PREVALENCE OF THE FEMALE ATHLETE TRIAD AMONG JUNIOR FEMALE LONG DISTANCE RUNNERS IN ITEN, ELGEYO-MARAKWET COUNTY, KENYA

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DECLARATION

This thesis is my original work and has not been presented for a degree in any university for any award.

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DEDICATION

I dedicate this study to my late Dad, Daniel Muia Mbithi. Dad, finally it has come to pass.

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To my supervisors: Dr. Wright, Dr. Onywera and Dr. Kuria;- I heartily thank you. It was your collective understanding, wisdom, leadership, inspiration and valuable assistance that aided the successful completion of my study.

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To the Lord: Thank You for making me unique, helping me to stand steadfast and giving me the will to accept every day as a new challenge

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OPERATIONAL DEFINITIONS OF TERMS

Adolescent: The period in human growth and development that occurs after childhood and before adulthood, from ages 10 to19 and represents one of the critical transitions in the life span.

Athlete: A student involved in organized competitive athletics in the previous (2012) or coming year (2013) at the regional, district, provincial, national or international level.

Amenorrhea: A student experiencing absence of menstrual bleeding for more than 90 days

Body image: A mental depiction of how the students perceived their bodies; that is the contour, size and appearance of their bodies. Body image can be manipulated by various dynamics, including ethnic and societal.

Disordered Eating: This was considered as restrictive eating behaviour that did not essentially get to the level of a clinical eating disorder. In this study bulimic tendency, drive for thinness and body dissatisfaction were indicative of disordered eating as well as restricting the amount and type of food to control weight.

Eating Disorder: Clinical psychological disorder defined and characterized by abnormal eating behaviours, an irrational fear of gaining weight and false beliefs about eating, weight and shape, these include anorexia nervosa, bulimia nervosa and eating disorder not otherwise specified (EDNOS)

Energy Availability: Expressed as the daily dietary energy intake minus the exercise energy expenditure, therefore, it was the sum of the remaining dietary energy required for other metabolic processes of the body after exercise

Exercise Energy Expenditure: Defined as the energy used up during exercise training.

Eumenorrhea: Normal menstrual cycles at intervals around the median for young women. The median is an interval of 28 days that varies with a standard deviation of 7 days

Female Athlete Triad: Relationship among energy availability, menstrual function, and BMD that may have clinical manifestations including eating disorders, functional hypothalamic amenorrhea and osteoporosis (ACSM, 2007)

Junior athlete: In this study refers to an athlete aged between 16-17 years by 31st December, 2013, in high school and engaged in competitive athletics not necessarily at the elite level.

Low Bone Mineral Density: Described by use of ultrasound in g/cm^3

Non-athlete: Student not in any organized competitive form of sport but participating in leisure sport.

Oligomenorrhea: Experiencing menstrual cycles longer than 45 days

Primary Amenorrhea: Lack of menses before the age of 15 years

Secondary Amenorrhea: Absence of three (3) or more consecutive periods after menarche

ABBREVIATIONS AND ACRONYMS

ACSM	American College of Sports Medicine
A.I.C	Africa Inland Church
AK	Athletic Kenya
BD	Body Dissatisfaction
BN	Bulimia Nervosa
BMD	Bone Mineral Density
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BUA	Broadband Ultrasound Attenuation
BW	Body Weight
CDR	Cognitive dietary restraint
DDS	Dietary Diversity Score
DE	Disordered Eating
DEXA	Dual Energy X-ray Absorptiometry
DEO	District Education Officer
DT	Drive for Thinness
E_1	Estrone
E_2	Estradiol
E_3	Estriol
EA	Energy Availability
EAT	Eating Attitude Test
ED	Eating Disorder
EDI-3RF	Eating Disorders Inventory Test and 3 Factor- eating questionnaire

EDI	Eating Disorder Inventory
EDNOS	Eating Disorders not Otherwise Specified
EEE	Exercise Energy Expenditure
EI	Energy Intake
FAT	Female Athlete Triad
FAO	Food and Agriculture Organization
FANTA	Food and Nutrition Technical Assistance Project
FFM	Fat Free Mass
FNB	Food and Nutrition Board
FRS	Figure Rating Scale
FSH	Follicle Stimulating Hormone
GnRH	Gonadotropin Releasing Hormone
IAAF	International Athletics Association Federation
IDDS	Individual dietary diversity score
IOC	International Olympic Committee
IOCMC	International Olympic Committee Medical Commission
ISAK	International Society for the Advancement of Kinathropometry
ISCD	International Society for Clinical Densitometry
KSSSA	Kenya Secondary Schools Sports Association
LBM	Lean Body Mass
LH	Leutinizing Hormone
LPD	Luteal Phase Deficiency
METS	Metabolic Equivalents
MF	Menstrual Function

NCAA	National Collegiate Athletic Association
NACOSTI	National Commission for Science, Technology and Innovation
PTH	Parathyroid Hormone
QUI	Quantitative Ultrasound Index
RDA	Recommended Daily Allowance
RPE	Rate of Perceived Exertion
SA	South Africa
SOS	Speed of Sound
SPSS	Statistical Package for Social Sciences
TFEQ	Three Factor Eating Questionnaire
WHO	World Health Organization

ABSTRACT

Adolescents regularly participating in sports and do not meet their energy intake may develop several medical conditions, such as disordered eating, menstrual dysfunction, and decreased bone mineral density, collectively referred to as the Female Athlete Triad (FAT). Limited data is available on components of FAT in adolescent athletes of African descent. This study's aim was to investigate the presence of the components of the female athlete triad amongst a group of junior long female distance runners and non-athletes in Kenya. One hundred and ten students randomly selected from secondary schools in Iten, Elgeyo-Marakwet County, took part in this cross-sectional comparative study. Students completed demographic, health, sport and menstrual history questionnaires as well as a 5-day weighed dietary record and exercise log to calculate energy availability (EA). Heel bone mineral density was assessed with ultrasound. Subscales of the Eating Disorder Inventory and the cognitive dietary restraint subscale of the Three-Factor Eating Questionnaire measured disordered eating. Dietary intake was analysed with Nutri-survey and dietary diversity determined by the Individual Dietary Diversity Score (IDDS) using 5-day dietary records. Fewer mothers (19 vs. 40%, χ^2=12.9, p=0.02) and fathers (28 vs. 50%, χ^2=11.8, p=0.06) from athletes had tertiary education than non-athletes, and more mothers from non-athletes had formal employment than athletes (54 vs.13%, χ^2=22, p<0.001). Energy availability was significantly lower in athletes than non-athletes (36.5 ± 4.5 vs. 39.5 ± 5.7 kcal/kg/FFM/day, p=0.003). More athletes than non-athletes were identified with clinical low EA (17.9 vs. 2 %, [OR = 9.5, 95% CI (1.17, 77), p=0.021). Subclinical (75.4 vs. 71.4%) and clinical DE behaviour was similar between athletes and non-athletes, (4.9 vs. 10.2%, respectively, χ^2=1.1, p=0.56). More athletes than non-athletes had a body mass index of < 17.5 kg/m^2 [16.1 vs. 0%, OR= 0.8, 95% CI (0.7, 0.9), p=0.004]. No significant differences were noted for carbohydrate, fat, calcium, magnesium, B_2 and zinc intake between groups. IDDS was higher in students in day schools than in boarding schools (4.36±0.7 vs. 3.8±0.6, χ^2 =13.4, p=0.001). More athletes (72.1% vs. 32.7% χ^2 =17, p=0.000) reported restricting the types of food eaten and the amount to control weight (68.9% vs. 32.7%, χ^2 =14, p=0.000). More athletes reported clinical menstrual dysfunction in comparison to non-athletes (32.7% vs. 18.3%, χ^2=7.1 p=0.02); primary amenorrhea (13.1% vs. 2.0%) and secondary amenorrhea (19.7% vs. 10.2%). BMD tended to be higher in athletes compared to non-athletes (0.629±0.1 vs. 0.592±0.1 g/cm^2, p=0.06). Kenyan adolescent athletes and non-athletes present with low energy availability and menstrual disturbances which are key components of the female athlete triad. Energy intakes should be increased in the student population to match the energy expended and menstrual disturbances closely monitored in athletic adolescent girls since exercise induced amenorrhea signals energy drain.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Physical activity promotes good health and is recommended for women of all ages (Loucks & Nattiv, 2005). Involvement in organized sports can offer many benefits, such as improved self-esteem and body image and encouragement for individuals to remain active throughout their lives. However, excessive physical activity, without a concomitant increase in appropriate dietary intake, is associated with energy deficiency and may result in health and performance declines over the long-term (Mountjoy *et al*., 2014). Athletes can develop disordered eating (characterised by abnormal eating patterns), which are associated with menstrual dysfunction and ultimately lead to decreased bone mineral density (BMD), or osteoporosis. These conditions often occur together and are collectively referred to as the Female Athlete Triad (FAT) (Nattiv *et al*., 2007).

The term 'Female Athlete Triad', was first coined in 1992 by the American College of Sports Medicine (ACSM). This was in response to several studies that concluded that some female athletes suffer from the inter-related symptoms of disordered eating, amenorrhea and low bone density. Each disorder on its own can be of significant medical concern, but when all three components are present; the effects have greater potential for serious negative impact on health and performance since the components are inter-related (Nattiv *et al*., 2007).

The FAT definition was updated by ACSM, (2007) whose position refers to a spectrum of energy availability from optimal energy availability to low energy availability with or without Disordered Eating (DE) or an Eating Disorder (ED). Energy Availability (EA) is the amount of dietary energy remaining for other body functions after exercise training. When EA is too low, physiological mechanisms reduce the amount of energy used for cellular maintenance, thermoregulation, growth and reproduction (ACSM, 2007). The compensation tends to restore energy balance and promote survival but impairs health. Some athletes reduce EA by increasing exercise energy expenditure more than energy intake, while others fail to increase energy intake to match exercise energy expenditure. According to the American Academy of Paediatrics Committee on Sports Medicine and Fitness, (2005) this lower energy intake is sometimes accompanied by pathogenic body weight control behaviours. Such behaviours may include;- skipping meals, fasting, induced vomiting, binge eating, and use of diet pills, laxatives, diuretics and enemas.

All female athletes are potentially at risk of the Triad, however those participating in sports which emphasize a thin body or those competing in sports where low body weight is a prerequisite such as gymnastics, ballet, figure skating, swimming, and distance running may be at an increased risk for the Triad (Torstveit and Sundgot-Borgen, 2005; Phillipa, Andrea and Eleanor, 2007). However this may not be necessarily be true in athletes in Africa since no studies have been carried out on African athletes. The magnitude and seriousness of this growing problem was highlighted in the International Olympic Committee Medical Commission's (IOCMC) consensus conference on Sports Nutrition (Loucks, Kiens and Wright, 2011).

Disordered eating behaviours are more often considered the causal factor for the Triad (Beals and Manore, 2002). An athlete's desire to lose a few kilograms with the aim of improving performance could be the starting point for disordered eating (Rumball and Lebrun, 2004). Although this may seem a harmless behaviour, it could lead to full-blown eating disorders such as anorexia nervosa and bulimia nervosa. In sports emphasizing a lean physique there may be an altered view as to what is an acceptable caloric intake. Koutedakis and Jamurtas (2004) found that female dance students and ballerinas consumed less than the daily recommended calorie intake which were below 70 and 80% of RDA respectively. Additionally considerable caloric restriction causes changes to the cardiovascular, muscular skeletal, thermoregulatory and endocrine systems due to the reduction of the metabolic rate (Thrash and Anderson, 2002).

There are many underlying causes of amenorrhea; however athletes have been shown to share the same hypothalamic amenorrhea profile (Goodman and Warren, 2005). A mistaken belief among athletes and coaches is that menstrual cycle cessation occurs when body fat levels are reduced to optimal during sport, thus signifying acceptable training volume and intensity (Manore, 2002; Monica and Jorunn, 2005). However, the lack of menstrual cycle could signify an energy-conserving strategy to protect more important physiological body processes during times of energy deficit (Loucks and Thuma, 2003). Alterations in the menstrual cycle of female athletes are thought to be caused by various factors (Burrows, Bird, and Nevil, 2003). In some cases, menstrual cycle abnormalities are explained by low circulating metabolic and reproductive hormones caused by an energy deficit due to restrictive eating behaviour and/or failure to increase energy intake to compensate for increased energy expenditure due to excessive training (Burrow *et al*., 2003; Miller, 2003; De Souza *et al*., 2004; Loucks and Nattiv, 2005).

Menstrual function and bone health are closely related (Sanborn *et al*., 2000). Due to the suppressed gonadotrophin releasing hormone (GnRH) pulsatility and subsequent estrogen deficiency, low BMD occurs (Rosen and Klibanski, 2009). Estrogen, occurs in three forms:- estrone (E_1), estradiol (E_2) and estriol (E_3). Estradiol and progesterone work together in bone formation, powerful bone destructive cytokines are released and increase rapidly with dropping estradiol levels (Pfeilschifter *et al*., 2002). Estradiol helps in bone formation through two key actions: uptake of vitamin D related intestinal calcium absorption and inhibition of bone resorption through the esteoprotegerin system (Liao, Luo and Su, 2002).

In adolescence when peak height and menarche occurs, there is also a gain in body weight, bone and BMD (Bailey *et al*., 2000). Consequently the levels of estrogen and growth hormones are increased during this period (Barr *et al*., 2001). Absence of menstruation after menarche is associated with low circulating levels of estradiol and progesterone, as a result of hypothalamic suppression due to low calorie intakes compared to the level of energy expenditure or due to ovarian dysfunction, hence lower estradiol and BMD values occurring (Hoch, Lal, Jurva and Gutterman, 2007). Studies show that a low peak BMD early in life may not be completely reversible, even if menses resume and energy deficit is fulfilled. This predisposes the athlete to fractures later in life (Hoch *et al*., 2007; Feingold and Hame, 2006; Burrows *et al*., 2007).

Several studies indicate that prevalence of disordered eating and EDs are higher in athletes than non-athletes. A study on the prevalence of Triad among a group of Norwegian elite female and male athletes, with 1620 elite athletes and 1696 non-athletes sought to determine the presence of eating disorders. Results indicated that more athletes (13.5%) than non-athletes (4.6%) had subclinical or clinical eating disorders and concluded that EDs are higher in athletes than non-athletes (Sundgot-Borgen and Torstveit , 2004). Similarly Bryne and Mc lean (2002) studied a group of 263 elite Australian athletes and a similar number of non-athletes and the results showed a higher prevalence of EDs in the athletes than non athletes. Several studies in Africa have also reported an increasing number of clinical eating disorders and disordered eating among college and high school students (Bennet, Sharpe, Freeman and Carson 2004; Fawzi, Hashim, Fouad and Abdel-Fattah, 2010).

Research studies indicate that amenorrhea is more prevalent in the athletic population with ranges of 3-66% than in the general population at 2-5% (Jeane, Mitchell and Mandra, 2006; Torstveit and Sundgot-borgen, 2005). Although many studies indicate that menstrual dysfunction occurs more frequently in athletes, the large discrepancies in numbers are associated to the inconsistency in the definition of amenorrhea, selection bias and underreported minor menstrual irregularities (Torstveit and Sundgot-borgen, 2005). Studies among Caucasians however indicate that girls involved in athletics tend to experience menarche at a later age than non athletic girls, thus leading to concerns that intensive sports training might delay sexual maturation (De Souza and Williams, 2004). Since menarche is occurring at an earlier age, the American Society of Reproductive Medicine Practice Committee revised the age of primary amenorrhea from 16 to 15 years (Practice Committee of the American Society for Reproductive Medicine, 2004).

Peak bone mass occurs during the first three decades of life (Golden *et al*., 2002), with females attaining 95% of maximum bone density by 18 years, therefore maximizing peak bone mass at this formative stage is of ultimate importance. During the initial years that constitute the pubertal growth spurt, bone deposition is also rapidly occurring accounting for 60% of final bone mass (Sabatini, 2001). Any dietary inadequacies and disruption of the menstrual cycle will impair bone formation more severely at this time than at any other stages in life (Sabatini 2001; Golden *et al*., 2002). Adolescents must be adequately nourished to ensure progression of normal and continuous growth and development. For the adolescent athlete, proper nutrition is critical for both good health and optimal sports performance, since nutritional needs are increased by both training and the growth process (Nichols *et al*., 2007).

Several studies have examined the Triad and its components among African female athletes (Seed, Olivier, Allin and Nxumalo, 2004; Caradas, Lambert and Charlton 2001;

Havemann, De-lange, Pieterse and Wright 2011; Robbeson, Havemann-Nel and Wright, 2013; Micklesfield, Norris and Pettifor, 2011; Micklesfield *et al.*, 2007), however most of these report on Caucasian populations. Limited data is available on the energy status and components of the Triad in athletes from minority groups. This study therefore sought to generate data on the Triad amongst junior female Kenyan athletes (a minority group) due to the paucity of literature in this and investigate the bone health and nutritional status of a group of Kenyan athletes'.

1.2 Problem statement

Despite the potentially serious health and performance disorders that can occur as a result of the components of the female athlete triad, there is limited data on the subclinical and clinical components of the Triad in young African young athletes, as most studies to date have focused on those of Caucasian descent. Availing data on the Kenyan adolescent athletes is necessary to help in early identification of the triad components. There is also need to increase knowledge among coaches, athletic trainers and other health professionals on the FAT in order to adequately care for the well being of female athletes.

A study by (Goodwin *et al*., 2014) and the first to investigate the Triad among Kenyan athletes reported the presence of the Triad components among elite adult female athletes. An appeal too has been made for research on the components of the Triad and energy availability in non-Caucasian athletes (Mountjoy *et al*., 2014). The race of an individual also has the potential to influence many of the Triad components, for example due to socio-cultural factors black women in general are more tolerant of a bigger body size which may reduce their risk for disordered eating and low energy availability (Puoane *et al*., 2005).

Hulley, Currie, Njenga, and Hill (2007) reported a low risk for disordered eating among adult Kenyan runners (11.1%) compared to Caucasian runners (48.1%) from the United Kingdom. However, due to acculturation, risk for disordered eating may increase in black African women and adolescents (Bennet *et al*., 2010). Race has also been thought to play a role in Bone Mineral Density (BMD); evidence shows that African blacks have greater BMD than Caucasians (Micklesfield, Norris & Pettifor, 2011). This may reduce the risk for low BMD and stress fractures in African athletes.

