance (ANOVA) was used to analyze differences between dietary intake of male and female athletes. The level of statistical significance for analysis was set at $P<0.05$.

3.8 Validity and Reliability

Validity of a research instrument is its ability to measure what it sets out to measure so that differences in individual scores can be taken as representing true differences on the characteristics under study (Mugenda and Mugenda, 1999). To ensure validity of the data, the scales used to take measurements were calibrated using known weights. Each measurement was taken twice on two different days and an average of the two used. To avoid diurnal variations in weight, the respondents were all weighed in the mornings before start of the training sessions. According to Marfell (2006), the best times for the measurements to be taken is in the morning twelve hours after having ingested food.

Reliability is degree to which an assessment tool produces stable and consistent results by the same person when re-examined with the same test on different occasions (Mugenda and Mugenda, 2003).To ensure reliability, a test-retest was carried out on the seven day food record among fifteen male and ten female college students from Rift Valley Technical Training Institute not participating in the survey. The questionnaire was given out to the respondents during the pretest. After this, the wording of the questions on nutritional knowledge was changed as the respondents felt it was not very clear. The average length of time required in carrying out anthropometric measurements, comprehension by participants and length of time needed to complete the survey was considered in the pre-test. The actual procedure to be used during the study was used with the same interviewers and appropriate changes made according to suggestions by the participants.

3.9 Ethical Considerations

Permission to carry out the research was obtained from the administration of both institutes (Appendix Participants were briefed on the purpose and requirements of the study. Those who took part in the study were requested to sign a consent form (Appendix 1) indicating their consent to take part in the study. Privacy and confidentiality was ensured by not requiring the participants to reveal their names or courses they were taking in college. Instead each participant was assigned an identification number to protect their identity. All consent forms and completed questionnaires were stored by the researcher in a locked cabinet to ensure the information remained confidential. Data was stored in a computer with a protected password. Data was backed up in a memory stick that was locked in a personal cabinet.

CHAPTER FOUR

RESULTS AND DATA PRESENTATION

4.1 Introduction

This chapter presents the results of the study. The aim of the study was to determine the dietary intake of college athletes as well as their eating patterns. The factors that could influence their dietary intake and nutritional status were also investigated. These included social economic factors, health status and nutritional knowledge. Anthropometric measurements of all the athletes were taken to determine body mass index (BMI) and percentage body fat. The sample consisted of college athletes who were enrolled in Rift Valley Technical Training Institute and O'lessos Technical Institute in Uasin Gishu and Nandi Counties respectively. Out of the 71 questionnaires distributed, sixty seven (n=67) were filled and returned with n=42 male athletes and n= 25 female athletes.

4.1 Demographic Characteristics of Athletes

Table: 4.1 Demographic Characteristics of Athletes

Characteristic	Frequency	Percentage %
Gender		
Male	42	62.7
Female	25	37.3
Age of respondents		
18-21	15	22
22-25	51	76.1
26 years and above	1	1.5
Marital status		

Single	66	98.5
Married	1	1.5
Year of study		
1st year	22	32.2
2nd year	33	47.2
3rd year	12	18.6
Residence of athletes		
College hostels	9	13.4
With parents	4	6
With friends	42	62.6
Alone	12	18

Data presented in Table 4.1shows how the respondents were distributed according to gender, year of study, age and marital status. From a sample of 67 athletes, 62.7% (n=42) were male, while 37.3%, (n=25) were female. The average weight of male athletes was 63.6 kg while that of female athletes was 55.1 kg. Majority, 76.1% (n=51) were between 22 – 25 years, while 1.5%, (n=1) was above 26 years of age. Only one male athlete was married while the rest, 98.5 % (n=66) were single. Results also showed that 47.2% (n=33) were in the second year of study, 32.2% (n=22) and 18.6% (n=12) were in first and third years respectively. Regarding residence of the athletes, 62.6% (n=42) lived with friends, 18% (n=12) lived alone, 13.4% (n=9) lived in college hostels and 6% (n=4) lived with their parents. No athlete reported use of vitamins or food supplements during the training period.

4.2 Dietary Intake of College Athletes Compared to Recommended Dietary Allowances

Table 4.2: Macro Nutrients Intake of Male Athletes

Nutrient	Mean	% of RDA	Std. Deviation	t	P value
Energy RDA (kJ)	12133.6	77.9	1200	1.811	0.076
Energy intake (kJ)	9450.8				
Water RDA (ml)	3700.0	61.0	794.8	3.622	0.001*
Water intake (ml)	2259.2				
Protein RDA (g)	60.5	122.5	13.2	-7.751	0.000**
Protein intake (g)	74.1				
Fat RDA (g)	69.3	60.3	15.1	13.399	0.000**
Fat intake (g)	41.8				
Carbohydrate RDA(g)	293.1	142.8	43.3	-2.125	0.038*
Carbohydrate intake (g)	418.5				
Dietary fiber RDA (g)	30.0	114.3	8.7	-3.685	0.001*
Dietary fiber intake (g)	34.3				

n= 42; *p< 0.05; **p< 0.001

The energy intake for male athletes was 9450.8 kJ, which was lower than the recommended intake of 12133.6 kJ (t= 1.811, p<0.05). Water intake was 2259.2 ml which was also lower than the recommended intake of 3700 ml (t = 3.622, p<0.05). The protein intake of 74.1gwas significantly higher than the recommended 60.5g intake (t = -7.751, p<0.05). The fat intake of 41.8g by the male athletes was significantly lower than the recommended value of 69.3g (t= 13.399, p<0.05). The findings also showed that the intake of carbohydrates and dietary fiber were higher than the recommended values. The intake of each macronutrient was also expressed as a percentage of the RDA. Water and fat intake fell below 2/3 of the RDA. These results are summarized in table 4.2 above.