From the early 1990s, Athletics Kenya (AK) with the help of the International Athletics Association Federation (IAAF) put in place programmes for competitive sport due to the successes of elite Kenyan distance runners internationally (Saltin *et al*., 1995). Additionally the shifting societal attitudes towards competitive sport and media coverage of national and international competitions focusing attention on very talented young competitors coupled with the fame and fortune afforded to runners has inspired youngsters to adopt running as a potential career (Onywera, Scott, Boit and Pitsiladis, 2006). This has led to an increase in the number of young Kenyan athletes specializing in sport from an early age and to training year-round in an effort to compete at an elite level.

Consequently the lure of a college scholarship or a professional career can also motivate junior athletes to commit to specialized training regimes at an early age.

However rigorous training at a tender age coupled with inadequate dietary intakes may affect the development of the junior athlete. Most of these young athletes are in boarding schools and the meals provided do not always cater for their increased energy needs which, in turn, may predispose them to an energy deficiency. For the first time, this study identifies and evaluates subclinical and clinical components of the female athlete triad amongst adolescent female athletes and non-athletes in Kenya.

1.3 Purpose

Little is known about the prevalence of the components of the Triad among junior long distance athletes in Kenya, the purpose of this study was therefore to determine the prevalence of components of the triad in high school female long distance runners in Kenya compared with a control of sedentary students from the same high schools.

1.4 Objectives

1.4.1 Main objective

The main objective of this study was to investigate the presence of all the three components of the Female Athlete Triad (Triad) amongst a group of junior long distance runners in Kenya

1.4.2 Specific objectives

The following were the specific objectives, to;

1. Establish the energy availability of junior female athletes and non-athletes.
2. Determine eating behaviours in junior female athletes and non-athletes.
3. Establish the menstrual patterns of junior female athletes and non-athletes.

4. Describe the bone health status of junior female long athletes and non-athletes.
5. Establish the nutrient intakes and dietary diversity of junior female athletes and non-athletes.
6. Determine the relationships between the components of the triad among junior female athletes and non-athletes.

1.5 Hypotheses

Ho_1: There is no significant difference in energy availability between athletes and non-athletes.

Ho_2: There are no significant differences in the occurrence of disordered eating between athletes and non-athletes

Ho_3: There is no significant difference in menstrual function between athletes and non-athletes

Ho_4: There is no significant difference in nutrient intakes and eating habits of athletes and non-athletes

1.6 Significance

There is paucity of data on the occurrence of the Triad on young athletes in Kenya and minority races; this study therefore contributes to ongoing research on the Triad especially among adolescent athletes. Results of this study also provide information on the energy and nutrient intakes among junior athletes that can be adopted for policy planning in sports organizations. Results also highlight the need for training athletes on their energy requirements.

1.7 Limitation

Various methodological issues in the present study need to be considered as limitations. The study sample comprised a specific population of secondary school girls selected from a rather limited geographical area which may limit the generalization of the results. Further the use of questionnaire assessments without follow up clinical interviews/assessments to confirm the presence of an eating disorder and blood biomarkers to confirm menstrual dysfunction was a notable limitation. BMD was assessed using norms derived from Caucasian samples which may not be applicable to an African sample; further this study used ultrasound and not DXA to measure BMD. Ultrasound is mostly used to evaluate BMD of postmenopausal women. Due to the financial cost of DXA scans and the distance that needed to be travelled to have the scans taken it was not possible to do these measurements. Having the BMD measurements from the ultrasound is still useful as it gives an indication of the difference in BMD between athletes and non-athletes in our study group.

1.8 Delimitation of the study

The study only focused on junior long distance female athletes in the selected secondary schools in Iten, Keiyo North district that have training facilities/programmes for young athletes, aged 16-17 years.

1.9 Conceptual framework

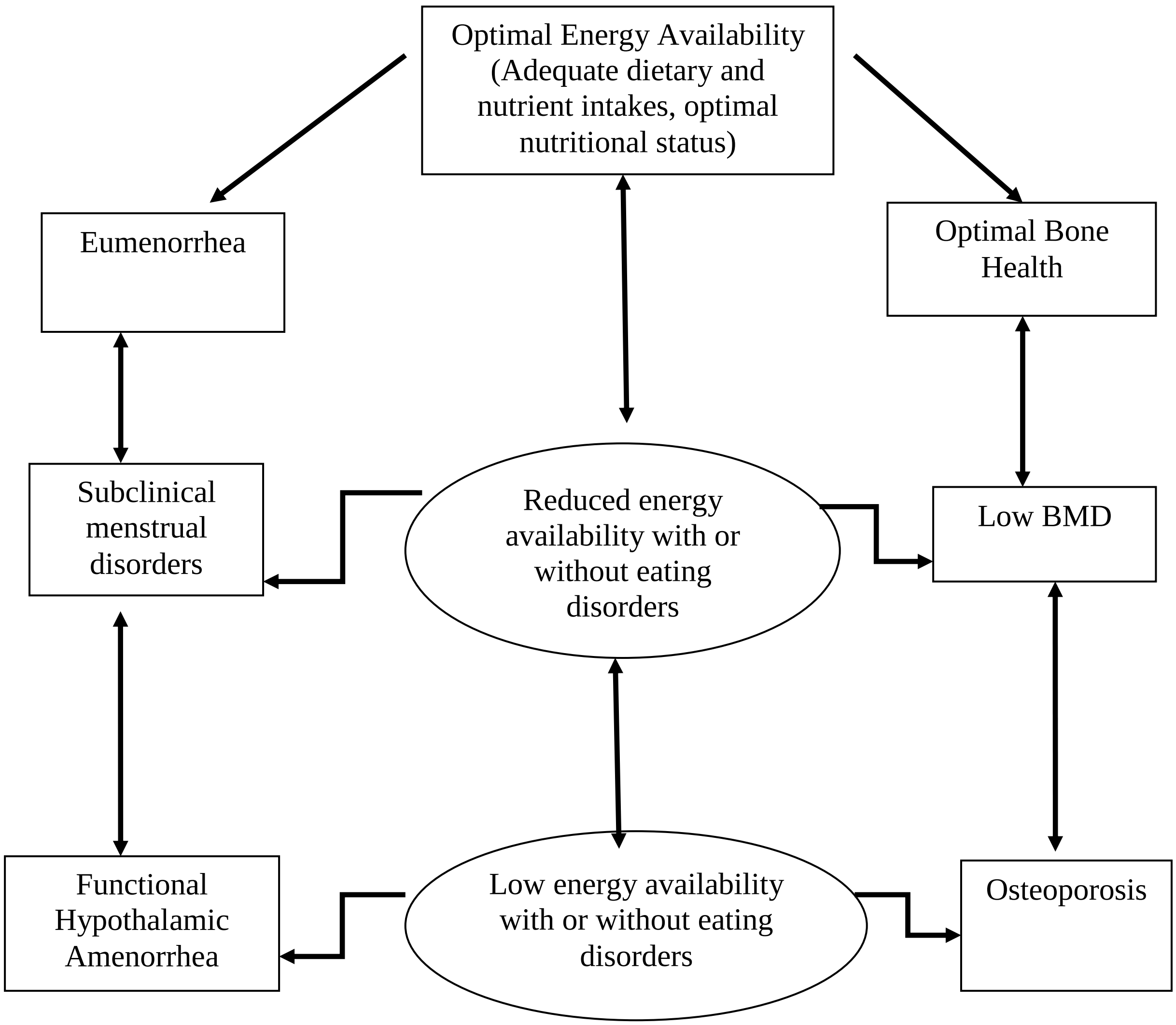


Figure 1.1: The female athlete conceptual framework

Source: Adapted from Nattiv *et al*., 2007

The three endpoints of the Triad are inter-related through psychological and physiological mechanisms (Figure 1.1). The athlete is psychologically pressured to perform optimally and may perceive this as a requirement to maintain a low body weight, resulting in a high volume of training. When training volumes are high and this is accompanied by low energy intake, the psychological stress hormones may lead to a physiological alteration in the endocrinological control of the menstrual cycle. This then may lead to an athlete becoming amenorrhoeic (loss of cycle after menarche). Amenorrhea will occur due to decreased production of estradiol through dysfunction of the hypothalamus. Estradiol plays a pivotal role in maintaining adequate bone mineral density; therefore a hypo-oestrogenic state (low oestrogen) is associated with low bone mineral density and consequently an increased risk of osteopenia/osteoporosis.

The clinical endpoints of the Female Athlete Triad are interrelated since energy deficiency associated with disordered eating plays a causal role in the development of menstrual disturbances (Loucks & Thuma, 2003; De Souza *et al*., 2007), and both inadequate energy intake and a hypo-oestrogenic environment associated with amenorrhea play a causal role in initiating bone loss (De Souza *et al.*, 2008; Ihle & Loucks, 2004). Not all athletes will present with severe conditions at the extremes of the continuums, but rather may display intermediate, or “subclinical,” presentations of one or more of the conditions. An athlete, may show signs of restrictive eating but not meet the clinical criteria for an eating disorder. The athlete may also display subtle menstrual disturbances, such as anovulation, or luteal phase defects, or even a change in menstrual cycle length, but may not yet have developed amenorrhea. Likewise, bone loss may occur but may not yet have dropped below her age-matched normal range for bone mineral density.

CHAPTER TWO: LITERATURE REVIEW

2.1 Female Athlete Triad

Moderate exercise can increase strength and endurance, improve cognitive function, neuromuscular coordination, management of body weight and composition, and have a positive effect on mental well-being (Goodman & Warren, 2005). In addition, the positive effects of mechanical loading via exercise on bone mineral density (BMD) have been well documented in humans (Jaffre *et al*., 2001). However, females who undergo intense physical training are also at risk of developing exercise-related disorders such as disordered eating, amenorrhoea, and osteoporosis. These three interrelated components make up the female athlete triad (ACSM, 2007; Goodman & Warren, 2005; Nattiv *et al*., 2007).

In 1992 the link between energy availability and menstrual status was first established, and the association of disordered eating, amenorrhea, and osteoporosis was formally given the term Female Athlete Triad (Goodman & Warren, 2005). In 1997 the American College of Sports Medicine published a position stand which was then updated in 2007, providing a review of the research and giving recommendations for screening, diagnosis, treatment, and prevention of the triad (Nattiv *et al*., 2007).

The 2007 ACSM looked at each disorder as a point on a continuous spectrum rather than as a severe pathologic endpoint, as follows: disordered eating was been replaced by a spectrum ranging from optimal energy availability to low energy availability with or without an eating disorder. Amenorrhea was been replaced by a spectrum ranging from eumenorrhea to functional hypothalamic amenorrhea and osteoporosis replaced by a spectrum ranging from optimal bone health to osteoporosis (Nattiv *et al*., 2007).

The 2007 ACSM also emphasized that energy availability is the basis for all the other two components of the FAT (Nattiv *et al*., 2007) and without correction on the energy availability, full recovery from the syndrome is not possible. The ACSM emphasizes that athletes who expend large amounts of energy in prolonged exercise training can become energy deficient without eating disorders, disordered eating or even dietary restriction. The female athlete triad is often difficult to recognize and can have a significant impact on morbidity and mortality rates in a young females in the population.

The ACSM identified three distinct origins of energy deficiency in athletes. The first is obsessive eating disorders with their attendant clinical mental illnesses. The second is intentional and rational but mismanaged efforts to reduce body size and fatness to qualify for and succeed in athletic competitions. This mismanagement may or may not include disordered eating, the third is the inadvertent failure to increase energy intake to compensate for the energy expended in exercise (Loucks *et al*., 2011).

Some female athletes do not consider training or exercise as sufficient to accomplish their idealized body shape or level of thinness. Therefore, a significant number of active females diet and use harmful weight-loss practices to meet their goals (Smolak, Murnen & Ruble, 2000; Byrne & McLean, 2001). These patterns may lead to under-nutrition, menstrual dysfunction, and sub-sequent bone loss. Each individual component of the triad increases the chance of morbidity and mortality, but the dangers of the three together are interdependent (De Souza *et al*., 2008). A female athlete can have one, two or all the three parts of the Triad (Monica & Jorunn, 2005). This study sought to assess the various components of the triad in Kenyan junior athletes and non-athletes and fill the void on paucity of data on the triad in Kenyan athletes.

2.2. Triad Components

2.2.1 Disordered Eating

The first component of the female athlete triad, energy availability (EA) (Nattiv *et al*., 2007; De Souza & Williams, 2005) is defined as "dietary energy intake minus exercise energy expenditure" and is intended to capture those athletes who may have eating and weight concerns but do not have "significant psychopathology" and not necessarily meeting the criteria for disordered eating. Disordered eating, which affects as many as two thirds of young female athletes (Bratland-Sanda, Eriksson & Sundgot-Borgen, 2012) consists of restrictive eating behaviours that do not necessarily reach the level of a clinical eating disorder (Beals & Manore, 2000). Women athletes with disordered eating may limit their caloric and/or fat intakes but maintain high training levels, often resulting in a state of chronic energy deficit. Disordered eating occurs on a continuum from dieting and restrictive eating, abnormal eating behaviour, and finally clinical eating disorders (Sundgot-Borgen & Torstveit, 2010).

Many athletes reduce energy availability intentionally to optimize body size and composition for competitive success. Some athletes practise disordered eating, including fasting, skipping meals, purging, and using diet pills, laxatives, and diuretics (Beals & Hill, 2006; Manore, Kam & Loucks, 2007; Sundgot-Borgen & Torstveit, 2004). For some athletes, low energy availability expresses an eating disorder, which is a life-threatening clinical mental illness that requires medical and psychiatric treatment (Rome *et al*., 2003).

Elite athletes often embody the concept of physical perfection. However, not all athletes *de facto* have a subjective feeling, that their bodies are adapted to the optimal paradigm of their specific sport (Sundgot-Borgen & Torstveit, 2010). Those athletes often experience pressure to achieve this “ideal” body type (Drinkwater *et al*., 2005). In addition to the socio-cultural demands placed on male and females to achieve and maintain an ideal body shape, elite athletes are also under pressure to improve performance and conform to the specific requirements of their sport (Drinkwater *et al*., 2005). Athletes are also evaluated by coaches and officials such as judges on an almost daily basis (Nattiv *et al*., 2007). These factors may lead to dieting, use of disordered eating, and the development of severe eating disorders. Clinical experience and research evidence have dictated that disordered eating and eating disorders such as anorexia nervosa, bulimia nervosa and binge eating commonly begin with behaviour that resembles dieting (Fairburn & Harrison, 2003; Fairburn e*t al.*, 2005).

The onset of eating disorders typically occurs during adolescence, when changes in body shape affect personal appearance. Incidence rates for anorexia nervosa are highest for females in high school age (15–19 years) (Hoek & Van Hoeken, 2003). For many athletes, it is desirable to have a high lean body mass and low body fat mass to achieve a high power-to-weight ratio (O'Connor *et al*., 2006). There are sports that require horizontal (such as running and long jump) or vertical (for example high jump, gymnastics, and ski jumping) movements of the body where excessive fat mass is considered a disadvantage. A high fat mass has also been shown to increase energy demands and could therefore affect performance negatively (Kiflu, Reddy & Babu, 2012).

Female athletes may also under-eat for reasons unrelated to sport (Loucks *et al*., 2011). More young female athletes report improvement of appearance than improvement of performance as a reason for dieting (Martinsen *et al*., 2010). Although some studies have assessed eating disorders among various groups in Kenya (Njenga & Kangethe, 2004; Furnham & Alibhai, 1983) data is lacking on eating and disordered eating among adolescent athletes. Disordered eating in this study was assessed using the Eating Disorder Inventory-3 (EDI-3) drive for thinness (DT), bulimia (B) and body dissatisfaction (BD) subscales (Garner, 1983) as well as the cognitive dietary restraint (CDR) subscale of the Three-Factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985).

2.2.2 Menstrual Dysfunction

The second component of the Triad, menstrual dysfunction describes the spectrum of menstrual function from eumenorrhea to amenorrhea and enables clinicians to capture a large portion of athletes who may have low oestrogen levels but who still experience menstruation (Nattiv *et al*., 2007). As more women become active in sports and physical activities, more research is being accrued on effects of physical activity on the menstrual cycle. It has been noted that female athletes often have a delay in menarche and/or develop irregular menses during their training (De Souza *et al*., 2010). Although the prevalence of menstrual irregularities differs between various sports, the rates are often quite high, affecting from 12 to 79% of athletes (O'Donnel & De Souza, 2004; Warren & Perlroth, 2001). In a recent study of female high-school athletes, 23.5% of those surveyed had menstrual irregularity (Nichols, *et al*., 2006).

Menstrual dysfunction includes luteal suppression, anovulation, oligomenorrhea and both primary and secondary amenorrhea (Dawson & Reilly, 2008). Luteal suppression is marked by a shortened luteal phase and a prolonged follicular phase in which estradiol levels decrease. The cycle length usually does not change; the athlete will continue to ovulate although it may be later in the cycle and usually has regular menstruation.

Primary amenorrhea has recently been defined as the failure to achieve menarche by age 15 in the presence of normal development of secondary sex characteristics (American Society for Reproductive Medicine, 2006). Eumenorrhoea is defined as a menstrual cycle every 21-45 days, secondary amenorrhoea as no menstrual cycle for more than 90 continuous days after menarche, and oligomenorrhoea as cycles longer than 45 days (Mountjoy *et al*., 2014). Care however has to be taken to exclude other causes of menstrual dysfunction, particularly polycystic ovarian syndrome (Awdishu *et al*., 2009). Anovulation is marked by low levels of estradiol and progesterone, which deter follicular development, as well as by an absence of ovulation (De Souza & Toombs, 2010). Although the circulating hormone levels are decreased, female athletes will often menstruate, some experiencing shortened or prolonged cycles because of the stimulation of their uterine lining by the low levels of estradiol.

Exercise training can have an impact on the menstrual cycle; if the exercise load is great enough it can lead to irregular or even the complete absence of menses, which has implications for reproductive health. Conversely, the menstrual cycle can affect exercise performance (Dawson & Reilly, 2008). Menstrual dysfunction has been observed in a significant proportion of elite, collegiate and high school female athletes (Torsveit & Sundgot-Borgen, 2005; O'Donnel & De Souza, 2004; Nichols, Rauh & Lawson, 2006; Nichols *et al*., 2007). Numerous studies have investigated the relationship between physical activity and menstrual dysfunction, a syndrome that also is called "exercise-induced menstrual dysfunction" (Loucks *et al*., 2011; Loucks *et al*., 2003). The reported incidence of exercise-induced menstrual dysfunction varies among adolescent athletes: from 1–66% depending on the type and intensity of athletic activities and the definition of menstrual dysfunction (Goodman & Warren 2005; Torstveit& Sundgot-Borgen 2005; O'Donnel & De Souza, 2004).

There are many influences on athletes' menstrual cycle including age, weight, psychological stress, nutritional inadequacies, genetic predisposition, percent body fat, amount of exercise, and others (Greydanus & Patel, 2002). The endocrinal equilibrium that regulates reproductive function in women can be affected by physical and psychological factors. Intensive physical exercise in female athletes can lead to competition-induced stress and reduction of body fat and total body weight, which are predisposing factors to menstrual dysfunction (Loucks *et al*., 2003). Although weight-bearing physical activity in women, such as basketball, volleyball, weightlifting, and running is beneficial to the skeleton, excessive exercise to the point of incurring menstrual dysfunction might also be a risk factor for decreased bone mass (New, 2001).

The beneficial effect of physical activity in women on bone mineral density can be lost if the amount of exercise is so intensive that it brings about menstrual disturbances (Mountjoy *et al*., 2014). Data is lacking on the menstrual function of adolescent athletes and athletes in general in Kenya. This study therefore sought to analyse menstrual function in junior athletes and non-athletes. Self-reported menstrual function gathered information on age of menarche, frequency and characteristics of menses during the preceding twelve months prior to the study.

2.2.2.1 Regulation of the Menstrual Cycle

The normal menstrual cycle varies greatly in length (Burrows & Bird, 2000). The menstrual cycle is divided into 3 phases; the first phase coinciding with menstrual bleeding is known as the menstrual phase, the second phase is dominated by estrogens and is known as the follicular phase, and the third is dominated by progesterone and is known as the luteal phase (De Souza *et al*., 2003). The phases result from the highly regulated cyclic fluctuations of the anterior pituitary gonadotrophins (specifically lutenising hormone, and follicle-stimulating hormone (FSH), growth hormone and prolactin that act upon the ovaries (Scheid *et al*., 2009; Schneider & Warren, 2006). FSH stimulates the growth and development of the primary follicles in the ovary, leading to ovulation, while lutenising hormone is responsible for estrogen production and secretion forming the corpus luteum, which in turn releases progesterone for the maintenance of the endometrium.

This complex and intricate relationship is based on both positive and negative feedback mechanisms co-ordinated by the hypothalamic-pituitary-ovarian axis, and a disruption at any point in this sequence will result in menstrual disturbances. Although this study did not measure the ovarian hormones, it is imperative to understand the regulation of the menstrual cycle.

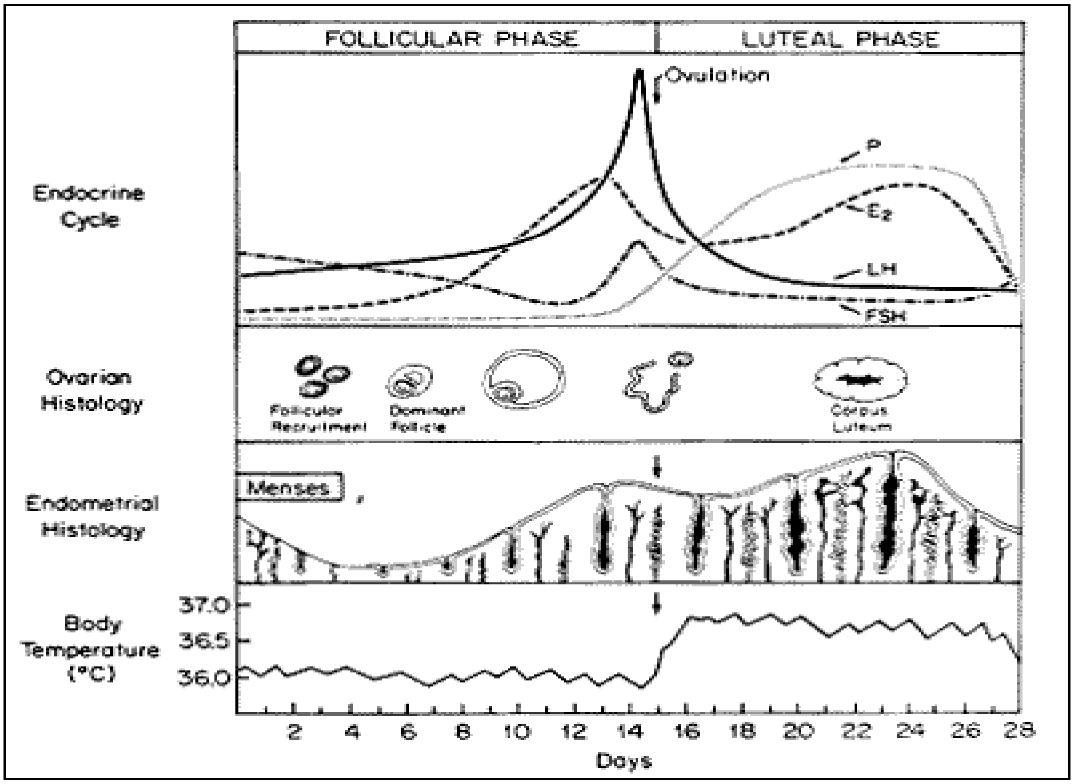


Figure 2.1: Changes in hormones, the ovary and the endometrium throughout a normal menstrual cycle

Source: Silverthorn and Dee Unglaub, (2013).

2.2.3 Bone Health

The third component of the female athlete triad, bone health (ISCD, 2004) describes a continuum extending from optimal bone health to osteoporosis and focuses on bone strength, which consists of BMD (or bone mineral content) and bone quality. The International Society for Clinical Densitometry recommendation is to determine BMD using bone densitometry (DXA) scan by comparing chronologic age and sex using a Z-score distribution. The Society further recommends that the term osteopenia not be used in describing bone density and that the term osteoporosis is reserved for “low BMDs,” with secondary clinical risk factors such as “chronic malnutrition, eating disorders, hypogonadism, glucocorticoid exposure and previous fractures (ISCD, 2004).

Athletes with a Z-score two standard deviations below the mean are to be termed “low bone density below the expected range for age” if they are premenopausal women and “low bone density for chronologic age” if they are children. The 2007 ACSM position stand further defined “low BMD” as - “a history of nutritional deficiencies, hypoestrogenism, stress fractures, and/or other secondary clinical risk factors for fracture together with a BMD Z-score between –1.0 and –2.0 standard deviations below the mean” and osteoporosis as - “secondary clinical risk factors for a fracture with a Z-score ≥ –2.0 standard deviations (Nattiv *et al*., 2007).

In exercising women, the rate of bone formation and the hormones that promote bone formation are suppressed within 5 days when energy availability is reduced from 45 to less than 30 kcal · kg FFM^{-1} · day^{-1}, and the rate of bone resorption is increased when energy availability is reduced enough to suppress oestradiol (Ihle & Loucks, 2004). In amenorrhoeic runners, the rate of bone formation and bone mineral density (Nichols, Bonnick, & Sanborn, 2000) are both low.

Menstruating athletes gain approximately 2-4% of bone mass per year, whereas amenorrheic athletes tend to lose 2% of BMD per year (De Souza *et al*., 2008). Thus, it is easy to see why athletes who are involved in high-impact sports can still be more susceptible to fractures than their nonathletic and menstruating athletic counterparts. Often these fractures are due to the increased stress sustained by these bones in the course of physical activity (De Souza *et al*., 2008).

On the other hand, it is commonly accepted that weight-bearing exercise provides an osteogenic stimulus to bones. Observations suggest that repetitive stress applied to weight-bearing sites over extended periods of time serve as an important strengthening agent for bones (Bass *et al*., 2002; To,Wong & Lam, 2005; To & Wong, 2011). BMD was estimated using ultrasound of the calcaneus (heel) since the funds would not allow for a full body scan.

2.3 Relationship between Energy Deficit and Amenorrhea

The first study to link menstrual disorders to energy drain was carried out in dancers and published in 1980, since then several other studies have also documented the relationship between energy drain and menstrual disorders in athletes (Nattiv *et al*., 2007; Loucks & Thuma, 2003; Castelo-Branco, Reina & Montivero, 2006). Amenorrhea is primarily caused by disruptions in the normal signalling processes between the hypothalamus and the pituitary gland. In normal functioning of the reproductive system there is pulsatile release of GnRH from neurons of the hypothalamus and lutenising hormone (LH) from the pituitary gland. When the LH pulsatility is irregular and infrequent, normal ovarian function, follicular development, ovulation, and luteal function is suppressed (Castelo-Branco *et al*., 2006).

To determine the effect of energy availability on LH, investigators measured lutenising hormone pulsatility after manipulating energy availability, defined as the difference between caloric intake and output in 29 healthy, regularly menstruating, sedentary young women of normal body weight in Ohio, (Loucks & Thuma, 2003). Study subjects were randomized to restricted energy availability treatments of (10, 20, and 30 kcal/kg lean body mass [LBM] per day and underwent repeated trials controlling their diet and exercise for 5 days in the early follicular phase of the menstrual cycle. The study determined that energy availability of about 30 kcal/kg/ LBM per day had no effect on lutenising hormone pulsatility, however below this benchmark lutenising hormone pulse frequency decreased, while lutenising hormone pulse amplitude increased. Results also indicated that subjects with shorter luteal phases were more sensitive to a decrease in energy availability as indicated by the disruption of their lutenising hormone pulses (Loucks & Thuma, 2003). This study clearly showed the dependent relationship between lutenising hormone pulsatility and energy availability, as has also been demonstrated by other studies (Loucks, 2004; Nattiv *et al.*, 2007).

The hormone leptin has been attributed to be an important mediator between nutritional status and reproduction. Leptin is a hormone secreted by the adipose tissue; its levels are dependent on fat mass and respond to alterations in caloric intake. Research has previously shown that with limited energy availability, physiological mechanisms will reduce the amount of energy used for many processes, including reproduction, in order to compensate for the deficiency (Sundgot-Borgen & Torstveit, 2010). For normal reproductive function to occur, body fat levels must reach a certain optimal level, and be maintained at that level (Sundgot-Borgen & Torstveit, 2010). This study sought to find if there was any relationship between energy deficit and the occurrence of amenorrhea in both the athletes and non-athletes.

2.4 Bone Loss and the Female Athlete Triad

Bone undergoes a continuous process of remodelling throughout the lifecycle. Remodelling is influenced by factors such as; dietary intake and particularly calcium that aids in bone formation, hormonal status of the individual and weight bearing physical activity that has an effect on bone loading (Nichols, Sanborn & Essery, 2007). With a compromised hormonal status, BMD is negatively impacted due to the protective role of hormones on bone remodelling.

Bone turnover markers are an indirect measure of bone formation and bone breakdown and are usually measured in blood serum and in urine (Torstveit, Rosenvinge, & Sundgot-Borgen, 2008). Studies have shown that reduced bone formation is linked to both low body mass index and estrogen deficiency and that osteoporosis in hypothalamic amenorrhea has a direct relationship with nutritional issues (De Souza & Williams, 2004). Negative energy balance has been linked to reduced bone turnover as was demonstrated among a group of amenorrheic distance runners therefore highlighting the potential link between body mass index, energy deficit, and hypothalamic dysfunction (De Souza & Williams, 2004).

When normal women were put under dietary restriction, changes in bone turnover were noted. Ihle & Loucks (2004) also demonstrated a direct relationship between energy availability and bone turnover in healthy women with restricted energy availability. In anorexic subjects bone resorption did not decline until menses resumed. Such findings indicate that both nutritional and estrogen-related components affect bone resorption

(Dominguez, Goodman & Sen, 2007, hence estrogen deficiency is not the only likely cause of dysfunction in bone formation.

Women who suffer eating disorders have shown increased risks of fractures compared to women in the general population, due to their chronic energy deficit. One study (Vestergaard *et al*., 2003) found that women with anorexia nervosa had a higher risk to all types of fractures compared to the general population. The study indicated that women with bulimia nervosa were 1.4 times likely to suffer fractures while those with eating disorders not otherwise specified were 1.8 times at risk. Women with anorexia nervosa indicated a 5.3 increased risk of hip fracture compared to the general population. The study therefore concluded that severely underweight women who presented with a fracture sustained from a low-energy trauma and without any accompanying medical conditions, suspicions of anorexia would be raised. This study sought to determine if there were any relationship between the bone density and other variables of the triad.

2.5 Exercise and Menstrual Cycles

Being physically active has obvious health benefits, however high training loads can have an adverse effect on the normal menstrual cycle (Dawson & Reilly, 2008). Studies indicate that young girls having both a low body mass and body fat and who undertake intense exercise training may experience delayed menarche (Reilly, 2000; Warren and Perlroth, 2001). In older female athletes, intense exercise training result in a shortened luteal phase while subsequent intensive training will lead to a more severe condition, secondary amenorrhea, which refers to an absence of menses for a prolonged period (Dawson & Reilly, 2009).

Speed (2007), found a 20% prevalence of exercise-induced amenorrhea in female athletes and an even greater prevalence (44%) of athletes who exercised vigorously compared to 5% of women in the general population. The study also indicated that exercise induced amenorrhea would be as high as 50% in female athletes that covered more than 130 km weekly. Consequently, higher incidences of exercise-induced amenorrhea have also been reported in younger and lighter athletes, those that have low body fat, experiencing more life stress, have higher training regimes and mileage, train at a faster pace and compete frequently (Reilly, 2000).

Although studies link secondary amenorrhea to low levels of body fat, low body weight, energy imbalance, high training load and psychological stress (Reilly, 2000), the exact mechanisms are not fully understood. However, exercise training that lowers body fat leads to a reduced peripheral production of oestrogen (Reilly, 2000). Secondary amenorrhea can be reversed by reducing the intensity and frequency of training and increasing body fat (Dawson & Reilly, 2008).

2 .6 Prevalence of the Triad in Athletes

The prevalence of disordered eating and eating disorders has been reported to be highest among adolescent and adult athletes competing in weight sensitive sports (Torstveit *et al*., 2008). Rosen & Klibansiki, (2009) have reported disordered eating in young female athletes. Although disordered eating can be seen in athletes participating in all manner of sports athletes at higher risk for the development of these behaviours include those in which leanness is emphasized such as gymnastics, ballet dancing, diving, and figure skating or perceived to optimize performance for example long-distance running and cross-country skiing and those that use weight classification (Johnson, 1994). Estimates of the prevalence of eating disorders among female athletes have shown to range from less than 1% to as high as 75% (Gadpalle, Sandborn & Wagner, 1987, Burckes-Miller & Black 1988). Studies generally indicate a substantially higher prevalence among females than males (Andersen, 1995).

A higher prevalence of disordered eating was reported among non- athletes compared to athletes in a study of high school athletes (Martinsen *et al.*, 2010; Rosendahl, *et al.*, 2008). Results from these studies however are faced with a major limitation in that they are based on self-report. Other studies on adult athletes using a two-step approach (self-report via questionnaire followed by clinical interview by experienced therapist) indicated that athletes tend to underestimate disordered eating and eating disorders (Sundgot-Borgen & Torstveit, 2004; Torstveit *et al.*, 2008). Therefore, the prevalence of eating disorders might be higher than indicated from these studies using self-report and especially in high risk adolescents.

Several factors contribute to the development of disordered eating patterns in the junior athlete including; pressure to perform optimally, desire for appropriate sport weight, social factors such as idealization of thinness in Western cultures, psychological factors such as poor coping skills, unhealthy family dynamics, low self-esteem and personality traits such as perfectionism, compulsiveness, and high achievement expectations (Putukian, 2001). Additionally, studies indicate that sports coaches can either reduce or increase risk of eating disorders dependent on their coaching style and environment provided to the athlete (Currie, 2010). A performance-related and body weight pre-occupied coaching style was found to increase body image anxiety, dieting and fear of fatness (Biesecker & Martz 1999). Similarly, a supportive and caring coaching style reduces the risk of eating disorders in young athletes (Currie, 2010).

The prevalence of amenorrhea has been reported to range from 6 to 43% in runners (Cobb *et al*., 2003), 1–21% in both high school (Nichols *et al*., 2007) and collegiate athletes across a wide assortment of sports (Beals & Hill, 2006; Beals & Manore, 2002). The prevalence of amenorrhea is higher in female athletes and physically active and exceeds the 2–5% that has been observed in the general population of sedentary college-aged women (Torstveit & Sundgot-Borgen, 2005; O'Donnell & De-Souza, 2004). Adolescent athletes including; - gymnasts, ballet dancers, runners, divers, and cheerleaders have reported primary amenorrhea and delayed menarche (Beals & Manore, 2002, Warren *et al*., 2004). Primary and secondary amenorrhea in adolescent athletes have been attributed to exercise training without appropriate regard for social self-selection factors that are known to influence the timing of pubertal maturation particularly in sports like gymnastics and ballet (American Society for Reproductive Medicine, 2006).

The prevalence of osteopenia in amenorrheic athletes is estimated to range from 1.4 to 50% (Cobb *et al*., 2003; Khan *et al.*, 2003) with a lower prevalence of osteoporosis (De-Souza *et al.*, 2008; Khan *et al.*, 2003). Stress fractures have also been reported to be more common in female athletes and physically active women who suffer amenorrhea than in their physically active counterparts with normal menstrual cycles (Nattiv *et al.*, 2007; Nattiv, 2000). Several studies including (Micklesfield *et al*., 2011; Micklesfield *et al*., 2007; Thandrayen *et al*., 2009) have investigated ethnic differences in BMD in reference to South African (SA) populations and reported the incidence of fractures to be lower in the SA black population than in the white population. Robbeson *et al*., (2013) investigating the female athlete triad in white SA student track and field athletes reported normal BMD in the athletes despite insufficient intakes of energy and nutrients. A recent study (Wright *et al*., 2012) reported that white and black athletes had similar BMD which was higher in white and black non athletes concluding that physical activity seemed to play a bigger role in BMD than ethnicity.

Sufficient data have not yet been collected to allow for definitive answers on the BMD status of African athletes. Almost all the reported data is from South Africa, thus a need for investigation on other African countries, a gap this study sought to fill.