Table 4.3: Micro-nutrient intake of male athletes

Nutrient	Mean	%RDA	Std. Deviation	T-test	p
VIT A RDA (mcg)	949.1	167	989..3	-4.76	0.000**
VIT A intake (mcg)	1584.1				
VIT B1 RDA (mg)	1.2	167	6.0	-0.957	0.343
VITB1 intake (mg)	2.0				
Folic acid RDA (mcg)	393.8	64.3	92.2	11.416	0.000**
Folic acid intake (mcg)	253.2				
Vit C RDA(mg)	99.8	82.6	37.0	3.511	0.001*
Vit C intake (mg)	82.4				
Potassium RDA(mg)	3247.5	67.7	843.8	9.304	0.000**
Potassium intake (mg)	2198.3				
Calcium RDA (mg)	1028.1	70.2	226.4	10.114	0.000**
Calcium intake (mg)	722.1				
Iron RDA (mg)	16.0	106	26.7	-0.247	0.805
Iron intake (mg)	16.9				
Zinc RDA (mg)	13.1	95.4	20.8	0.209	0.836
Zinc intake (mg)	12.5				

n=42; * $p< 0.05$; ** $P<0.001$

The intake of Vitamin A, 1584.1mg and magnesium, 404.5 mg was significantly higher than recommended values ($t = -4.76$ and 2.4 and respectively, $p<0.05$). The intakes of folic acid 253.2 mcg, Vitamin C 82.4mg, potassium 2198.3 mg and calcium 722.1 mg were significantly lower than the recommended values (t= 11.4, 3.5, 9.3 and 10.1 respectively; $p<0.05$). No significant differences were found in the intakes of vitamin B_1 iron and zinc (Table 4.3).

4.2.2 Dietary Intake of Female Athletes

Table 4.4: Macro Nutrients Intake of Female College Athletes

Nutrient	Mean	% of RDA	Std. Deviation	t	p value
Energy intake (kj)	8322	90.4	337.2	-0.8	0.001**
Energy RDA (kj)	9204.8				
Water intake (ml)	1678.0	62.1	514.9	-6.583	0.000**
Water RDA (ml)	2700.0				
Protein intake (g.)	70.8	117.8	16.0	2.228	0.05*
Protein RDA (g.)	60.1				
Fat intake (g.)	39.2	57.4	10.5	-9.193	0.000**
Fat RDA (g.)	68.3				
Carbohydrate intake (g)	330.4	114	56.3	2.339	0.041*
Carbohydrate RDA(g)	290.7				
Dietary fiber intake (g.)	33.7	110	5.9	2.093	0.063
Dietary fiber RDA (g.)	30.0				

n=25; * $p< 0.05$; ** $p< 0.01$

Table 4.4 presents the mean daily macro nutrients intake for female athletes. The intakes of energy (8321.9 kj), water (1678ml) and fat (39.2gm) were significantly lower than the recommended values with t =-0.463, t=-6.583 and t=-9.193 respectively significant at p<0.05. Carbohydrate intake of 330.4g was higher than recommended value of 290.7g, the differences was significant at t= 2.339, p=0.05.

Table 4.5: Micronutrient Intake of Female College Athletes

	Mean	% of RDA	Std. Deviation	t	p
VIT A intake (mg)	2028.2	227	1693.8	2.16	0.056
VIT A RDA (mg)	890.9				
Folic acid intake (mcg)	262.6	65.7	67.3	-6.8	0.000**
Folic acid RDA (mcg)	400.0				
Vit C intake (mg)	101.1	101	50.7	0.073	0.944
Vitamin C RDA (mg)	100.0				
Sodium intake (mg)	1188.4	59.4	936.5	-2.874	0.017*
Sodium RDA (mg)	2000.0				
Potassium intake (mg)	2320.9	66.3	573.4	-6.82	0.000**
Potassium RDA (mg)	3500.0				
Calcium intake (mg)	595.0	60	178.5	-7.525	0.000**
Calcium RDA (mg)	1000.0				
phosphorus intake (mg)	1081.7	154	149.2	8.484	0.000**
phosphorus RDA (mg)	700.0				
iron intake (mg)	12.7	70.6	2.6	-13.7	0.001*
Iron RDA (mg)	18				
zinc intake (mg)	11.3	135	1.5	4.493	0.001*
zinc RDA (mg)	8.4				

n=25; *p< 0.05; **p< 0.001

Results of micronutrient intake of female athletes indicated that the intakes of folic acid (262.6mcg), sodium (1188.2mg), potassium (2319.9mg), calcium (595mg) and iron (12.7mg) were significantly lower than the recommended values ($p<0.05$). The intake of phosphorus (1081.7 mg) was significantly higher than recommended value (Table 4.5).

Table 4.6: Acceptable Macronutrient Distribution Ranges (AMDR) of College Athletes

Nutrient	AMDR for males n=42	AMDR for females n=25
Carbohydrates	74.1%	66.4%
Proteins	13.1%	11.7%
Fat	16.7%	17.7%

The macronutrient intake for both male and female athletes was compared to the Acceptable Macronutrient Distribution Ranges (AMDR). The AMDR is expressed as a percentage of total energy. The AMDR ranges for carbohydrates, proteins and fats were 74.1%, 13.1, and 16.7% respectively for male athletes, while for female, they were 66.4%, 11.7, and 17.7% respectively.

4.2.3 Comparison of Nutrient Intake between Male and Female Athletes

Table 4.7: Comparison of Nutrient Intake between Male and Female Athletes

	Mean				
	Male (n=42)	**Female (n=25)**	**Std. Deviation**	**t**	**p**
Energy intake (kj)	9214	8322.8	376.4	1.708	0.044*
Water intake (ml)	2401.3	1678.0	853.6	2.682	0.01*
Protein intake (g)	75.0	70.8	12.7	0.913	0.365
Fat intake (g)	42.4	39.2	15.3	0.664	0.51
Carbohydrate intake (g)	441.1	330.4	482.8	0.754	0.455
Dietary fiber intake (g)	34.3	33.7	9.2	0.189	0.851
VIT A intake(mg)	1473.0	2028.2	622.3	-1.78	0.081
VIT B1 intake (mg)	2.2	1.1	6.7	0.539	0.592
Folic acid intake(mcg)	250.9	262.6	67.2	-0.52	0.605
Vit C intake (mg)	77.9	101.1	31.7	-1.92*	0.06*
potassium (mg)	2168.4	2320.9	694.7	-0.673	0.504
Calcium (mg)	753.2	595.0	362.8	1.398	0.168
Phosphorus (mg)	1140.6	1081.7	307.0	0.616	0.541
Iron (mg)	16.6	18.0	3.5	-1.134	0.262
Zinc (mg)	12.8	11.3	2.6	1.769	0.082

*significant at $P<0.05$

The study also compared the dietary intake of male and female athletes. Except for water, the study found no significant difference in the intake of the various nutrients. Although the male athletes consumed higher carbohydrates, proteins and fats, when calculated relative to body weight, the distribution was similar in males and females (Table 4.7).

4.3 Nutritional Status of Male and Female Athletes

Table 4.8: BMI (Kg/m^2) of Athletes

	n	Mean	Std. Deviation	Minimum	Maximum
Male	42	19.6	1.2	17.3	22.1
Female	25	19.2	1.2	17.1	21.2

ANOVA (F-test) = 21.1 *p-value = 0.87*

Male athletes had a BMI of $19.6kg/m^2$ with a maximum of $22.1kgm^2$ and minimum of 17.3 Kg/m^2 while that of females was 19.2 kg/m^2. There was no significant difference between BMI of male and female athletes (ANOVA = 21.1, $p>0.05$). These results are summarized in table 4.8.

Table 4.9: Body Fats of Athletes

	n	Mean (%)	Std. Deviation	Minimum (%)	Maximum (%)
Male	42	6	1.1	4	8.5
Female	25	11.7	4.9	5.5	15.7

ANOVA = 55.4 *p-value = 0.000*

In relation to body fats, male athletes had 6% while female athletes had 11.7% body fat. (ANOVA = 55.4, $p<0.05$) as shown in table 4.9.

4.4 Eating Patterns and Meal Frequencies of Athletes

Table 4.10: Eating Patterns and Meal Frequencies of Athletes

		Frequency	Percent
Person prepares your meals	Self	51	74.6
	Parents	7	10.2
	Hostel Food	8	11.9
	Wife	1	1.7
Most important meal of the day	Breakfast	37	55.9
	Lunch	6	8.5
	Supper	24	35.6
Favorite Food	*Ugal*i and *Sukuma*	6	8.5
	Ugali fresh milk	22	32.2
	BeefUgali	2	3.4
	Ugalimursik	14	20.3
	Githeri	6	8.5
	Others	2	3.4
Times per day respondents eat	Once a day	1	1.7
	Twice a day	5	6.8
	Thrice a day	51	76.3
	Four times a day	10	15.3
Frequency of eating fruits	Once a day	26	39
	Once week	40	59.3
	Twice a week	1	1.7
favorite beverage	Tea with Milk	42	63
	Milk alone	13	20
	Soda	5	7
	Beer	2	3
	Fruit juice	5	7
Snacks Between meals	Yes	14	20.7
	No	53	79.3

The study sought to establish who prepared the athletes meals during training and competitions. Majority of them 74.6% (n=50) reported that they prepared their own meals, 10.2% (n=7) reported that their meals are prepared by parents, 13.4% (n=9) ate meals prepared in the institutional kitchens and only one athlete (1.7%) reported that he had a wife who prepared meals for him (Table 4.2).

Results showed that 55.9% (n=37) of the athletes regarded breakfast as their most important meal while 35.6% (n=24) considered supper as the most important, while 8.5% (n=6) considered lunch as the most important.

The study established that *Ugali* and Fresh milk was the most favored food by athletes (32.2%), followed by *Ugali/Mursik* (20.3%), while 8.5% (n=6), 3.4% (n=2) and 3.4% (n=2) indicated that *Githeri*, *Ugali* Beef and other foods as their favorite foods respectively. Tea with milk was reported to be a favorite beverage by 63% (n=42), 20% (n=13) preferred milk alone, 7% (n=5) soda and fruit juices and only 3% (n=2) took beer as their favorite drink.

The majority of the athletes reported that they consumed three meals a day (76%), 15.3% (n=10) ate 4 times a day, and 6.8% (n=5) two times per day. A small percentage of athletes 1.7% reported that they ate only once a day. Majority 79.3% (n=53) did not take snacks in between meals, while 20.7% (n=14) took snacks. Athletes further reported that they consumed fruits once a week (59.3%), twice a week (1.7%) and (39%) reported that they took fruits at least once a day.