2.7 Effects of Low Energy Availability and Eating Disorders on the Junior Athletes Sports Performance

The effect of an eating disorder on exercise performance is determined by how long the disorder has been present and the severity of the disorder. Whether an eating disorder affects performance in a specific sport is determined by the nature of sport. This is dependent on whether the predominant requirement of the sport is power, strength, endurance or motor skills (Sundgot-Borgen, 2002).

In the early stages of an eating disorder, the body adapts and uses up body stores for fat, minerals and vitamins. Athletic performance may not decrease at this stage and the athlete may perceive the disordered eating behaviour as being harmless. Endurance performance is however likely to deteriorate if liver and muscle glycogen levels are depleted or if the athlete becomes dehydrated or anaemic. Dehydration is common in both anorexia nervosa and bulimia nervosa and acute dehydration has other consequences for sports performance such as loss of motor skill and coordination (Sundgot-Borgen, 2002). This study did not delve into the effects of low energy availability in the athletes; however this is important to note so as to show the fatal effects of the same.

2.8 Health Consequences of the Triad on the Athlete

When energy availability is low, the possibility that macronutrient and micronutrient intakes are low is high (Woolf & Manore, 2006). Reduction in intakes of both macronutrients and micronutrients and especially the essential amino and fatty acids, will likely decrease the body's ability to build bone, maintain muscle mass, repair damaged tissue, and recover from injury (Manore *et al*., 2007). Micronutrients also play a vital role in building bones and muscle tissue, replacing red blood cells, and providing co-factors for the energy-producing metabolic pathways (Manore *et al*., 2007).

Chronic eating disorders can give rise to health problems. Starving in anorexia nervosa and the binge-purge cycle in bulimia nervosa, result in reduced energy availability and micronutrient deficiencies that have far reaching consequences for the health of the athlete (ACSM, 2009). Energy and macronutrient deficiency in people with athletic nervosa may affect mood, endocrine status, growth, reproductive function and bone health (Williams *et al*., 2001).

According to the ACSM, stunted growth in adolescent athletes occurs during prolonged periods of low energy, protein and micronutrient intake. The effects of stunting may be delay the onset of puberty in child athletes, additionally poor bone development will lead to increased susceptibility to fractures and bone problems in later life (Jeukenndrup & Gleeson, 2009).

Because ovarian steroid hormones, particularly estradiol, facilitate calcium uptake into bone and inhibit bone resorption, amenorrhea may predispose female athletes to osteoporosis, a pre-mature loss of bone quality and quantity (Bloomfield, 2001). This condition can occur despite the fact that load-bearing physical activity induces greater bone-mineral density. There seems to be a threshold of dietary calcium intake below which physical activity may have minimal effect on the increasing bone mass (Bloomfield, 2001). Intake of vitamin D is likely to be influenced by calcium intake and vice versa. Pertaining bone health, both high dietary calcium intake and high vitamin D intake lead to reduced levels of bone resorption (Devine *et al*., 2002).

The mechanism underlying the bone loss observed in amenorrheic athletes is two-fold, including both hormonal and nutritional components (De Souza *et al*., 2008; De Souza & Williams, 2005). Bone is an active tissue which undergoes cycles of resorption and formation. When both estrogen and energy are deficient, an uncoupling of bone turnover occurs; bone resorption increases while on the other hand bone formation decreases, ultimately resulting in bone loss (De Souza *et al*., 2008). As demonstrated in their study Ihle & Loucks (2004), posit that with reduction in energy availability, there is a decrease in estrogen which coincides with an increase in markers of bone resorption, providing support for the role of estrogen in suppressing the bone-resorbing effects of osteoclasts.

Athletes with eating disorders have shown to have decreased spinal vertebral bone mineral densities than non athletes with eating disorders, indicating that as much as exercise training may lessen the amount of bone loss, exercise alone cannot protect the athlete from osteoporosis (Golden, 2002). The likelihood of fractures has also been related to abnormal and restrictive eating behaviours (Golden, 2002). Bone strength and the risk of fracture depend on the density and internal structure of bone mineral and on the quality of bone protein, which may explain why some people suffer fractures while others with the same BMD do not (Golden, 2002).

The strongest evidence for health consequences of the Triad relates to stress fractures. Stress fractures are common injuries reported by athletes and especially among long-distance runners (Iwamoto & Takeda, 2003). The withdrawal of estrogen at any age is associated with bone loss and reduced BMD and could lead to osteoporosis in cases of prolonged withdrawal (Nattiv, 2000). Demineralisation of the bone is due to prolonged hypoesteogenia which upsets the balance between bone resorption and bone remodelling (Dawson & Reilly, 2008). As a result bone density is reduced, an action similar to that found in post-menopausal women, which consequently increases the risk of stress fractures (Dawson & Reilly 2008). The absence of menstrual cycles and the associated low plasma estradiol levels may decrease BMD to such an extent that fractures will occur under minimal impact loading (Marcus, 2001). Stress fractures have been reported to be two to four times more common in athletes and physically active women with menstrual dysfunction than their physically active counterparts who are menstruating (Nattiv *et al*., 2007; Nattiv, 2000).

Bone development normally continues up to 25 years of age, after which, a gradual loss occurs with advancing age. Peak bone mass is reached during the first 3 decades of life (Katzman, 2005*)*. Females attain 95% of maximum density by 18 years of age, after which all women will experience age-related bone loss. Maximizing peak bone mass during the formative years is therefore of utmost importance. The initial two to three years that are characteristic of the pubertal growth spurt are usually accompanied by deposition of 60% of final bone mass, therefore, failure to meet the recommended dietary intakes and disruption of the normal menstrual cycle may impair bone formation more severely at that time than any other (Sabatini, 2001; Golden, 2002).

A female athlete's BMD reflects her cumulative history of energy availability and menstrual status as well as her genetic endowment and exposure to other nutritional, behavioural and environmental factors (Sabatini, 2001). As in the case with sufferers of anorexia nervosa, athletes who experience estrogen deficiency because of low energy availability are usually chronically undernourished with inadequate protein and micronutrient intake, which further reduces the rate of bone formation (Sabatini, 2001). Low energy availability has an adverse effect on the cortisol and leptin hormones hence suppressing bone formation.

The effects of the components of the Triad may predispose the athlete to the risk of cardiovascular disease through endothelial dysfunction (De Souza & Williams, 2004; Rickenlund *et al*., 2005a) and also decrease immune function (Montero *et al*., 2002). It is important to discuss the health effects of the triad in order to better understand why the triad has been an emerging health issue among athletes and to also be able to give sound education to the young athletes.

2.9 Eating Disorders in Adolescents

Eating disorders emerge in adolescence and young adulthood (Carney and Scott, 2012). Epidemiological research indicates that the highest incidence of anorexia nervosa occurs in young females ages of 15 to 19 years (Keski-Rahkonen *et al*., 2007), whereas bulimia nervosa occurs in young females ages 16 and 20 years (Keski-Rahkonen *et al*., 2009). Considering this age of onset, many of the young who develop eating disorders are students who spend a significant amount of time at school around their peers. Although high school athletic participation in and of itself is not necessarily associated with disordered eating and can even be considered a protective factor in some cases (Hoch *et al*., 2009), students involved in certain sports that emphasize thinness and a lean physique for peak performance or extremes of weight loss are more at risk of the Female Athlete Triad (Weltzin *et al*., 2005).

2.9.1 Eating Disorders in Sub-Saharan Africa and Middle East

Eating disorders among children and adolescents are thought to be rare in sub-Saharan Africa, with the exception of South Africa (Smolak & Thompson, 2009). However disordered eating attitudes and behaviours have been found among both black and white adolescent girls in South Africa urban settings at prevalence rates similar to those found in the United States and Western Europe (le Grange, 2006). Black girls in rural Zuluspeaking areas also reported disordered eating attitudes, however at lower rates than in urban areas (Szabo & Allwood, 2004).

Several studies from sub-Saharan Africa indicate a growing concern in disordered eating behaviours. A study of black Nigerian secondary school and university women by Oyewumi and Kazarian, (1992) using the EAT-26 questionnaire found that the subjects reported disordered eating. Additionally, Hooper and Garner (1986) administered the Eating Disorder Inventory (EDI) to Black, White and mixed- race school girls in Zimbabwe and reported high subscale scores among Black adolescent girls. Eddy and Hennessey (2003), using a Kiswahili version of the EDI in a random sample of 200 Tanzanian females between the ages 13 and 20, reported very low rates of disordered eating behaviours.

Among several populations of Middle Eastern young women, disordered eating has been found to be as common as in Western Europe or the United states (Al-Adawi *et al*., 2002; Halevy & Halevy, 2000; Eapen *et al*., 2006). Al-Adawi and colleagues reported that 36.4% of Omani teenage boys and 29.4% of Omani teenage girls reported likelihood for anorexic-like behaviours compared with 9% of their non-Omani peers. Nasser, (1994) found partial and full-syndrome bulimia nervosa among high school girls in Egypt. Disordered eating attitudes and behaviours have also been reported among adolescent Israeli women (Smolak and Thompson, 2009). In a study of adolescent girls 12-18 years of age in five Israeli school subtypes and residential neighbourhoods, Latzer and Tzischinsky (2003) found that girls aged 16.6 to 18 years reported highest scores on the EDI-2 as compared with other groups. The major causes for the cross-cultural spread of eating disorders have been thought to be:-the processes of westernization, modernization, industrialization, urbanization, and social transition (Anderson-Fye & and Becker, 2003).

Although several studies have been carried out in Africa on eating disorders and disordered eating among adolescents, such data is lacking on adolescent athletes and non-athletes in Kenya. This study thus sought to fill this gap by evaluating clinical and sub-clinical disordered eating in high school athletes and non-athletes.

2.10 Recommended Daily Nutrient intakes in athletes

Reduced intakes of macronutrients, especially the essential amino and fatty acids, affect the body’s ability to build bone, maintain muscle mass, repair damaged tissue, and recover from injury (Manore, 1999). Micronutrients are of utmost importance in building bone and muscle tissue, replacing red blood cells, and providing co-factors for the energy-producing metabolic pathways.

When energy intake is low, it follows that intake of other macronutrients namely: - protein, carbohydrate, and essential fatty acids will be below the recommended levels (Beals & Manore, 1998; Manore, 1999). When carbohydrate intakes are low, glycogen stores will not be fully replenished during periods of high intensity exercise training (Burke, Millet, & Tarnopolsky, 2007). The majority of female athletes in exercise training need a minimum of 5 – 6 g of carbohydrate per kilogram of body weight to maintain adequate glycogen stores to be used during exercise training (Burke et al., 2001; Burke, Kiens & Ivy, 2004). If exercise intensity and duration are high and training occurs on a daily basis, carbohydrate needs may be 7 – 12 g of carbohydrate per kilogram of body weight (Burke *et al*., 2004).

Although limited data are available on the protein requirements of female athletes, it is recommended that they consume more protein; 1.0 – 1.3 g protein per kilogram of body weight (Phillips, 2004; Tarnopolsky, 2004) than the Recommended Dietary Allowance (RDA) of 0.8 g per kilogram of body weight (Institute of Medicine, 2005). However elite endurance athletes have protein requirements as high as 1.6 – 1.7 g per kilogram of body weight (IAAF Consensus Statement, 2007; Tarnopolsky, 2004); although these requirements are still being debated (Millward, 2004). Protein recommendations assume that the athlete is healthy, weight stable, and in energy balance. The Institute of Medicine's Acceptable Macronutrient Distribution Range for fat is 20 – 35% of energy (Institute of Medicine, 2005).

Physically active women who restrict their energy intake or eliminate food groups from their diet, can have low micronutrient intakes, especially the energy (B-complex vitamins), blood (folate, vitamin B-12, iron) (Woolf & Manore, 2006), and bone-building (calcium, magnesium, and vitamin D) nutrients (Manore, 1999, 2000, 2002). These nutrients maintain the health of the body and provide energy for physical activity. Additionally exercise increases the need for some micronutrients, such that active females with low dietary intakes are at risk for poor nutritional status (Manore, 2000, 2002).

Calcium serves many important functions and facilitates the processes of nerve conduction, muscle contraction, maintenance of blood calcium levels, and mineralization of bone. In addition, calcium absorption may be hindered by low estrogen levels in girls and young women with disordered eating and/or amenorrhea (Cobb *et al.*, 2003; Manore 2002; Beals & Hill, 2006). The new 1998 Dietary Recommended Intake for calcium is 1300mg/day for young athletes between the ages of 9 and 18 years and 1000mg/day for adult females aged 19 to 50 years.

Iron is an important mineral for optimal athletic performance, due to its oxygen carrying capacity and role in energy production (Stipanuk, 2000). Studies report that approximately 15-60% of female athletes have poor iron stores compared to 20-30% in the general population (Haymes, 1998; Haymes & Clarkson, 1998). The World Health Organization recommends an intake of 13mg/day for iron in adolescent girls, and the Food and Nutrition Board, 2004 recommends 15mg/day for female athletes.

Magnesium intakes however largely depend on the total energy intakes (Manore, 2002) and if energy intake is restricted, magnesium intakes can be low. Several studies have indicated that 1.4mg of riboflavin per 1000 kcal is required to maintain a good status in active women, while 1.6mg of riboflavin per 1000 kcal is required to maintain good riboflavin status when individuals are dieting for weight loss and exercising (Manore, 2002). Based on metabolic studies, approximately 1.5 to 2.3 mg/day of pyridoxine is required to maintain good pyridoxine status (Hansen *et al*., 1997). The current FNB, 2004 RDA is 1.3mg/day for women.

Although the nutrient intakes of athletes are not very different from the general population, few studies have been carried out on the nutrient intakes of athletes and the ones carried out are not current. This study therefore seeks to fill in the gap by providing data on nutrient intakes in high school athletes.

CHAPTER THREE: METHODOLOGY

3.1 Study Design

The study adopted a cross-sectional descriptive comparative study design. This design examines the relationship between variables of interest as they exist in a defined population at a single point in time.

3.2 Study Variables

The dependent variables were: energy availability, bone health and menstrual status, while the independent variables included; - disordered eating, dietary diversity, age, body mass, and BMI.

3.3 Study Area

The study was carried out among junior athletes in 6 selected secondary schools in Iten, Keiyo North district, Elgeyo-Marakwet County. The Keiyo, a subgroup of Kalenjins are the predominant tribe in Iten and have won about 75% of all major distance running races in Kenya (Onywera *et al*., 2006; Manners, 1997). Day and boarding schools included: - Singore girls, Kessup A.I.C girls, Iten day, St. Alphonsus Mutei girls, Sergoit Secondary School and Chebonet day mixed secondary school. These schools were chosen due to their track records of producing elite athletes who begin training while still in high school. A comparison between day and boarding schools was necessary to determine if there were differences in intakes.

3.4 Target Population

Long-distance (1,500m and above), athletes and non-athletes, were recruited from secondary schools in Iten. Both athletes and non-athletes had to be 16-17 years old as per the IAAF definition of a junior athlete.

3.4.1 Inclusion Criteria

Inclusion criteria were female athletes aged 16-17 years competing competitively at regional or higher level in the previous or coming year. Non-athletes were students not enrolled in any organized sport but were involved in leisure sport for purposes of calculating the exercise energy expenditure. It was assumed that the athletes were spend more time and energy in organised sport than non-athletes. The non-athletes were of same age and in the same classes and schools as the athletes.

3.4.2 Exclusion Criteria

Students were excluded if they were currently experiencing or had previously experienced any known bone diseases that had been clinically diagnosed by a qualified clinician or were pregnant

3.5 Sample Size Determination

A priori sample size calculations using G Power 3.1.2 (Faul *et al*., 2009) based on data from previous studies (Nattiv *et al.*, 2007; Stunkard & Messick, 1985) was used. Sample size calculations were performed to determine the number of students per group. An effect size of 0.38 (0.3), an alpha error probability of 0.05(0.05), a power of 0.80 (0.95) and 1(109) degree of freedom required a total sample size of 100 students to test the hypotheses using the aforementioned statistical analyses. Thus, the sample size calculations indicated that 45 students per group provided adequate power (1-β = 0.80) to detect significant differences and associations at a large effect size for analyses.