To investigate the culture and tradition of athletes in relation to dietary intake, the athletes were asked whether their culture recommended a particular food to enable them perform well in competitions. A large number of the athletes 76.3% (n=51) reported that their culture had no traditional food recommended for athletes, contrary to 11.9% who reported their culture believed that taking *mursik* before competitions helped them perform better. In addition, 91.5% (n=61) reported that they; 5 did not have any special meals during training. Moreover, 87.7% (n=59) revealed that coaches did not recommend specials meals for athletes. There was an interesting response by 12.3% (n=8) athletes who reported that their coaches recommended taking of beetroot before performance. There was no scientific explanation to this by the athletes.

4.5 Nutrition Knowledge of Athletes

Descriptive terms were used to determine the level of nutrition knowledge of athletes whether excellent, good, moderate or little. Results indicated that 21% (n=14) had excellent knowledge of RDA of nutrients, 27.8% (n=19) had good knowledge, 41.2% (n=28) had moderate while 10% (n=7) indicated they had very little knowledge of RDA. Majority, 57% (n=38) had excellent knowledge of the functions of nutrients in the body while only 3% (n=2) had little knowledge of functions of nutrients in the body. Only 12% of the athletes (n=8) had an excellent knowledge of dangers associated inadequate intake of nutrients while 50% (n=34) had little knowledge of the same.

Table 4.11: Level of nutrition knowledge of athletes

Attribute		Excellent	good	Moderate	little
Knowledge of recommended Dietary allowance of nutrients	Percentage	21	27.8	41.2	10
	Frequency	14	19	28	7
Knowledge of functions of	Percentage	57	28.3	11.7	3

nutrients in the body					
	Frequency	38	19	8	2
Knowledge of the best source of nutrients	Percentage	58	20.7	13.2	8.1
	Frequency	39	14	9	5
Knowledge of dangers associated with inadequate intake of nutrients	Percentage	12	14.8	23.2	50
	Frequency	8	10	16	34

Table 4.12: Source of nutrition knowledge of athletes

		Frequency n=67	Percentage %
Source of knowledge	Coaches	13	19.2
	College Courses	11	15.8
	magazine	23	34.8
	internet	12	17.3
	books	9	13.3

The source of nutrition knowledge varied among the athletes with 34.8% (n=11) reporting that they obtain information from magazines, 19.2% (n=6) from coaches, 17.3% (n=5) from internet and colleges courses and 13.3% (n=4) from books. This information is summarized in table 4.12.

4.7 Physical Activities of College Athletes

Table 4.14: Physical Activities of College Athletes

Race	Frequency	Percentage
Short races (100m-200m)	2	3.4
Medium races (400m- 800m)	22	32.8
Long distance (1500m-10000m)	41	61.1
Marathon	17	25.4
Length Of Competing		
Less than one year	5	6.8
1-5 years	53	79.5
more than five years	9	13.7
Races Participated In…		
Athletics Kenya meetings	35	59
KETTISO	28	47.5
KCB Marathon	2	3
Kass marathon	3	3
Olympics	2	3.4
Rift Valley Charity Run	4	6.8
Others	14	23.8

Findings in table 4.14 revealed that majority 61.1% (n=41) of the athletes in the training institutes train and compete in long distance (1500m-10000m) races, 32.8% (n=22) of the athletes compete in medium races and 25.4% (n=17) compete in marathons. There was minimal participation in short races (3.4%). Further, the study established that most of the athletes 79.5% (n=53) had been competing for 1 – 5 years while 13.7% (n=9) and 6.8% (n=5) indicated that they have been competing for more than five years and less than one year respectively. The results revealed that 59% (n=35) have participated in Athletic

Kenya meetings, followed by 47.5% (n=28) who reported to have participated in Kenya Technical Training Institutions Sport Organization (KETTISO). Only 3% had participated in KCB marathon or the Olympics.

4.8 Energy Expenditure and Energy Balance of Athletes

Table 4.15: Energy Expenditure and Energy Balance of College Athletes

	Energy Intake (kJ)	Energy Expenditure (kJ)	Energy Balance (kJ)
Male	9029	10656.6	-1627.6
Female	8322	10418	-2096

The total daily energy expenditure derived from physical activities was 10656.6 kJ in male athletes while that of female athletes was 10418 kJ. Energy balance was obtained from the difference between energy intake and energy expenditure. This put both male and female athletes in negative energy balance of -1627.6 kJ and – 2096 kJ respectively.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary and discussion of the research findings from the study. It also provides conclusions, recommendations and suggestions for further research.

5.2 Discussion of the Findings

5.2.1 Carbohydrate Intake of Athletes

The carbohydrate intake of athletes was expressed as percentage of RDA to determine how the intakes differed with RDA. Male athletes had 142.8% of RDA while female athletes had 114% of RDA. This implied that the athletes met and exceeded the RDA. When expressed relative to body mass, the daily carbohydrate intake was 6.6g/kg body weight /day and 6.1g/kg body weight/day for male and female athletes respectively. This met the recommendations of 5-7g/kg body weight per day for moderate intensity exercise (IOM, 2002; Burke et al, 2004). Higher dietary carbohydrate content during training and exercise has been reported to result in better maintenance of physical performance in athletes and may affect mood state (Archten *et al*, 2004). The high carbohydrate diet as is evident in this study is consistent with results of other studies on Kenyan athletes. In their study of Kenyan runners, Onywera et al (2004) and Mukeshi and Thairu (1993) found that the diet of Kenyan runners was high in carbohydrates. Christensen *et al* (2002) in a study of male adolescent Kalenjin runners in Kenya also found the diet of the athletes to be high in carbohydrates. They attributed the high carbohydrate intake to the fact that the staple diet of the people of Rift Valley is *ugali* which the athletes were found to consume on a daily basis. The high carbohydrate diet in athletes in the current study can also be attributed to high intake of *ugali* which was taken on a daily basis and sometimes more than once a day. Unlike the Kenyan athletes, studies of other athletic populations have shown an under-consumption of carbohydrates (Grandjean, 1989; Guadalupe, 2000 and Hinton, 2004). The carbohydrate intake of athletes in this study was in line with recommendations of sports nutritionists for greater need of carbohydrates since athletes burn glycogen during exercise hence, stores are depleted (Browning and Giroux, 2010).