3.6 Sample Selection and Sampling Technique

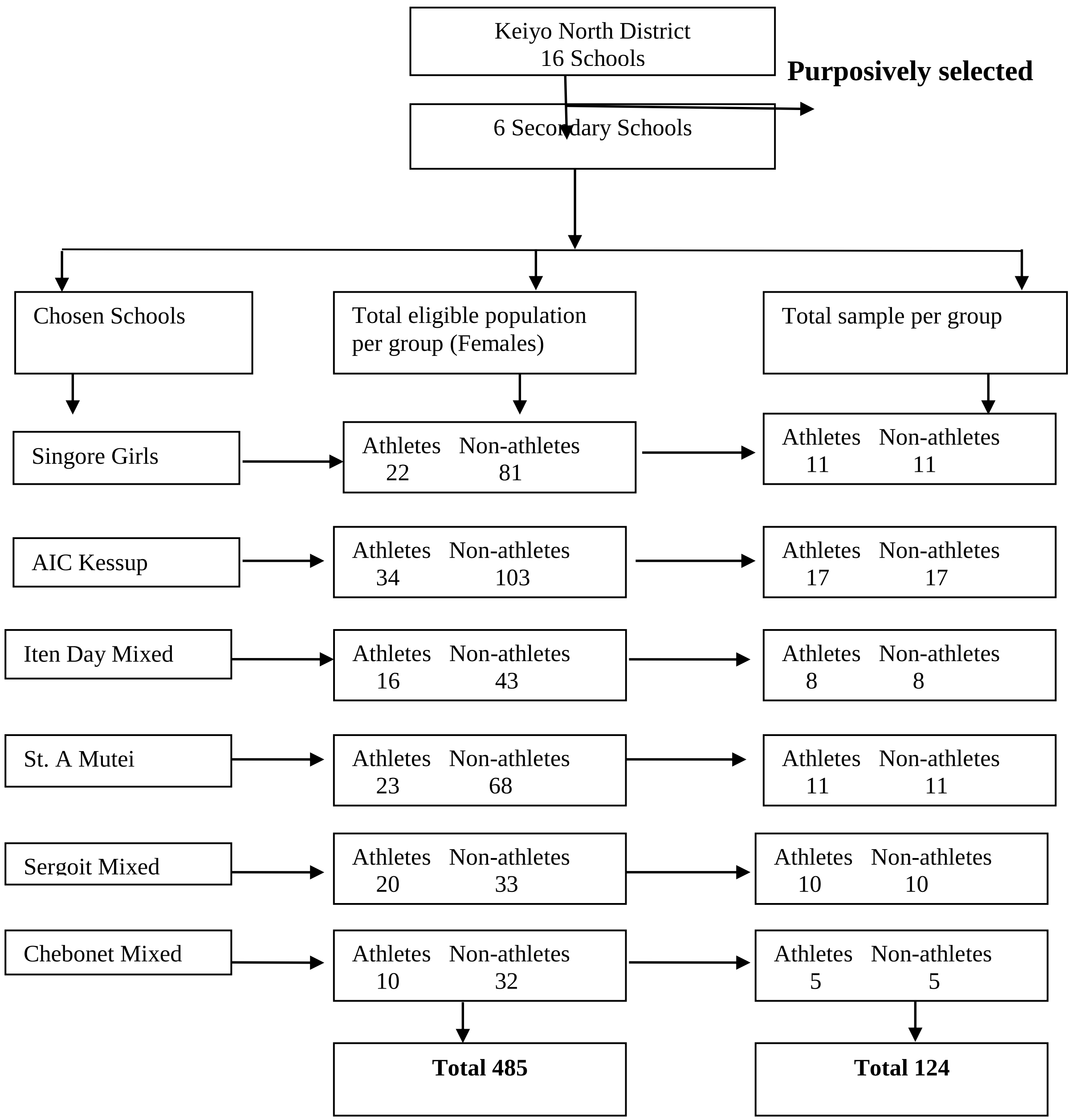


Figure 3.1 Sampling Frame of the study

Figure 3.1 indicates the sampling frame of the study. Based on past exemplary athletic performance and famed for producing elite athletes, six secondary schools (10% of the total population of schools as per Cochran, (1963) rule of sampling when the population is small) were purposively chosen to form the sampling frame. From each of the schools a comprehensive sample of all long distance athletes who met the inclusion criteria was drawn. A simple random sampling technique was used to select 50% of the athletes in each of the schools. The numbers chosen in each school was proportionate to the size of the school, thus the schools that had a higher population has a proportionately higher number of participants chosen. A similar number of non-athletes, from the same secondary schools as the athletes were also randomly sampled and included in the population sample as non-athletes. Majority of the athletes were drawn from boarding schools therefore the number targeted from day schools was much lower. The non-athletes had to be of the same age as the athletes and from the same classes. Although the actual sample size as per the sample size determination was 45 by 45 in each group, a 20% increase was factored in to cater for attrition rates. From the sampling a total number of 124 students would make the study population as illustrated above.

Table 3.1: Summary of students per school

School Name	Type of school	Frequency	Percentage %
Singore Girls	Boarding	22	20.0
Iten Mixed Day	Day	16	14.5
A.I.C. Kessup Girls	Boarding	27	24.5
Chebonet Day	Day	9	8.2
Sergoit Mixed	Boarding	16	14.5
ST. Alphonsus Mutei Girls	Boarding	20	18.2
Total		**110**	**100**

Although the sampling frame indicated 124 students as students, a total of 110 students formed the actual study sample (Table 3.1). Ten students did not consent and four did not complete all their questionnaires and especially the dietary data since they were send away from school due to school fee balances. A total of 110 students were adequate as sample size calculations had indicated a minimum of 45 students per group to detect any significant differences.

3.7 Research Instruments

A demographic, health and sports participation questionnaire modified by the researcher from standard questionnaires was used to gather information on athlete's age, ethnicity and education level (Appendix 2). Data on family background such household head, marital status of household head; parents' main occupation, education levels and number of siblings were also sought. The menstrual history questionnaire sought information on menstrual status and changes associated with training and competition

(Appendix 2). Information on history of injuries and current sports participation was also sought by use of this questionnaire. To confirm presence or absence of disordered eating, the Eating Disorder Inventory-3 questionnaire (Stunkard & Messick, 1985) was used (Appendix 3). A five day dietary record collected data on energy availability, nutrient intakes (Appendix 4) and individual dietary diversity (FANTA, 2007) (Appendix 5), three day recordings of food intake have been shown to give data comparable to seven days. Five day Exercise/activity logs were used to calculate exercise energy expenditure (Appendix 6). Calcaneus bone mineral density was assessed using ultrasound (Hologic IEC 601-1 Class II Type BF.IPXO, Advanced clinical version 2.13, Japan).

3.8 Pre-testing of Demographic, Health and Sports participation Questionnaire

Prior to the study 20 questionnaires were administered to 10 student athletes and 10 non-athletes that were not part of the study sample. The pre-testing group was of same age and met the inclusion criteria as the study sample. This sample was drawn from two secondary schools in Keiyo South district. The aim of the pre-test was to establish whether the data collection tools would collect the needed information.

3.9 Validity and Reliability of questionnaires

3.9.1 Face Validity of Demographic, Health and Sports participation Questionnaire

During the pre-test the face validity of the questionnaires was determined. This ensured that the students understood the questions in the context that they had been posed and that the responses given were what were expected from the questions. The questionnaire was then reviewed and adapted.

3.9.2 Reliability of Eating Disorder Inventory Questionnaire

The 91 items in the eating disorder inventory questionnaire were tested on the pre-testing group and subjected to the Cronbach's alpha reliability analysis to test for their reliability and yielded an alpha of 0.813 which is within the recommended ranges. Other studies (Thiel & Paul, 2006; Rose *et al*., 2013) have also found the test-retest reliabilities for the eating disorder inventory (EDI) subscales to be high ranging from 0.80 to 0.89. The EDI is thus an instrument with a good reliability for the assessment of eating disorder symptoms. The body dissatisfaction subscale of the EDI-3 has good test-retest reliability and convergent validity with other measures of overall body dissatisfaction (Garner, 1991)

3.10 Data Collection Techniques

Data collection was undertaken in the first term of the academic year which runs from January to March. The Kenya Secondary Schools Sports Association (KSSSA) has scheduled competition in athletic activities in this term. This term was chosen since the junior athletes are training maximally and it would give a better perspective on training regimes. Exercise energy expenditure would thus be at optimal hence giving a good indicator in comparison with energy intakes. Participating students completed questionnaires on socio-demographic, disordered eating and menstrual pattern information at their respective schools with the aid of the researcher. The students all converged at a central place on one weekend after all the questionnaires and the diet and exercise logs had been filled to have the body measurements taken.

3.10.1 Dietary Intake, Energy Availability and Dietary Diversity

Graduate nutrition research assistants trained students on keeping a 5-day dietary record (including 3 training and 2 non-training days), during both the week and weekend, but spread to a two week period (Appendix 4). Three day recordings of food intake have been demonstrated to provide comparable data to 7 day records in women who may underreport their food intake (Goris and Westerterp, 2001). Each student weighed using an ECKO Kitchen Scale or measured (using standard measuring cups) all food and beverages consumed after careful instructions on how to measure and report food and beverage items by the graduate nutrition students. In addition, each student received a hand-out with generic sketches of food and beverage portion sizes to guide them (Senekal and Steyn, 2004).

Students were instructed to follow customary eating habits and to weigh and record all food and beverages before consumption and weigh any left over's. The research assistants visited the students on a daily basis during meal times to ensure that the recording was being done well. Each student was to describe the nature of the product (for example; full cream milk, white bread, and skinless chicken), the method of preparation (for example; boiled, fried, grilled, and roasted), the brand name where relevant and the quantity taken. The diet records were done within five days spread into a two week period in order to capture the different menus offered in the schools. The records were returned after the two week period of recording, and were all checked for completeness. The 5-day food diary enabled calculation of nutrient intake, with specific reference to energy intake (kcal/day), carbohydrate (g/kg/body weight), protein (g/day), fat (g/day) calcium intake (mg /day), iron (mg /day), magnesium intake (mg/day), phosphorous intake (mg/day), zinc intake (mg/day), and folate (ug/day) intake (Nutri Survey Version 12).

Training and exercise logs were kept alongside diet records (Appendix 6). Students documented the type of exercise, exercise duration (in minutes), and exercise intensity/rate of perceived exertion (RPE) according to the 20 point Borg scale. Students were trained how to accurately keep these records and assign RPE points using the Borg scale. Engagement in planned leisure sport was used to calculate exercise energy expenditure in non-athletes and purposeful exercise were recorded by athletes. Upon return of the log each activity was subjectively assigned a metabolic equivalent (MET) as per Ainsworth's compendium (Ainsworth *et al*., 2011).

Intensity of activities in the compendium was classified as multiples of 1 MET based on kilogram body weight and duration of activity in minutes. All METs associated with exercise as outlined above were used to calculate exercise energy expenditure in calories, irrespective of the intensity level of the exercise activity. Exercise energy expenditure was not adjusted for resting energy expenditure. Actual estimates of energy expenditure can be accomplished using heart rate monitors and accelerometers. Funding for this study was, however, limited and therefore not possible. Athletes were highly motivated and committed to take accurate exercise records. Training was provided on how to distinguish between different levels of METS and exercise logs were monitored throughout the study

Students also completed a training questionnaire to assess age at onset of training in sport, training undertaken per week (hours of training, exercises undertaken in the training sessions, frequency of training per week). A typical training day consisted of a 1-hour run at moderate to high intensity in the morning and up to a 2-hour run at a very easy to moderate intensity in the evening for at least 4 days in a week.

Individual dietary score (IDDS) (FAO, 2008) was used to determine the diversification of the diet. Dietary diversity score (DDS) is an indicator of adequacy of energy and nutrient intake (FAO, 2013). A dietary diversity questionnaire was used to establish the variety of food groups consumed (Appendix 5). From the diet logs the trained graduate research assistants were able to extract information on the different food groups taken to help in computing the IDDS. A total of 9 food groups were included in the IDDS. These food groups were: (1) starch staples, (2) grains and tubers, (3) dark green leafy vegetables, (4) other vitamin A rich fruits and vegetables, (5) other fruits and vegetables, (6) organ meats, (7) meat and fish, (8) eggs, and (9) legumes, nuts, and seeds (FAO, 2008). Each student received a point if they consumed food from one of the 9 food groups described above. An average from the 5-day food record was used to calculate these scores. For each student the IDDS was the sum of these points and could range from 0 (no food intake in the 5-day record) to 9 (maximum diversity).

According to the Food and Agriculture Organization (FAO, 2008), there is no agreement on a cut-off to define a dichotomous indicator, for most age-groups so it is recommended to use the score as a continuous indicator. However in this study a cut-off point of 6 food groups was used based on other two studies in adolescents (Mirmiran *et al*., 2004; Vakili *et al*., 2013). Consumption of less than 6 food groups in any given day was considered as low dietary diversity.

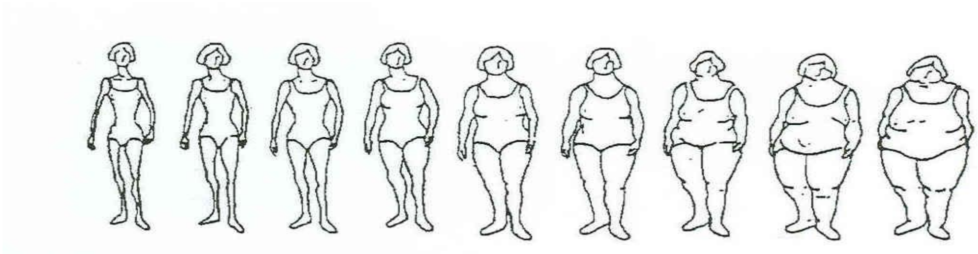
3.10.2 Disordered Eating

Disordered eating was assessed using the Eating Disorder Inventory-3 (EDI-3) which is a self-reported questionnaire that assesses attitudes, feelings and behaviour associated with eating disorders and is suitable for screening for eating disorders in a non-clinical setting (Garner, 1983) (Appendix 4). The EDI-3 has three subscales, Drive for Thinness (DT), Body Dissatisfaction (BD) and Bulimia (B) subscales (Garner; 1983) as well as the Cognitive Dietary Restraint (CDR) subscale of the Three-Factor Eating Questionnaire (TFEQ) (Stunkard and Messik, 1985; Bardone-Cone and Boyd, 2007). These subscales have been used to assess disordered eating in a non-clinical setting and among athletes (Vescovi, Scheid, Hontscharuk and De Souza, 2008).

The EDI has also been shown to be a valid indicator of disordered eating in black African women (Fawzi *et al*., 2010). The nine items EDI-3 BD measures overall (dis)satisfaction with the shape and size of various body parts, while the seven item EDI-3 DT assesses preoccupation with body weight, fear of gaining weight, desire to be thin and food intake restriction. The CDR subscale of the TFEQ is often used as a valid measure of the intent to diet and successfully represents the dieting behaviour component of the restraint (Stunkard & Messik, 1985). Statements are rated on a 5-point scale ranging from never, rarely, sometimes, often, and usually to always. Students were to read the statements and chose the one best answer that described their feelings and attitudes towards food and body image.

The responses for the EDI-3 were scored accordingly and students were categorized with subclinical disordered eating if they scored ≥7 for the EDI-3 DT and/or ≥9 for the EDI-3 BD and/or ≥9 TFEQ-CDR subscales and/or had a BMI <17.5 kg/m^2. Clinical disordered eating was identified as scoring ≥ 15 for the EDI-3 DT and/or ≥14 for the EDI-3 BD subscales (Gibbs *et al*., 2013; De Souza et *al*., 2014).

Students also completed a body weight questionnaire, questions included a Body Silhouette Assessment Scale where subjects chose the body silhouette on a scale from 1 (very thin) to 9 (obese) representing their actual (ABS) and ideal body silhouette (IBS) (Williamson *et al.*, 2000) (Appendix 2).The discrepancy between ‘actual’ and ‘ideal’ silhouette termed Feel Minus Ideal Discrepancy (FID) was also calculated to give an indication of body image dissatisfaction and whether they were trying to lose, gain or maintain weight



1 2 3 4 5 6 7 8 9

Figure 3.2: The figure rating Scale

Source: Albert Stunkard (1983).

The body image figures have been ordered by size and assigned values of 1 through 9 by the author.

Dietary data were analyzed using the Nutri-survey software programme version 12 (2007) to establish the habitual mean daily energy and nutrient intakes of subjects. Version 12 of the software programme has Kenyan foods included. The possibility of over- and underreporting was evaluated by calculating the mean reported Energy Intake (EI) in relation to calculated Basal Metabolic Rate (BMR) (rEI:BMR) according to the Goldberg method (1991). Over and under-reporters were not excluded in the sample. Predicted BMR was calculated with the Schofield Equation (Schofield, 1985). A rEI:BMR value of < 1.11 denotes under reporting while a value of > 2.42 denotes over reporting (Black , 2000). Mean Energy Availability (EA) was calculated with the formula adapted from Manore *et al*., (2007)

EA = (Mean daily energy intake (kcal/day) – mean daily exercise energy expenditure (kcal/day) / Fat-free mass (kg)

Students presenting with energy availability < 30 kcal/kg FFM/day were categorized as having clinically low energy availability, 30 to 45 kcal/kg FFM/day with subclinical low energy availability, and ≥ 45 kcal/kg FFM/day with optimal energy availability, as suggested for sedentary women (Loucks, 2007; Gibbs *et al*., 2013).

3.10.3 Menstrual Function

The menstrual history questionnaire (Appendix 2) which is based on self report was administered to collect information on menstrual function over the preceding 12 months. Immediately after menarche, young women are keen on menstrual patterns and this reduced the recall bias. Students documented information on age of menarche, frequency and characteristics of menses during the preceding twelve months based on recall. Students also documented changes in menstrual cycle during training and competition periods (Appendix 2).

To analyse menstrual function, eumenorrhoea was defined as a menstrual cycle every 21-45 days, primary amenorrhea as absence of menstrual cycle by age 15, secondary amenorrhoea as no menstrual cycle for more than 90 continuous days after menarche, and oligomenorrhoea as cycles longer than 45 days (American College of Obstetricians and Gynaecologist , 2006). Students were classified with clinical menstrual dysfunction if they reported primary, secondary, or oligomenorrhoea (Gibbs, *et al* 2013).

3.10.4 Bone Health

Bone mineral density (BMD) was estimated using a Sahara Clinical Bone Sonometer (Hologic IEC 601-1 Class II Type BF.IPXO, Advanced clinical version 2.13, Japan) ultrasound of the calcaneus (heel bone). The heel is the preferred peripheral site proven in numerous prospective studies to predict fracture risk (Langton *et al.*, 1984). Each student underwent a single scan analysis conducted by a Hologic certified technician. The Sahara Clinical Bone Sonometer measures the speed of sound (SOS, in m/sec) and the Broadband Ultrasonic Attenuation (BUA, in dB/MHz) of an ultra-sound beam passed through the heel. The SOS and BUA results are combined linearly to obtain the Quantitative Ultrasound Index (QUI) and an estimate of the BMD of the heel (est. heel BMD, in g/cm^2), the same type of result reported by x-ray based bone densitometry systems. Estimated heel BMD is the parameter used most frequently in the interpretation of Sahara heel ultra-sound results. Heel BMD was used to describe the difference in BMD between athletes and non-athletes. Although ultrasound is more widely used to predict BMD in post-menopausal women, calcaneus ultrasound has been used to predict BMD in white adolescent female endurance athletes from five secondary schools in Pretoria, South Africa (Hanekom & Kluyts, 2003). It is acknowledged that dual x-ray absorptiometry is the recommended method to assess BMD in pre-menopausal women but was not available for this study. The use of ultrasound is a limitation however it gives an indication of the difference in BMD between athletes and non-athletes in this study group. Self- reported osteoporosis/low bone mineral density diagnosed in a certified (government or private) health facility qualified the respondent to be classified as "at risk" for low BMD (Nattiv *et al*., 2007).

3.10.5 Anthropometric Measurements

Graduate students from exercise and sports science were used to take the measurements as per International Society for the Advancement of Kinathropometry's International Standards for Anthropometric Assessment Criteria (ISAK) (Marfell-Jones *et al*., 2006). Weight was recorded with a calibrated digital beam scale (Seca 874 digital medical scale, USA) and height with (Seca 213, USA) stadiometer to the nearest decimal place. Shoes and heavy outer clothing were removed. Weight was measured to the nearest 0.1 kg and height to the nearest 0.1 cm.