5.2.2 Protein Intake of Athletes

Exercise physiologists and sport nutritionists generally agree that exercise increases the need for protein (ADA, 2000). The protein intake for athletes in this study was 122.5% and 117.8% of RDA for male and female athletes respectively. When expressed relative to body mass, the athletes' diet consisted of 1.2 g/kg body weight and 1.3g/ kg body of protein for male and female athletes respectively. This met the recommendation of 1.2-1.4g/kg body weight/ day for individuals participating in endurance sports (IOM, 2002). The AMDR of 13.1% and 11.7% for male and female athletes respectively was within the range of 10%-35% recommended by the Institute of Medicine (2002). According to Ronnie and Tipton (2000), if an athlete is consuming 12-15% of their recommended energy intake from proteins, they do not need supplementation from extra protein. This implies that the athletes in this study would not require supplementation on proteins.

Studies on protein intake of athletes have shown higher intakes of proteins when compared to the recommended values. Browning and Giroux (2010) in their study of college cross country runners observed an intake of 2g/kg of body weight while Berning et al (1991) in their study of adolescent athletes established that males consumed 2.14g of protein per kg of bodyweight a day while females consumed 1.84g per kg body weight. The high protein diet of the athletes in this study can be attributed to the intake of kidney beans in *githeri* and in bean stew.

5.2.3 Fat Intake of Athletes

The intake of fat for athletes in this study was at 60.3% of RDA and 57.4% of RDA for male and female respectively. This was found to be very low as it fell below two thirds of the RDA. When expressed in absolute terms, the intake of fat was 0.7g/kg body weight per day for both male and female athletes. The contribution to total energy intake was 17.4% and 17.6% for male and female athletes respectively. Dietary recommendations for active individuals focus on getting keeping fat intake to 25%-35% of energy intake which is within the AMDR for fat of 20%-35% (IOM, 2002). This implies that these did not meet the dietary recommendations for fat intake or AMDR for fat. This is contrary to the findings of Browning & Giroux (2002) where athletes were found to consume 31% of their total energy from fats. Fat in athletes is essential and low fat intakes of less than 15% of energy may decrease energy and nutrient intakes and consequently exercise performance.

5.2.4 Energy Intake of Athletes

Caloric intake is a very important aspect of nutrition for runners as low intake will not provide enough energy to sustain a high level training and competition. Both male and female athletes in this exhibited energy intake below the recommendations. Low energy intake was found in Kenyan athletes in a study by Onywera et al (2004) where the diet was high in carbohydrates and proteins but low in fats and energy. A similar study carried out by Mukeshi and Thairu (1993) on Kenyan long distance male runners also reported low energy intake. However, a study done on Ethiopian athletes established that the athletes met dietary recommendations for all the macronutrients (Beis *et al*, 2011). On the other hand, the low energy and fat intake by both groups could be attributed to the low consumption of those products that provide high fat and energy like snacks. The macronutrient intake of both male and female athletes was also compared to the Acceptable Macronutrient Distribution Ranges (AMDR). The AMDR are ranges of intake for a particular energy source that are associated with a reduced risk of chronic disease while providing adequate intake of the essential nutrients (FNB/IOM, 2002). The acceptable macronutrient distribution ranges were set at (45%-65% of energy) for carbohydrate, (10%-35%of energy) for protein and (20%-25% of energy) for fat. The athletes in this study had an AMDR of carbohydrate (74.1% of energy), protein (13.1% of energy) and fat (16.7% of energy) for the male athlete. The distribution for the female athlete was carbohydrate (66.4% of energy), protein (11.7% of energy) and fat (17.7% of energy). This implied that both male and female athletes met the Food and Nutrition Board recommendations for carbohydrates and proteins but failed to meet the recommendations for fat. The low energy from fats was also observed in the dietary intake of fat which was lower than the RDA. Similarly, Christensen et al (1993) reported an AMDR of 71% from carbohydrates for Kalenjin runners while Onywera et al (2004) reported 76.5% from carbohydrates in Kenyan elite athletes. This implies that Kenyan athletes are likely to obtain the bulk of their energy from carbohydrates while failing to meet the acceptable range from fats. The low intake energy intakes of athletes in this study can be associated with marginal intakes of important nutrients like calcium, folic acid and magnesium which help in energy production.

5.2.5 Water intake of athletes

Water intake for both male and female athletes in this study was found to be below that recommended by the American Dietetic Association. According to ACSM, ADA and CD (2000), athletes should drink enough fluid during and after exercise to balance fluid losses from sweat and urine. Having a deficit level of hydration for the athletes in this study could lead to problems such as declining performance and increased muscle injury (ACSM, ADA and CD, 2000). According to FDA recommendations, healthy but sedentary individuals should consume 3.7 liters of water from food consumption and liquid intake. An athlete who may lose water in rigorous training and competition may require more than 3.7 liters of water to regulate the function of the body. The athletes in this study consumed 61% and 62.1% of these recommendations for male and female athletes respectively. This implied that the athletes in this study were not meeting the necessary water intake requirements.

5.2.6 Micronutrients Intake of Athletes

The results of this study showed low consumption of folic acid, calcium, vitamin C and potassium below 100% for both male and female athletes. However, the consumption of vitamin A and B1 was higher than 100% of the RDA. The low intake of micronutrients by athletes in this study may be attributed to the low consumption of fruits and vegetables reported by the athletes. The dietary shortages of these micronutrients can have consequences for both health and performance (Kreider et al, 2010). Contrary to the findings of this study, other studies on micronutrient intake of athletes have reported consumption in excess of RDAs by virtue of their increased energy intake (Aerenhouts et al, 2012). Similarly, in a study of elite female athletes in Greece, Hassapidou and Manastrantonic (2001) reported micronutrient intakes above the recommended values with the exception of iron. However, potassium which is necessary for maintenance of cellular fluids and the regulation of blood pressure fell below 100% of the recommendations like in other studies (Aerenhouts *et al*, 2007; Ziegler *et al*, 1998). Calcium is needed for bone acquisition and the needs of calcium are high in athletes. Due to the high level of activities that athletes are involved in, bone density can be achieved with an adequate intake of calcium (Vincente- Rodriguez *et al*, 2008).

The consumption of iron was significantly lower in the female athletes. Low iron intake in female athletes is one of the most prevalent nutrient deficiencies and if not checked can impair muscle function and limit work capacity. Nande et al (2009) also found the consumption of thiamine and folic acid among female athletes to be lower than the respective RDA while male athletes' folic acid was significantly lower than RDA. The shortage of micronutrients in the athletes diet in this study can be attributed to the low intake of fruits and vegetables reported by the athletes in their diet records.

5.2.7 Differences in the Dietary Intake of Male and Female Athletes

Although male athletes in this study consumed higher carbohydrates, proteins and fats than the female athletes in absolute terms, when calculated relative to body weight the distribution was similar in both. It is often assumed that males are easily able to meet recommendations and to have a high enough intake to prevent deficiencies of vitamins and minerals (Hinton *et al*, 2004). In a study of American college athletes it was found that the diets of male athletes were characterized by high intakes of sodium, cholesterol and saturated fats whereas the diets of female athletes were generally characterized by a diet which was more likely to meet nutrient recommendations (Hinton et al, 2004).

5.2.8 Nutritional Status of Male and Female Athletes

The weight and height of the athletes were measured and BMI values calculated. The findings indicated BMI of male athletes was 19.6 while that of female athletes was 19.2. These values can be classified as normal according to Gallagher et al (2000) who categorized BMI scores between 18.5and 24.5 as normal. However, five female athletes had a BMI score of less than 18.5 which is regarded as underweight. According to (Kreider, 2004), a very low BMI may be an indication that the weight is too low which is likely to lower immunity.

The study also determined percent body fat using skin fold thickness of the athletes. The mean percentage body fat was 6% and 11.7% for male and female athletes respectively. This level was far below the range for male and female athletes as per the classification of sports medicine of 14-20% for women and 6-13% for men (ACSM, 2000). Although the athletes in this study had a normal BMI, the same did not apply for percentage which was classified as significantly lower than the requirement for athletes. Similar results were reported by Leelarthaepin, Chesworth and Boleyn (1993) and Nowak, Knudsen and Schulz (1988). This is a potential danger zone that would lead to potential health consequences if not checked

5.2.9 Eating Patterns and Meal Frequencies of the Athletes

Majority of the athletes consumed meals irregularly, and were found to be following a dietary pattern of two or three meals a day. They also skipped meals; these were attributed to college timings and practice schedules. A few attributed the skipping of meals to lack of money to purchase food. In addition, majority did not take snacks in between meals and consumed fruits once a week. Failure to eat snacks among athletes as demonstrated in this study implies that the athletes lacked adequate carbohydrates contrary to the American Dietetic Association (2000) requirement that the athletes consume adequate carbohydrates to nourish the body. In his study of athletes, Burke *et al* (2003) established that the athletes ate approximately on five separate occasions each day with snacks and drinks consumed between meals. This was consistent with guidelines for sports nutrition hence, the athletes were likely to consume adequate intakes of carbohydrates. Sports nutritionists often recommend that athletes consume snacks in between meals in order to meet energy needs as well as ensuring meals are not skipped (Kreidal et al, 2010).

The athletes in this study indicated they ate fruits once per week, similar to findings by Clarke, Reed, Crouse and Armstrong (2003) that the diet of college athletes was generally low in fruits, vegetables and whole grains. According to Lamprecht, (2012) irregular or inadequate consumption of fruits and vegetables has been associated with an inadequate supply of important micronutrients like vitamins and minerals. One interesting observation on the eating patterns of the athletes was on the consumption of *ugali* which 90% of the athletes reported to be their favorite dish. Similarly in their study of Kenyan athletes, Onywera et al (2004) found that *ugali* provided about 23% of the runners' energy. The high intake of *ugali* as revealed in this study was attributed to the fact that the North Rift grows a lot of maize hence making it a staple food of the people in this region. The high intake of *ugali* was also identified by Christensen *et al* (2002) in their study of male adolescent Kalenjin runners in Kenya. The athletes' staple food was maize and kidney beans which were consumed as *ugali* and *githeri* served on a daily basis.

5.2.10 Nutrition Knowledge of Athletes

Though the athletes in the current study had a general understanding of nutrition, there was a greater number that lacked specific knowledge like recommended dietary allowances (58.8%), functions of nutrients (42%) and sources of nutrients (43%). Studies have shown that college athletes from a wide variety of sports have insufficient understanding of the dietary necessities of the human body (Rosenbloom et al 2002; Runn et al, 2011). The athletes in this study had their major source of nutrition knowledge as magazines, coaches and the internet in that order. The specific magazines or newspapers were not noted but it appeared that the athletes felt comfortable consulting magazines rather than the coaches who would be expected to know more. None of the athletes reported consulting nutrition journals which would provide valuable information on their dietary requirements. However, in their study, Douglas and Douglas (1984) found parents to be the primary source of nutritional knowledge among athletes. According to Zawila et al (2003), the quality of nutrition sources is more important than the number of nutritional sources a runner uses and the coach may need to assume a more active role in nutritional education.