Body composition was assessed using body mass and skin-fold measurements as per ISAK assessment criteria using a Harpenden® skin fold calliper, (Amazon, UK) (Appendix 7). Estimating body fat using skin-fold thickness measurements is based on the concept that subcutaneous fat reflects the fat content in the body (Jackson & Pollock, 1985). Although under water weighing, DEXA and BOD POD are accurate methods of testing body fat, these were not possible due to lack of funding. Skin-fold models have previously been validated using UWW and DEXA as the criterion measure (Warner et al., 2004). This study adopted the developed skin-fold equation to predict fat free mass in collegiate female athletes using DEXA as the criterion measure (Warner et al., 2004).

Abdominal skin fold is the site 5 cm to the right hand side of the omphalion (midpoint of the navel). The subject assumes a relaxed standing position with the arms hanging by the side. The front thigh skin fold is the site at the mid-point of the distance between the inguinal fold and the anterior surface of the patella (Anterior patella) on the midline of the thigh. The subject assumes a sitting position with the torso erect and the arms hanging by the sides. The knee of the right leg should be bent at a right angle. Measurements at each of these sites were taken three times and an average value computed.

The body mass index was calculated by dividing the weight (kg) by the height (m) squared as per the WHO reference. Students were classified as per the 2014 Female Athlete Triad Coalition Consensus Statement on Treatment and Return to play of the Female Athlete Triad new triad guidelines (De-Souza *et al*., 2014) where underweight was defined as BMI ≤ 17.5, normal as BMI 17.5-24.9 and overweight as BMI ≥ 25. Students BMI were also classified according to the WHO (2006) BMI for age. The BMI number is plotted on the centre for disease control (CDC) BMI-for-age growth charts (for either girls or boys) to obtain a percentile ranking. Underweight was defined as less than the 5^{th} percentile, normal as 5^{th} percentile to less than 85^{th} percentile, overweight as 85^{th} to less than 95^{th} percentile and obese as equal to or greater than the 95^{th} percentile.

To calculate Fat Free Mass (FFM), the following regression model developed by Warner *et al.,* 2004 to predict fat free mass in female athletes was used;

FFM (Kg) = 8.51 + (0.809 × Weight kg) – (0.178 × abdominal skin fold in mm) - (0.225× thigh fold in mm)

The equation can be used in most athletic settings and is not ethnic specific and when tested on 101 National Collegiate Athletic Association Division I university female athletes in the US were found to have a predictive ability of R= 0.98 and standard error of the estimate = 1.1 kg.

3.11 Data Analysis

Quantitative data were analyzed with the Statistical Package for Social Sciences, Version 21 for Windows (SPSS)® software program. Data were analyzed for normality using the Kolmogorov–Smirnov test. Normally distributed data were expressed as mean ± SD. Non-parametric data (age of menarche, number of siblings, training hours per week, daily energy intake, and EDI-3 bulimia and body dissatisfaction subscales) were reported as median and inter-quartile ranges. Categorical data (BMI, age, energy availability and class) were expressed as percentage of total group. Differences between athletes and non-athletes were determined with chi-square analysis for categorical data, if more than 20% of the contingency cells had a value <5 a Fisher's exact test was used. A t-test was used to compare parametric continuous variables and a Mann Whitney U-tests to compare non-parametric continuous variables between groups. Statistical significance was set at $p<0.05$.

3.12 Clinical and Sub-clinical Definitions of the Triad

Table 3.2 indicates the operational definitions of the clinical and sub-clinical components of the Triad in this study as adapted from Gibbs *et al*., (2013). Bone mineral density was not included as ultrasound cannot be used to measure BMD in premenopausal women.

Table 3.2 Clinical and sub-clinical definitions of energy availability, disordered eating and menstrual dysfunction*

Components of the Triad	Subclinical definition	Clinical definition
Low energy availability (EA)	EA = ≥30 - ≤45 kcal·kg $FFM^{-1}·d^{-1}$	EA <30 kcal·kg $FFM^{-1}·d^{-1}$
Disordered eating	EDI-3 DT ≥7, EDI-3 BD ≥ 9, TFEQ CDR ≥ 9, BMI < 17.5 $kg·m^{-2}$	EDI-3 DT ≥ 15, EDI-3 BD ≥ 14
Menstrual dysfunction	Not measured	Primary amenorrhea: no menses by ≥15yr, Secondary amenorrhea: absence of menstrual cycle >90 continuous days after menarche, Oligomenorrhea: menstrual cycles > 45 days

*As classified by Gibbs *et al*, 2013. FFM=fat free mass, EDI=eating disorder inventory, DT=drive for thinness, BD=body dissatisfaction, TFEQ=three factor eating questionnaire, CDR=cognitive dietary restraint, BMI= body mass index.

3.13 Ethical considerations

Ethical clearance was sought from the Kenyatta University Ethical Review Board. A research permit was obtained from National Commission of Science, Technology and Innovation (NACOSTI). Clearance was also sought from the County Education Officer (CEO) in charge of Iten, Keiyo North County and the school heads of each of the schools visited. Before initiation of the data collection, the purposes and procedures were explained verbally and in writing to each participant. Informed, written consent was obtained from the students parents through the school principals. Once the parents gave consent the students assented. No information received from the study was given or disclosed to unauthorized persons external to the team implementing the study and only the required data was collected and used for the purpose of this study.

CHAPTER 4: RESULTS

4.1 General and Socio-demographic Characteristics of the Students.

A total of six secondary schools (4 boarding and 2 day) were purposively sampled due to their prowess in producing athletes in Keiyo North County. The majority of the students 24% were from A.I.C Kessup girls' secondary school, which also had the highest population of students among all sampled schools. Singore Girls had 20% of the total population and have the best performing female athletes in Keiyo North district. About 18% of the students were from St. Alphonsus Mutei Girls' school. Additionally 14.5% of students were drawn from Iten mixed day school and Sergoit mixed day. Chebonet day had the least number of the athletes at 8.2%.

As it can be noted from Table 4.1, the athletes differed significantly from the non-athletes (p=0.030) in the number of siblings. The athletes reported a higher number of siblings than the non-athletes. The majority of the students (92.8%) were of the Kalenjin community, with the rest 7.2% representing the Luhya, Luo, Kikuyu, Maasai and Kamba. The majority of the students were in Form 2, which is year two of high school in the Kenyan education system.

Table 4.1: Descriptive demographic characteristics of the total group, athletes and non-athletes

Variable	Category	Total group (N=110) %	Athletes (N=61)	Non-athletes (N=49)
Age (yrs)			16 (16;17)	17 (16; 17)
No of siblings			5 (3.5; 6)[a]	4 (3, 5.5)
		Percentage per group		
Type of school	Boarding	74.5	73.5	75.4
	Day	25.5	26.5	24.6
Ethnicity	Kalenjin	92.8	98.6	85.8
	Others	7.2	1.4	14.2
Class	Form 2	43.6	42.6	44.9
	Form 3	27..3	32.8	20.4
	Form 4	29.1	24.6	34.7

Non-parametric data presented as median and interquartile ranges (25^{th}; 75^{th} percentile)
[a]athletes differ significantly from non-athletes, independent t test, p=0.030

Fewer athletes than non-athletes came from households headed by fathers and had a single parent family. Results also indicated that the level of education of the non-athletes' parents as reported by the students, seemed to be higher than those of athletes' parents (Table 4.2). Fathers of non-athletes also tended to have more tertiary education than those of athletes (36.7 vs. 19.7%). There was no significant difference in fathers' occupation (p=0.06) among the athletes and non-athletes. Formal employment was defined as getting a regular wage. None of the students had ever smoked or used alcohol in their lifetime

Table 4.2: Parents education, employment and marital status of athletes and non-athletes

Variable	Category	Total group (N=110) %	Athletes (N=61)	Non-athletes (N=49)
		Percentage per group		
Fathers Education Level	Primary	30.0	34.4	24.5
	Secondary	42.7	45.9	38.8
	Tertiary	27.3	19.7	36.7
Mothers Education Level[1]	Primary and below	30.0	39.3	18.4
	Secondary	43.6	44.3	42.9
	Tertiary	26.4	16.4	38.7
Fathers Occupation	Formal Employment	51.6	43.9	63.9
	Non-formal employment	48.4	56.1	36.1
Mothers Occupation[2]	Formal Employment	31.7	13.5	54.2
	Non-formal Employment	68.3	86.5	45.8
House Hold Head[3]	Father	83.6	73.5	91.8
	Mother	16.4	26.5	8.2
Marital Status of House Hold Head[4]	Single	11.8	4.9	20.4
	Married	83.6	90.2	75.5
	Widowed	4.5	4.9	4.1

[1]Athletes differ significantly from non-athletes $\chi 2=9.16$, p=0.010; [2]Athletes differ significantly from non-athletes $\chi^2=20.13$, p=0.000; [3]Athletes differ significantly from

non-athletes, χ^2=7.0, p=0.030; [4]Athletes differ significantly from non-athletes, χ^2=6.3, p=0.044

Results on athletes' highest sporting levels are shown in Figure 4.1. Students participated in sport across all the levels.

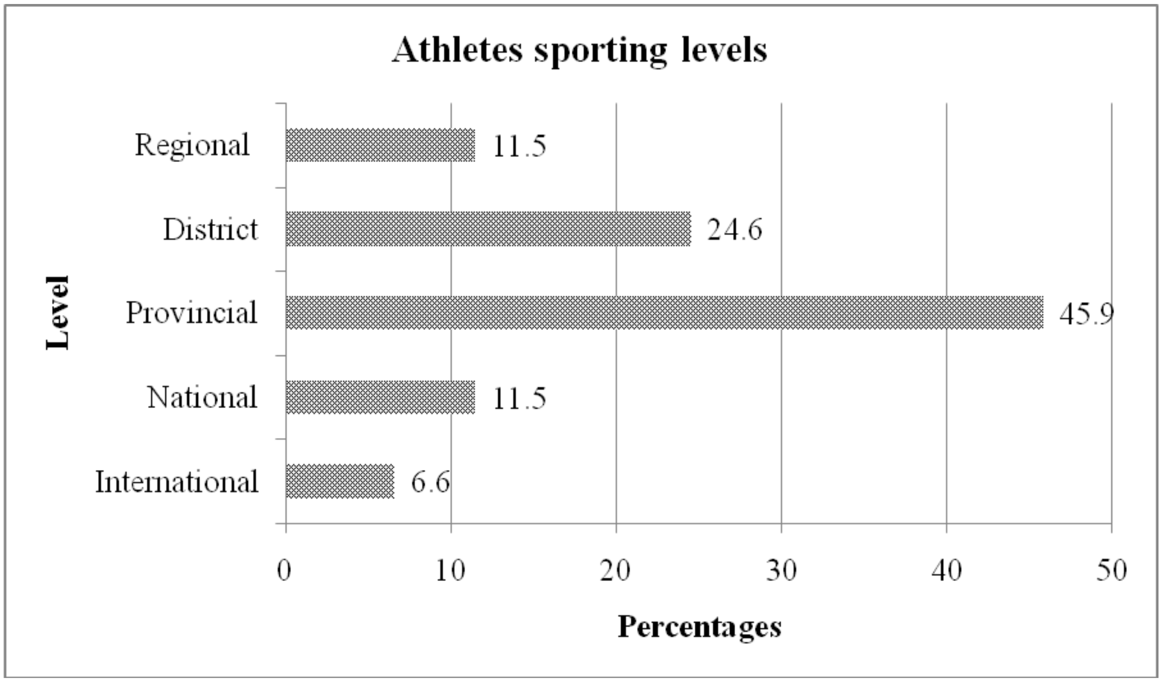


Figure 4.1: Reported athletes highest sporting levels

The athletes were involved in various athletic activities, with the majority participating in 1,500m as indicated in Table 4.3.

Table 4.3: Summary of the sporting activities that the athletes engaged in

Activity[1]	Frequency	Percentage %
1,500m	41	67.2
3,000m	28	45.9
5,000m	11	18.0
10,000m	2	0.3
Cross Country	18	29.5
Walking Race	3	0.5

[1]Multiple Response allowed

The student athletes were asked to state the duration of involvement in competitive athletics (Figure 4.2). The mean number of years involved in athletics was 4.9 ± 1.8 years indicating that the athletes began competitive athletics at a young age and possibly in primary school. The average time spent exercising per week was a mean of 8.8 ± 1.7 hours ranging from 5 to 13 hours for the athletes. On the other hand non-athletes spent a mean of 1.9 ± 1.1 hours with a range of 1 hour on the minimum and a maximum of 2 hours.

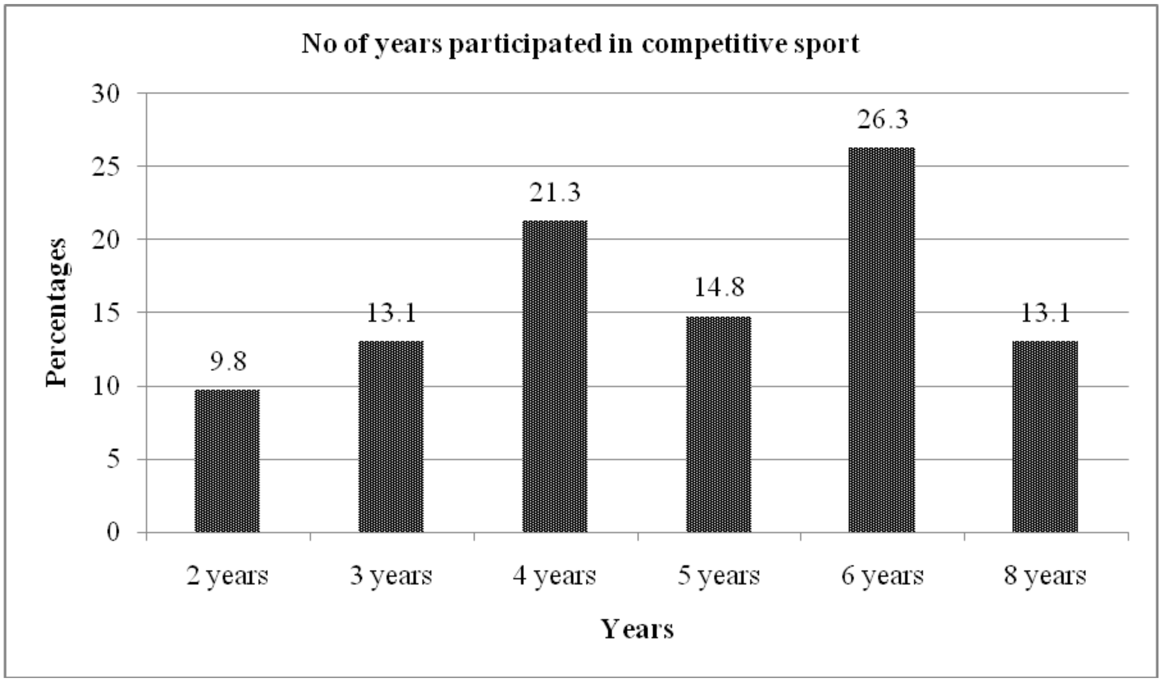


Figure 4.2: The number of years that the athletes had participated in sport

Out of the 110 students enrolled in this research nine (5 athletes and 4 non-athletes) did not turn up for anthropometric measurements. The findings as indicated in Table 4.4 show that Athletes were taller, had a lower body weight, BMI and FFM compared to non-athletes. Both the Triad classification for BMI and the WHO BMI percentiles for adolescents indicated that majority of the students had a normal BMI. Additionally, heel BMD tended to be higher in athletes than non-athletes. Fisher's exact test indicated that the presence of clinically diagnosed stress fractures reported by athletes and non-athletes was similar [16 vs. 10%, OR = 1.14, 95% CI (0.1, 6.0), p=0.9].

Table 4.4: Body composition and anthropometry among athletes and non-athletes

Variable	Athletes (N=56)	Non-athletes (N=45)	t-test p value
Height (cm)[1]	159.2±5.8	157.2±4.7	0.018*
Weight (kg)[2]	48 ± 6.1	52.±6.4	0.000*
Fat Free Mass (kg)[3]	41± 4.7	43.±4.8	0.000*
Body mass index (BMI)[4]	19±2.0	21.8±2.3	0.005*
BMI grouping			
Percentages			
≠Underweight (BMI≤ 17.5)	16.1	0	
Normal (BMI 17.5- 24.9)	82.1	88.9	
Overweight (BMI ≥ 25)	1.8	11.1	
π <5th percentile (underweight)	0	0	
>5th - < 85th percentile (Normal)	80.4	40.0	
>85th - <95th percentile (overweight)	19.6	51.1	
≥ 95th percentile (obese)	0	8.9	
Calcaneus BMD (g/cm²)	0.629 ± 0.1	0.592 ± 0.1	0.06

* Athletes significantly differ from non-athletes, ≠BMI classification as per the 2014 Triad guidelines (De Souza *et al*, 2014), π BMI classification as per WHO BMI percentiles for adolescents * athletes significantly differ from non-athletes

4.2 Results on the Triad components

This section will focus on the findings related to energy availability, disordered eating and other related components.

4.2.1 Energy availability, Disordered Eating and Related components

4.2.1.1 Energy Availability among Athletes and Non-athletes

Energy availability and energy intake was significantly lower in athletes than non-athletes respectively ($p=0.003$) (Table 4.5). Clinical low energy availability was identified among 17.9 % of the athletes and 2.2 % in non-athletes. About two thirds of the students (76%) reported subclinical low energy availability (42 athletes and 35 non-athletes). The mean energy intake expressed in kilocalories per day was significantly higher in non-athletes than athletes ($p=0.002$). Additionally mean daily energy and exercise expenditure was significantly higher in athletes than non-athletes ($p<0.001$) despite reporting a lower energy intake.