5.2.11 Energy Expenditure from Physical Activity

Both male and female athletes in this study were found to be in negative energy balance as they expended more energy in physical activities than what they obtained from dietary intake. This implies that the athletes did not vary their diets during the training period in order to make for the extra calories required. In athletes, expending large amounts of energy in exercise training can cause complications and especially in the female athlete where it may result in menstrual disorders. This was similar to the findings of Ismail et al (1997) on energy requirements of Malaysian athletes where energy intake remained consistent with intakes reported at times of peak training suggesting a marked negative energy balance at the time of peak training. On the contrary, in a research carried out by the American Dietetic Association (2008) on energy balance of highly trained female swimmers, the results showed that energy intake was adequate to satisfy the increase in energy expenditure associated with training. On the other hand, Martin *et al* (2006) conducted a nutritional analysis of elite women soccer players and found average daily intake to be lower than previously reported for female soccer players and fell below previous recommendations for soccer players (196.6 kj-251 kJ/kg/day). Statistical analysis revealed no significant difference between intake and expenditure suggesting average balance. The negative energy balance observed in this study could be attributed to the eating patterns of the athletes since they were not consuming high energy- giving snacks during training hence their energy intake was low. According to sports nutritionists, this energy deficiency during training may impair performance, growth and health (ADA, 2000).

5.3 Conclusions

The following conclusions were drawn from the study:

1. Both male and female athletes consumed adequate carbohydrates and proteins but intake of fats and water was below the RDA. The intake of calcium, folic acid and potassium was below RDA.

2. Both male and female athletes had on average a normal BMI value though their body fat was found to be far below the requirements for athletes.

3. The athletes consumed a limited variety of foods and in less amounts especially fruits and vegetables than they should during training and competition. They however consumed a lot of high carbohydrate foods especially *ugali* and githeri in almost their meals.

4. The athletes showed knowledge of basic nutrition concepts but displayed a lack of sports nutrition and many of them did not know the recommended dietary allowances for physically active people like themselves.

5. There was negative energy balance in both male and female athletes which if not checked can compromise performance.

5.4 Recommendations

The interest in running in Kenya is high and many young Kenyans view distance running as a ticket out of poverty. The country also looks at winning in international competitions as a way of marketing itself internationally and hence a way of enhancing both human and National Development. Since proper nutrition has been known to enhance athletic performance and recovery from injury, it is necessary to ensure that athletics are well informed on proper nutrition and facilitated on the same. Based on the findings of this study, the following recommendations were made:

1. There is need for institutes to hire the services of professional nutritional consultants to work alongside the coaches to ensure that as athletes undergo their training, their nutritional needs are met and are within the recommended values.

2. Educational programs for students on proper food selection, eating habits and physical activity are needed in tertiary institutes to improve the nutritional status of the college athlete.

5.5 Suggestions for further study

The following recommendations were made for further research:

1. The focus of this study was to explore the dietary intake of male and female college athletes and determine whether they meet recommended dietary allowances in a cross-sectional survey design. It did not, however, establish the relationship between dietary intake and performance of the athletes in a

longitudinal research design. As such, there is need to carry out longitudinal research to follow athletes over time and evaluate effect of dietary intake on performance.

2. Future studies can focus on other sports apart from athletics and determine whether there are any differences in dietary intake and practices.

3. Future studies can contain a sample from training institutions located in other geographical locations.

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APPENDICES

APPENDIX I: INFORMED CONSENT

I, ____________________ volunteer to take part in the following study:

Purpose of Study

I understand the purpose of this study in which I will participate is to determine adequacy of college athletes' diet.

Details of the Study

If I am to be included in the study, i understand that measurements of my weight, height and skin folds will be taken. I am aware that I will be required to keep a seven-day food record of all food, beverages and supplements that I will consume and that I may be required to provide copies of labels of the same for better assessment of my dietary intake. I am also aware that am required to keep an activity record on the same days that I record my food consumption, in which I will record the type of activity, and the time I began and ended that activity session.

Confidentiality

I understand that my right to privacy will be protected, and that the information collected in this study will not be used to subject me to any public embarrassment. I understand that I will be assigned a code number, and that from that point on I will only be referred to by respective code number and that my identity will only be known to the researcher of this study.

Volunteer Rights

I understand that I am free to drop from this study at any time and for any reason. I also understand that I will be dropped from this study if I do not complete all assessment information required.

Informed Consent Signatures

Name…………………….. Signature……… Date…..............

APPENDIX II: QUESTIONNAIRE

A: DEMOGRAPHIC CHARACTERISTICS

1) In which institution are you currently studying?

   Rift Valley Technical Training Institute ☐ Ol Lessos T.T.I ☐

2) Gender? Male ☐ Female ☐
3) Age? ________________________
4) What is your marital status?