Table 4.5: Energy status of athletes and non-athletes

Variable	Athletes (N=56) (Mean + SD)	Non-athletes (N=45) (Mean + SD)	t-test p – value
Energy availability (kcal/kg FFM[1]/day)	36.5 ± 4.5	39.5 ± 5.7	0.003*
% reporting clinical low EA[2]	10 (17.9)	1 (2.2)	
% reporting sub-clinical low EA	42 (75.0)	35 (77.8)	
% reporting optimal EA	4 (7.1)	9 (20.0)	
Mean energy intake (kcal/day)	2090 ±114	2160 ± 109	0.002*
Mean total daily energy expenditure (kcal/day)	1427 ± 238	1211 ± 168	<0.001*
Mean exercise energy expenditure (kcal/day)	591 ± 94.5	490 ± 85.6	<0.001*
Resting metabolic rate (kcal/day)	1396 ± 79	1496 ±96	<0.001*
Goldberg cut-off	1.6± 0.1	1.6 ± 0.2	0.256

Parametric variables are reported as means and standard deviation and non-parametric variable, mean energy intake, as median and inter-quartile ranges (25^{th}; 75^{th} percentile); *significantly different between groups. [1]FFM=fat free mass, [2]EA=energy availability. Basal metabolic rate calculated using the Schofield equation.

4.2.1.2 Prevalence of Disordered Eating

Table 4.6 provides information on disordered eating, EDI-3 and TFEQ CDR Sub-scales. Scores across all scales were similar for both groups. Additionally no significant differences were found between athletes and non-athletes in prevalence of subclinical

(75.4 vs. 71.4%) and clinical disordered eating (4.9 vs. 10.2%) respectively, (χ^2=1.1, p=0.569). Both athletes and non-athletes reported high percentages above the cut-off criteria for bulimia and the cognitive dietary restraint subscale.

Table 4.6: Eating disorder inventory Subscales and the three factor eating questionnaire Subscale scores

Variable	**Athletes (N=61)**	**Non-athletes (N=49)**	**Mann-Whitney U test p-values**
Eating Disorder Inventory subscales			
Bulimia score	3.2 ± 3.5	2.7 ± 3.1	0.210
Percentage of subjects scoring above the cut-off (≥ 5)	30	27	
Body dissatisfaction	5.7 ± 3.8	6.3 ± 3.8	0.549
Percentage of subjects scoring above the cut-off (≥14)*	5	8	
Percentage of subjects scoring above the cut-off (≥9)#	13.1	10.2	
Drive for thinness	5.6 ± 3.2	5.4 ±3.9	0.255
Percentage of subjects scoring above the cut-off (≥15) *	0	2	
Percentage of subjects scoring above the cut-off (≥7)#	46	36.7	
Three factor eating questionnaire subscale			
Cognitive dietary restraint	10.6 ± 3.7	9.5 ± 3.7	0.302
Percentage of subjects scoring above the cut-off (≥9)#	71	63	

Parametric variables are reported as means and standard deviation (t-test) and non-parametric variables as median and inter-quartile ranges (25th; 75th percentile) (Mann-Whitney U test), Categorical data reported as percentages *Cut-off for clinical disordered eating; #Cut-off for subclinical disordered eating.

4.2.1.3 Eating Habits of the Athletes and Non-athletes

A small proportion of athletes reported being vegetarians and equal percentages of the athletes were either vegans or lacto vegetarians (Table 4.7).

Table 4.7: Athletes and non-athletes eating habits

Variable	Athletes (N=61) %	Non-athletes (N=49) %
Vegetarian	16.4	0.4
Type of Vegetarian		
Vegan	4.9	0.2
Lacto/ovo	6.5	0.2
Lacto	4.9	0
Restrict types of food to control weight[1]	72.1	32.7
Restrict amount of food to control weight[2]	68.9	32.7
Food groups restricted		
Dairy (milk, cheese)	29.5	18.7
Red meat	9.1	0
Other meat/protein (chicken, turkey, fish, eggs)	6.8	20.1
Carbohydrates rich foods	14.8	16.4
Sweets (ice cream, cookies, candy)	6.8	12.5
Fats	25.0	25.0
Sweetened beverages	6.8	0
Fast food	1.2	0.2

[1]Athletes differ significantly from non-athletes $\chi^2 = 17$, $p<0.001$*; [2]Athletes differ significantly from non-athletes $\chi^2 = 14$, $p<0.001$*

Across all the food groups the athletes seemed to restrict intakes more than the non-athletes as indicated by a Fisher's exact test (χ^2 =51.55, $p<0.01$). Dairy products were the most restricted, followed by fats, meats and carbohydrates.

4.2.1.4 Macro and Micronutrient Intakes in Athletes and Non-athletes

Several nutrients important for bone formation and energy provision were determined. Although, the mean energy intake was significantly higher in the non-athletes than athletes (2160±109 vs. 2090±114, p=0.002), probably because the athletes were restricting intakes despite being provided with same meals, none of the groups met the recommended daily intake for energy.

Diet records revealed the consumption of a monotonous high carbohydrate diet consisting mainly of ugali (a dish made of maize flour and cooked with water) served with fried vegetable (cabbage or kale) and githeri (a mixture of boiled beans and maize). Meat was consumed twice weekly and a seasonal fruit was eaten sometimes with main meals (Table 4.8). The mean total group carbohydrate intake was 6.7±1.7g/kg body weight. No significant differences were noted in mean carbohydrate intakes between athletes and non-athletes (6.8±1.5 vs. 6.7±1.8g/kg body weight, p=0.704) per kg of body weight. Carbohydrates were the major intakes and accounted for 70.5% of the total daily energy intake.

Table 4.8: A typical daily menu for athletes and non-athletes

Meal time	Menu
Breakfast (7.00 am)	A cup of tea (full-cream milk and sugar) and buttered white bread
Morning snack (10.00 am)	A cup of tea (full-cream milk and sugar) (white buttered bread optional student has to buy own)
Lunch (12.45 pm)	Ugali (stiff cooked maize flour) served with fried cabbage or kale
Dinner (6.30 pm)	Fried bean stew (occasionally the stews have potatoes, peas and carrots added to them) OR Fried Githeri (mixture of boiled maize and beans) OR Boiled rice served with meat stew (has potatoes and carrots added) or bean stew (with or without potatoes, peas and carrots) and fried cabbage or kale)
Bed time drink (9.00 pm)	A cup of Cocoa/Milo without milk

Note: The items for lunch and dinner are interchanged on a daily basis. Meat is served not more than twice weekly. Occasionally a fruit in season is given at lunch and dinner. Common fruits are oranges, mangoes, bananas and passion fruits.

Significantly more non-athletes than athletes (97 vs. 76 %, p=0.002) were consuming the recommended dietary allowance for protein for sedentary women (0.8g/kg of body weight). A third of the athletes did not however meet the recommended intake for athletes (7-12g/kg of body weight). Fat intake ranged from 18%-23% of the total calories and slightly below the recommended ranges of 20%-30% of the total calories.

Although the groups mean intakes of calcium, magnesium, B_2 and zinc were within recommended ranges, notable percentages of the students did not meet the 100% recommended daily allowance for the micronutrients (Table 4.9). The mean intakes for iron, folate, and B_6 were below the recommended ranges, with well over fifty percent of the students not meeting the recommended intakes. No significant differences were noted between athletes and non-athletes intakes for all of the micronutrients except for folate (p=0.040). Both groups surpassed the RDA for vitamin B_2.

Table 4.9: Mean daily micronutrient intakes of athletes and non-athletes consuming less than the recommended ranges for each nutrient based on 5-day weighed food records

Nutrient	Total Group N=110	Athletes N=61		Non-athletes N=49		t- test p-value
	Intake < 100% RDA	Mean ± SD	Intake < 100% RDA	Mean ± SD	Intake < 100% RDA	
Calcium	24 (21.8)	1361± 106	17 (27.9)	1366 ± 72	7 (14.3)	0.086
Iron	64 (58.2)	11.1 ± 2.8	37 (60.7)	11.8 ± 2.6	27 (55.1)	0.557
Magnesium	48 (43.6)	345 ± 86	23 (37.7)	330 ± 87	25 (51)	0.162
Zinc	31 (28.2)	9.1 ± 3.0	18 (31.1)	9.2 ± 3.2	13 (26.5)	0.412
Folate	76 (69.1)	366 ± 46	47 (77)	370 ± 50	29 (59.2)	0.040*
B_2(Riboflavin)	0 (0)	2.1 ± 0.6	0 (0)	2.0 ± 0.6	0 (0)	
B_6(Pyridoxine)	78 (70.1)	1.3 ± 0.6	42 (68.9)	1.2 ± 0.5	36 (73.5)	0.596

RDA= recommended dietary allowance, SD=standard deviation *significant differences between athletes and non-athletes. Recommended dietary allowances as per the Food and Nutrition Board recommendations

4.2.1.5 Dietary Diversity Scores among Athletes and Non-athletes

Since the individual dietary diversity score does not indicate amounts taken, the IDDS was established based on the mean of the different number of food groups the students consumed within the five days they kept the food records. Nine food groups as recommended by FANTA/FAO, (2007) were considered. Of the nine food groups, the mean number of food groups taken for the five days was similar for athletes and non-athletes (3.90 ± 0.746 vs. 4.06 ± 0.689, χ^2 =2.10, p=0.302). There was however a significant difference in the mean number of food groups taken by the type of school, with those in day schools consuming a higher number of food groups than those in the boarding schools (4.36±0.7 vs. 3.8±0.6, χ^2 =13.4, p<0.001). Similarly a significant difference was noted by the name of the school, with Iten Day and Sergoit registering consumption across more food groups (χ^2 =104.3, p=0.000, minimum of 4 and a maximum of 9 food groups). Coincidentally, these students learn in day schools and therefore consume a greater variety of foods across the food groups than those in boarding schools.

4.2.1.7 Perception of Body Weight

4.2.1.7.1 Weight Regulation among Athletes and Non-athletes

The perception of the students on own body weight was established by asking questions on how they perceived their bodies, what they were doing about their current weights and why, and who was instrumental in shaping their perceptions and appearance in general. Table 4.10 indicates the responses and percentages for the various variables. When asked what they were doing in regard to their weight more athletes (64%) than non-athletes (53.1%) indicated that they were working on losing weight. This explains the slightly higher percentage of athletes (34.4%) as opposed to none athletes (32.7%) who tried to maintain their current weight. Only 1.6% of the athletes wanted to gain weight as compared to 12.2 % of the non-athletes.

Table 4.10: Body weight regulation information for athletes and non-athletes

Variable	Total group N=110	Athletes N=61	Non-athletes N=49
	Percentage per group		
Doing about weight			
Lose weight	59.1	64.0	53.1
Gain weight	6.3	1.6	12.2
Maintain weight	33.6	34.4	32.7
Doing nothing	0.9	0	2.0
Reason for change in weight			
Sports performance	50.9	90.2	2.0
Appearance	21.8	0	49.0
Health	21.8	8.2	38.8
None	5.5	1.6	10.2
Feel pressure to maintain a lean body shape			
Yes	78.2	80.3	75.5
Source of pressure [2]			
	N=86	**N=49**	**N=37**
Self	67.3	67.2	67.3
Coach	20.9	38	0
Friends	10	49.2	16.3
Training partners	22	38	0
Parents	5.5	8.2	20.4
Media	0.9	0	20.4
None	21.8	18	26.5
Regulate weight to meet the demands/weight requirements of sport			
Yes	82		

[2]Multiple Response allowed

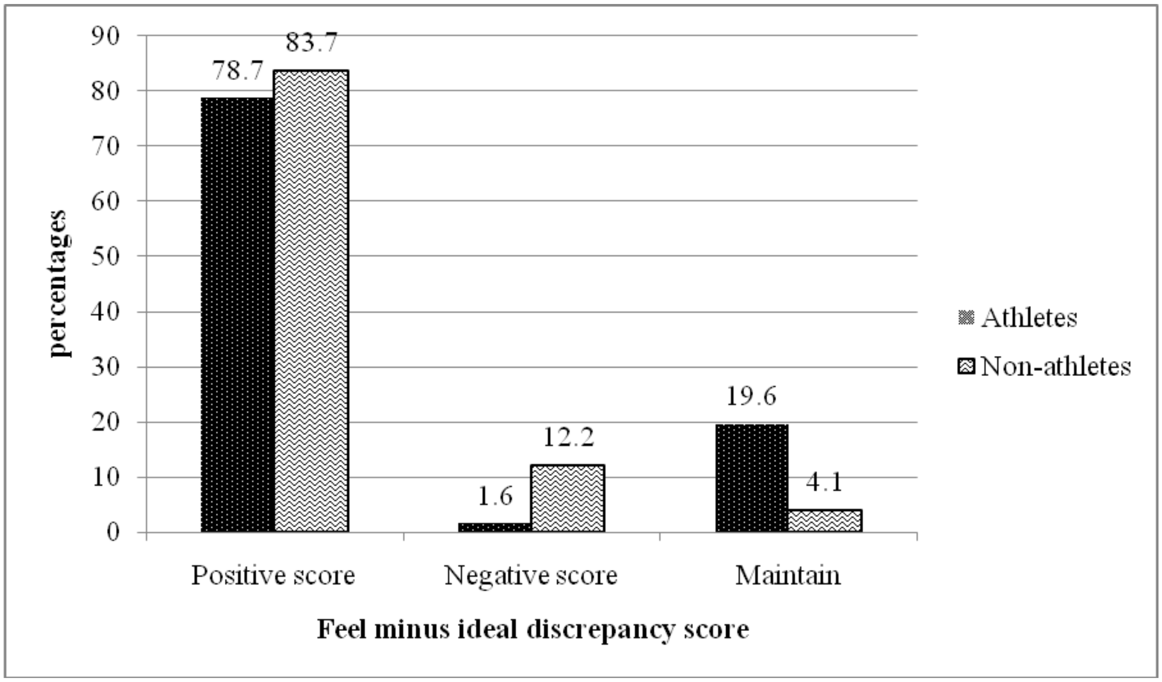
Asked the reasons for weight change, almost all the athletes (90.2%) mentioned sports performance as the main aim while the non-athletes (49%) were more concerned with their appearance. More non-athletes (38.8%) than athletes (8.2%) changed weight for health reasons.

The majority of the athletes (80.3%) and non-athletes (75.5%) had a positive response when asked if they felt pressure to maintain a lean body shape (Table 4.10). Those that felt pressure to achieve a lean body shape were asked to state the source(s) of pressure and an equal proportion of athletes and non-athletes (67.2% vs. 67.3%) stated that the pressure came from within them. Friends also played a significant role on body perception for 49.2% of athletes and 16.3% of the non-athletes. Notably 38% of coaches and training partners had a great influence within the athletic group. Consequently, parents and the media appeared to play a significant role on body weight perception among the non-athletic group than in the athletic group.

Additionally majority (82%) of the athletes regulated their weights to meet the demands or weights requirements for the specific sport activities they were involved in. Asked what they considered the ideal sport weight, the athletes reported a lower desired or “ideal” body weight with a mean of 43±4.7kg which is far lower than the mean of 48±6.1kg that was arrived at after taking their weights. When a dependent t test was done there was a significant difference between the reported ideal body weight and their current weight (p=0.03).

4.2.1.7.2 Feel minus Ideal Discrepancy Scores among Athletes and Non-athletes

Results from the figure rating scale used to evaluate body size satisfaction are as shown in Figure 4.3 below.



Positive score= desire for a smaller body size Negative score=desire for a larger body size Maintain=retain same body size

Figure 4.3: Figure rating discrepancy scores in athletes and non-athletes

Results from the figure rating scale indicated that cumulatively 80.9% of the students had a positive score indicating a desire to be smaller, 6.4% had a negative score indicating a desire to be larger and 12.7% were satisfied with their current figure. However, disintegrated into categories there was a significant difference between athletes and non-athletes (χ^2 =10.0, p=0.006) on the feel minus ideal discrepancy score (calculated as a difference between the actual and ideal sizes chosen), with slightly more non-athletes than athletes (83.7 % vs. 78.7%) desiring a smaller figure than their current figure. Additionally more non-athletes (12%) compared to athletes (1%) desired a slightly bigger figure than the current figure. More athletes (19%) than non-athletes (4%) were however comfortable with their body shape and indicated a desire to maintain their current figure. Both groups perceived themselves to be in the categories of silhouettes numbers 3-5. The most preferred body size silhouette was no.2 for both groups.

4.2.2 Menstrual Function in Athletes and Non-athletes

Athletes and non-athletes gave self-reported menstrual information on age of menarche, frequency and characteristics of menses during the preceding twelve months as indicated in Table 4.11. Age of menarche was 14 (14;15) years, which was similar for athletes and non-athletes (Table 4.11). Similarly menstrual cycles in the last 12 and 3 months preceding the study were same for athletes and non-athletes. Cumulatively most of the students, 91.8% had experienced their first menstrual cycle by the time of the study, while 8.2% of the students had never had a menstrual cycle, besides having attained the age of menarche. No students reported oral contraceptive use, reproductive disorders, and none had previously visited a gynaecologist. Menstrual cycle changes during the competition season were reported by 45% of athletes, changes mostly included skipping of cycles and lighter bleeding. Most athletes did not know the reason for changes in menstrual function.

Table 4.11: Menstrual characteristics in athletes and non-athletes

Variable	Athletes (N=69)	Non-athletes (N=49)
Age of menarche	14 (14; 15)	14 (14; 15)
Menstrual cycles in last 12 months	11 (10; 12)	12 (10; 12)
Menstrual cycles in last 3 months	3 (2; 3)	3 (2; 3)
	Percentage per group	
Ever had a period	86.0	97.9
Menstrual changes with training	44.3	N/A
Menstrual changes during competition	25.0	N/A
Type of change		
Skipping cycle	60.0	N/A
Lighter bleeding	33.4	N/A
Heavier bleeding	6.6	N/A

Menstrual function was analysed and disintegrated into categories (Figure 4.4). More athletes reported clinical menstrual dysfunction (32.7% vs. 18.3%, $\chi^2=7.1$ $p=0.02$), namely primary (13.1% vs. 2.0%) and secondary amenorrhea (19.7% vs. 10.2%) compared to non-athletes. Overall a slightly higher percentage of non-athletes (87.8%) reported normal menstrual cycles (eumenorrhea) than the athletes.