1	2	3	4	5	6
Unmarried	Married	Divorced	Separated	Living together	Others specify

5) In what year of study are you? First ☐ Second ☐ Third ☐

	College Hostels				
6) Where do you reside?	1	2	3	4	5
		With friends	With spouse	With parent s	With grandparents
7) Whom are you living with currently?	1	2	3	4	5
8) Who prepares your meals	Self	House help	Spouse	Hostel s	
	1	2	3	4	
9) Which is your most important meal of the day?	Breakfast	Lunch	Dinner	Others	
	1	2	3	4	5
Others					

b. Eating patterns and meal frequencies

	Ugali & sukumawiki	**Ugali & fresh milk**	**Ugali& mala**	**Githeri**	**Chapati**
10) Which is your favorite food ?(multiple responses allowed)	1	2	3	4	5
	Once a day	**Twice a day**	**Three times a day**	**Others**	
11) How many times a day do you eat?	1	2	3	4	
	Once a week	**Twice a week**	**Three times a week**	**Others**	
12) How often do you eat fruits and vegetables	1	2	3	4	
	Tea with milk	**Milk alone**	**Soda**	**Beer**	**Fruit juice**
13) Which is your most favorite beverage	1	2	3	4	5
	Energetic	Easily available	Easy to prepare	Other	
14) Why is the beverage above your most favorite?	1	2	3	4	
Other	Gives me energy	Cheap and easily available	Balance d	Easy to prepare	Other
	1	2	3	4	5

15) Why do you consider the meal above your favorite?...
....
....
....

B. EATING PATTERNS AND DIETARY INTAKE AND PRACTICES

NO.	STATEMENT	YES	NO
1	Are there days you skip meals?		
2	Do you take any special meals during training?		
3	Do you have any knowledge of sports nutrition?		
4	Do you take any nutritional supplements?		
5	Do you take snacks between meals?		

C. FOOD HABITS DURING TRAINING

1) Are there foods that an athlete should not eat in your community?
   Yes ☐ No ☐

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

2) Does your institution provide ant special diet during training and competitions?
   Yes ☐ No ☐

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

3) Do your coaches recommend any special foods during competition and training?
   Yes ☐ No ☐
   If yes which one?
....
....
....

D: HEALTH STATUS

4) Do you suffer from any medical condition?
Yes ☐ No ☐

If yes which one?
....
....
....

5) Have you ever been injured during training and competitions?
Yes ☐ No ☐

If yes what was the nature of the injury?
....
....
....

6) How long did the injury take to heal?
....
....
....
....

7) Did the medical condition above interfere with your;
Dietary intake? Yes ☐ No ☐
Training Activities? Yes ☐ No ☐

8) Female athletes only: Do you consider your menstrual Cycle to be regular?
Yes ☐ No ☐

If yes, how?...
....
....

E PHYSICAL ACTIVITIES

9) Which race do you compete in?
   - Short races (100m – 200m) ☐
   - Medium races (400m – 800m) ☐
   - Long distance (1500m – 10000m) ☐

10) How long have you been competing?
   - Less than 1 year? ☐
   - 1 – 5 years ☐
   - More than 5 years? ☐

11) What competitions have you participated in the last 12 months?
   - RUTTI Run ☐ KCB Marathon ☐ ^%&$%^$%^ ☐
   - KETTISP Nationals ☐
   - Others____

12) How do you rate your performance in these competitions?
   - Excellent ☐
   - Good ☐
   - Fair ☐
   - Poor ☐

13) What would you attribute to the performance above?
   - Hard Training ☐
   - Good Nutrition ☐
   - Others, please specify…………………………………………………..

F:SPORTS NUTRITION KNOWLEDGE

14) What is your source of nutrition knowledge?
Coach ☐ Books ☐ Friends ☐ Magazines ☐ Internet ☐
Newspapers ☐ College Courses ☐

14) On a scale of 1 – 4, how would you rate your knowledge of the following?

4=poor; 3=average; 2=good; 1=very good

	1	**2**	**3**	**4**
Recommended Dietary Allowances				
Importance of Carbohydrates in athletic performance				
Importance of proteins in athletic performance				
Importance of adequate caloric intake				
Sources of nutrients in the diet				

APPENDIX III: ANTHROPOMETRIC CHARACTERISTICS OF MALE ATHLETES

Respondent Number …….

S/NO	**FACTOR**	First Measurement		Second Measurement	Average
1	Weight (Kg)				
2	Height (cm)				
3	BMI(Kg/m^2)				
4	Tricep skinfold (upper arm, back) mm				
5	Suprailiac skinfold (hip, front) mm				
6	Thigh skinfold (mm)				
8	Body fat (%)				

APPENDIX IV: ANTHROPOMETRIC CHARACTERISTICS OF FEMALE ATHLETES

Respondent Number ………

S/NO	**FACTOR**	First Measurement		Second Measurement	Average
1	Weight (Kg)				
2	Height (cm)				
3	BMI(Kg/m^2)				
4	Tricep skinfold (upperarm, back) mm				
5	Suprailiac skinfold (hip, front) mm				
6	Thigh skinfold (mm)				
8	Body fat (%)				

APPENDIX V: SEVEN DAY FOOD RECORD

This seven day food record is designed to get an accurate description of your typical daily diet. Please try to be as accurate as possible by recording all the foods and beverages you eat and drink. If the food is prepared at home or in a restaurant, please include a description of the preparation techniques, for example, grilled, and fried. You have been provided with bowls and cups to assist in quantifying food consumed.

Table 4: Seven day food record

Respondent Number ……………

Day one food record Day of the week: Date:		
Time	Food & Beverage Description	Amount eaten

APPENDIX VI: ACTIVITY DIARY

Respondent Number………………

Date/ Time	Activity Description	Duration	Intensity Code

Note:

Intensity refers to how hard you are exercising. Please use the following codes to describe the intensity:

A- Low intensity

B-Moderate intensity

C-High intensity

APPENDIX VII: MAP OF STUDY AREA

Location of RVTTI