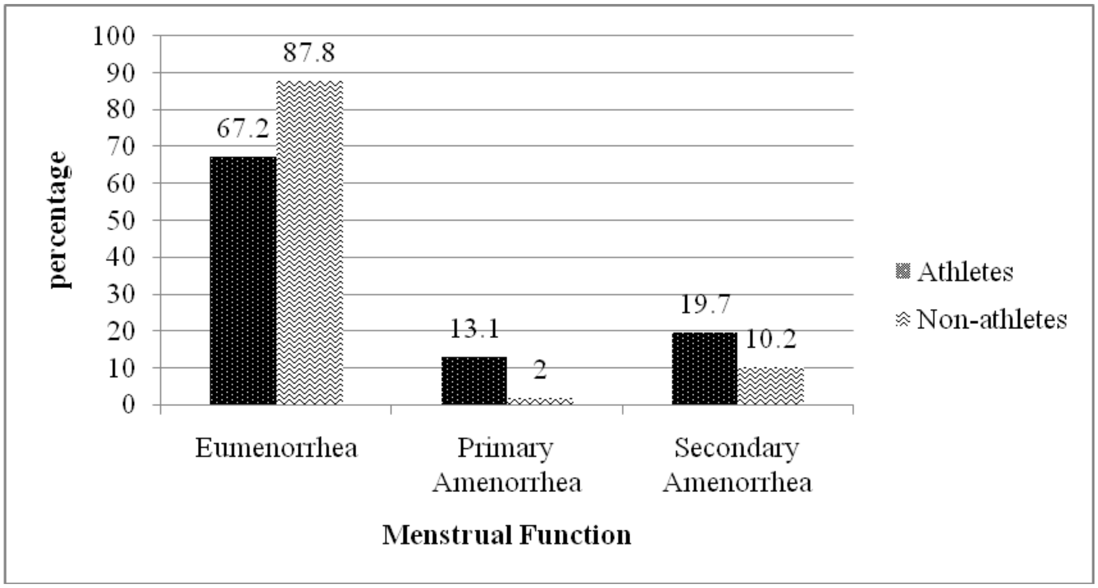


Figure 4.4 Menstrual functions of athletes and non-athletes

4.3 Number of Triad Components in Athletes and Non-athletes

The prevalence of subclinical and clinical components of the Triad was sought (Table 4.12). A similar prevalence between athletes and non-athletes was found for subclinical energy availability and disordered eating. More athletes had clinically low energy availability and menstrual dysfunction (8.9% vs. 0%, χ^2=4.2, p=0.04) than non-athletes.

Table 4.12: Prevalence of any one or any two Triad components among athletes and non-athletes

Triad components	Athletes		Non-athletes	
	Total N	% (n)	Total N	% (n)
Subclinical components				
EA <45 kcal·kg FFM^{-1}·d^{-1} with or without subclinical DE behaviour	56	69.6 (39)	45	71.2 (32)
Subclinical DE behaviour only	61	7.1 (4)	49	11.1 (5)
Clinical components				
EA < 30 kcal·kg FFM^{-1}·d^{-1} with or without clinical DE	56	17.9 (10)	45	2.2 (1)
Clinical DE only	56	3.6 (3)	49	11.1 (5)
EA < 30 kcal·kg FFM^{-1}·d^{-1} and MD	56	8.9 (5)	45	0 (0)*
Clinical DE and MD	61	3.3 (2)	49	2.0 (1)

EA= Energy Availability, DE= Disordered Eating, MD= Menstrual Dysfunction.
*Significant difference between athletes and non-athletes, Fisher's exact test [OR=0.6, 95% CI (0.5-6.9) p= 0.5]

4.4 Relationships Between various Variables

Binomial regression analysis was used to test relationships between various variables (Table 4.13). Using menstrual function as the dependent variable, the odds ratio indicated no linear relationship between menstrual function and the variables indicated.

Table 4.13: Binomial regression analysis indicating risk factors for menstrual dysfunction

Independent variables	Odds Ratio (95% CI)	p- value
Energy availability	2.7 (0.5-13.0)	0.2
BMI		
Normal	0.3 (0.07-1.25)	0.1
Underweight	0.5 (0.05-4.91)	0.5
Drive for thinness	0 (0)	1.0
Body dissatisfaction	0.9 (0.17-5.05)	0.9
Bulimia	0.7 (0.2-1.7)	0.4
TFEQ (CDR)	1.4 (0.5-3.5)	0.4

BMI= Body Mass Index, TFEQ= Three Factor Eating Questionnaire, CDR=Cognitive Dietary Restraint

When energy availability was used as the dependent variable, the odds ratio result indicated a weak but not significant relationship between low energy availability and body dissatisfaction [0.1 (0.03-0.8), p=0.02] (Table 4.14).

Table 4.14: Binomial regression analysis indicating risk factors for low energy availability

Independent variables	Odds Ratio (95% CI)	p- value
Body mass index		
Normal	0 (0)	1.0
Underweight	1.8 (0.2-15.5)	0..5
Menstrual function	2.7 (0.5-13.0)	0.2
Bone mineral density	0 (0)	1.0
Body dissatisfaction	0.1 (0.03-0.8)	0.02
Drive for thinness	0 (0)	1.0
TFEQ (CDR)	1.8 (0.5-5.9)	0.3

BMI= body mass index, TFEQ= three factor eating questionnaire, CDR=cognitive dietary restraint

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1 Demographic Characteristics of the Study Population

Background characteristics of students were different regarding the following aspects; number of siblings, household's head, marital status of the household head and parents' education level. It is a well-known fact that excelling in distance running at international level is seen as a way to economic success and to break the cycle of poverty for many Kenyan athletes (Saltin *et al*., 1995). Education is frequently used as a proxy indicator for socio-economic status (Maksimović *et al*., 2008). Interestingly in this study athletes' parents were less educated, more mothers were not formally employed, and they came from larger families than non-athletes. Results therefore seem to support this notion that economic success may be a motivator for athletes to compete in distance running in Kenyan, even from a young age.

Almost all selected students were of the Kalenjin ethnic community. This can be explained by the fact that Iten lies in the North Rift Valley which is predominantly Kalenjin and famed as the home of champions in athletics. The majority of the sampled schools were boarding schools a factor explaining the high number of the students drawn from boarding schools in this study. Students were drawn from forms 2, 3 and 4, since the study was carried out during the beginning of first term when form 1 students had not yet reported. Results indicated that the students begin sport activities at a young age, and if energy intake is not well regulated then, this may delay menarche and consequently lead to low BMD in later years.

5.2. Body Composition and Anthropometric Measurements in Athletic and Non-athletic High School Population

Body composition makes an important contribution to an individual's level of physical fitness (Shangold & Mirkin, 1994; Jung, 2012). Athletes were taller, had a lower body weight, BMI and FFM compared to non-athletes. Bush (2009) reports similar body composition characteristics in athletes compared to non-athletes in female high school athletes in California. Houtkooper (2000) reasons that body weight can influence an athlete's speed, endurance, and power, whereas body composition can affect an athlete's strength and agility. Additionally, a lean body is often advantageous in sports where speed is involved. In this study, athletes met all these requirements and could account for their exemplary performance in athletics. In a review of Kenyan dominance of distance running, Larsen (2003) argues that lower BMI and body mass are responsible for the superior running economy reported by Kenyan athletes.

The BMI is a measure of relative size based on the mass and height of an individual and compared against fixed thresholds for underweight and overweight. BMI is used differently for children and adolescents but calculated in the same way as for adults. It is then compared to typical values for other children and adolescents of the same age and compared against the percentile for children of the same gender and age. Both methodologies were used in this study and the BMI percentile seemed to be a better indicator in this group. As expected more non-athletes were overweight and obese compared to the athletes. Using the standard BMI scores a few of the athletes were underweight.

The athletes reported regulating their weight to meet the demands of sport. Scholars have observed that leaner subjects have been found to perform better than overweight subjects in physical performance activities which require specifically body movement through space such as running and jumping (Kiflu, Reddy & Babu, 2012).

5.3 Components of the Female Athlete Triad

5.3.1 Energy Availability and Related Components

5.3.1.1 Energy Availability

Research has shown that one of the primary causes of Triad-related health problems is a chronic energy deficiency (De-Souza & Williams, 2004; Loucks & Thuma, 2003; Williams *et al.,* 2001). This study also examined energy intake and expenditure in the two groups. Results of this study indicated a difference in energy availability ($p=0.003$) between the athletes and non-athletes. However it is worth noting that the means for both groups showed reduced energy availability. This is indicative that both groups were operating at sub-optimal energy balance that places them at a greater risk for energy deficiency. Energy deficiency can contribute to various health and performance consequences such as loss of muscle mass and increased risk of injury, fatigue and illness and subsequently menstrual disturbances (ACSM, 2007).

Female athletes require at least 2300 - 2500 kcal/day or an energy availability of ≥45 kcal/kg FFM/day to maintain body weight (Manore, 1999; Manore, Barr, & Butterfield, 2000). Insufficient energy intake in adult female athletes is however often found, especially in those competing in endurance sports (Tomten & Hostmark, 2006; Thong, McLean & Graham, 2006; Kopp-Woodroffe). Data on the energy intakes of adolescent female high school athletes in Kenya is limited. A recent study by Goodwin et al, (2014) reported low energy intakes in 61% of 25 elite Kenyan female athletes and 14 non-athletes. Additionally two earlier studies conducted in elite male Kenyan runners reported energy intakes below the recommended intake and showed them to have a negative energy balance (Onywera *et al*., 2004; Mukeshi & Thairu, 1993).

Consistent with these studies in elite female and male athletes, the current study established that most adolescent female students had subclinical low energy availability (≥30-<45 kcal/kg FFM/day). Around 18% of adolescent female athletes had clinical low energy availability (<30 kcal/kg FFM/day) an indication of a negative energy balance and energy deficiency (Manore *et al*., 2007; Mountjoy *et al.*, 2014). Energy intake in kilocalories was similar to studies of 14-19 year old athletes that found energy intakes between 2013-2248 kcal/day for females (Beals, 2002; Burke *et al.,* 2014; Gibson *et al*., 2011; Papadopoulou *et al*., 2002). Additionally, the mean daily energy intake of athletes and non-athletes was below the recommended 2300 kcal/day to maintain body weight (Manore *et al*., 2000). Low energy intake for female athletes is a major nutritional concern because a persistent state of negative energy balance can lead to weight loss and disruption of endocrine function (Gabel, 2006).

As expected, total daily energy expenditure and exercise energy expenditure was higher in athletes than non-athletes. The combination of a low energy intake and high energy expenditure therefore seemed to contribute to the sub-clinical and clinical low energy availability among athletes. It is worth noting that although there was a difference in energy availability (p=0.003) between the athletes and non-athletes, the mean EA for both groups were below the recommended 45 kcal/kg FFM/day. This indicates that both groups were operating at sub-optimal energy levels that place them at risk for energy deficiency. Previous research has shown that energy deficiency can contribute to health and performance consequences such as loss of muscle mass and increased risk of injury, fatigue and illness and subsequently menstrual disturbances (Mountjoy *et al*., 2014). It is therefore recommended that Kenyan adolescent athletes, coaches and school administrators should be educated on the energy needs of these young athletes and non-athletes to promote overall health and/or sports performance.

In many ethnic groups in Kenya, the staple foods are carbohydrates high in soluble fibres with ugali (stiff cooked maize flour) and githeri (mixture of boiled maize and beans) being the mostly consumed even in schools. Results of this study report a high carbohydrate diet (70.5%) similar to what was reported (76.5% total daily energy intake) in elite male Kenyan runners (Onywera *et al*., 2004). These high carbohydrate diets may increase fullness and satiety thus reducing total daily energy intake. Stubbs *et al*. (2004) found a high carbohydrate diet (62%) reduced *ad libitum* energy intake in untrained men with and without exercise. Additionally, the suppressive effect on energy intake of prolonged exercise and a high percentage carbohydrate diet were additive. It may therefore be that the sub-optimal energy status of adolescent athletes in the current study is a combination of their high carbohydrate diet and intensive training sessions. Other possible contributing factors include inadequate school meals that do not meet the athletes' increased energy requirements, ignorance from athletes and parents on their energy needs, insufficient resources to meet energy needs, and/or deliberate under-eating by students to attain a lean physique (Hulley & Hull, 2001).

5.3.1.2 Prevalence of disordered eating in Athletes and Non-athletes

In many exercising women, chronic energy deficiency and the associated metabolic adaptations are thought to be a result of disordered eating (Cobb *et al*., 2003). Approximately 53% of athletes in this study were identified with subclinical low energy availability and disordered eating (n=30/56) and 16.1% with clinical low energy availability and clinical disordered eating (n=9/56). This finding indicates that disordered eating is a contributory factor to low energy availability. Pernick *et al* (2006) found a high prevalence (18.6%) of disordered eating among high school athletes in Southern California. Similar to what others found in Caucasians, there were also a high percentage of non-athletes that presented with subclinical disordered eating (Smolak, Murnen, & Ruble 2000; Sundgot-Borgen & Torstveit, 2004). Likewise results of this study are in agreement with studies that have reported an increasing number of eating disorders and disordered eating among collegiate and high school students in Africa (Bennet *et al*., 2004; Fawzi *et al*., 2010).

Binge eating and cognitive dietary restraint was the most common forms of disordered eating in both athletes and non-athletes in the current study. The average body dissatisfaction and drive for thinness scores of the students were also comparable to what was found by Havemann, De Lange, Pieterse & Wright, 2011; and Hausenblas & Mcnelly, 2010. A high percentage of students in this study presented with subclinical disordered eating but only a few presented with clinical disordered eating. Very few students scored above the cut off points for clinical and subclinical body dissatisfaction. This may be associated with cultural norms of the ideal female body image that is traditionally larger in African women (Puoane *et al*., 2005). Another possible explanation might be that students were already lean as evidenced by their low average body mass index and therefore were happy with their current body image (Hausenblas & Downs, 2001). Among athletes there may also be a greater emphasis on performance than appearance which might explain low levels of body dissatisfaction and drive for thinness (Smolak *et al*., 2000). Nevertheless, approximately 5% athletes and 10% non-athletes were identified with clinical disordered eating in the present study.

The changing perceptions about body weight among blacks may be due to western media influences, which portray thin images as attractive as opposed to the traditional ‘big is beautiful’ (Puone *et al*., 2005). It may also be influenced through the exposure of young female athletes to the lean body images of international female distance athletes portrayed in the media. Almost a third of athletes and non-athletes scored above the EDI-3 bulimia subscale indicating binge eating behaviour. Possible reasons for binge eating are not clear. Hulley *et al*., (2007) reported a similar prevalence of binge eating in young adult non-athlete Kenyans (43.3%) but a lower prevalence in athletes (11.1%) and found that Kenyan women identified with Eating Disorder Not Otherwise Specified (EDNOS) reported binge eating as a key behaviour.

Pernick *et al*., (2006) on the other hand found a lower prevalence of binge eating in African American and Caucasian adolescent athletes compared to Latinos compared to results of this study. Whether age, cultural and/or ethnic differences played a role in the differences observed compared to the reports of others, is not clear. Research is therefore needed to explore motivators and risk factors for disordered eating and eating disorders in adolescent Kenyan girls. In summary, the large percentage of students identified with subclinical disordered eating and scoring high on the EDI-3 bulimia subscale raise concerns for clinical disordered eating and eating disorders.

5.3.1.3 Eating Habits among High School Athletes and Non-athletes

Results indicated that significantly more athletes than non-athletes were vegetarians and restricted the amount or type of food to control their weight. The restriction could be explained by the students desire to maintain a particular weight and physique as influenced by sport. Preoccupation with weight, body image, and food intake may lead to dieting and food restriction in an attempt to maintain a low body weight. Food restrictions can be unhealthy and expose the athletes to serious health problems, performance and even injuries due to macro and micro nutrient deficiencies. Studies have also associated food restrictions with menstrual dysfunction and potentially irreversible bone loss (Burrows & Bird, 2000; Williams *et al*., 2001). Results of this study support that of Reed *et al* (2012) that also found food group restrictions among female athletes. In our study many female athletes' restricted dairy and fat intake.

5.3.1.4 Macro and Micronutrient Intakes in Athletes and Non- athletes

Of particular concern were the low energy intakes in athletes and non-athletes which would be a direct result of deliberate under-eating or inadequate intakes as earlier explained. The inadequate energy intakes in adolescent students are worrying as this is a period of growth spurt and inadequate intakes may affect their growth as well as predispose the athletes to the components of the triad.

Low energy intake increases the risk that carbohydrate intakes will be below the recommended intake level. Additionally if energy intake is low, carbohydrate intake will be inadequate to replenish glycogen stores used during periods of high exercise training (Manore, 2002). However results of this study indicated that the carbohydrate intake for a majority of the students were within the recommended 6 -10 g carbohydrate per kilogram of body weight to maintain glycogen stores and support moderate to high-intensity training (Burke *et al*., 2011). The almost adequate carbohydrate intake and low total energy intakes could be explained by the fact that, fat intake was low hence contributing minimally to the total kilocalories. Whereas it is recommended that fat contributes 20-30% of the total kilocalories, in this study fat contributed only 18-23% of the total kilocalories.

The majority of the athletes, similar to results from previous food surveys in youth female soccer players (Gibson *et al*., 2011) had adequate protein intakes. Onywera *et al*, (2004) reported adequate protein intakes in elite Kenyan male athletes, which agree with the current study. Thus, the adequate protein intakes reported could be associated with the frequent intakes of non-animal high quality proteins taken in form of beans and whole grains, and the use of full cream milk in tea similar to what Onywera et al., (2004) report. A third of the athletes in this study did not however meet the recommended intakes for female athletes. These athletes could have been the vegetarians and those restricting intake of meat and dairy products. Inadequate energy intakes as is the case with the study students may cause protein to be used as a substrate for energy rather than for synthesising lean tissues (Parimalavalli & Sangeetha, 2011). Overall it is apparent that non-athletes consumed adequate protein to meet recommended intakes for sedentary women, namely 0.8 g protein/kg body weight (Phillips, 2004; Tarnopolsky, 2004). Research recommends that female athletes have higher protein intakes (1.2-1.4g protein/kg of body weight) (Lemon, 1995).

The mean fat free mass (kg) in the athletes was 41.0 ± 4.1kg which is much lower than the median reference value of 49.44 ± 0.1 kg recommended for female athletes by Santos *et al*., (2014). The reference values by Santos *et al*., (2014) are the first to present reference values for body composition in athletic populations within sports. These values are controlled for gender and type of sport but do not take age into consideration. The low levels of FFM are possibly linked to overall low energy and protein intakes.

There is no adequate intake (AI) or recommended daily allowance set for total fat; however the acceptable macronutrient distribution range recommended is that 20% to

30% of total calories come from fat. Results of this study indicate a lower intake than the recommended total percentage. Athletes may reduce dietary fat intake to create an energy deficit for the purpose of weight control. Results of this study are in agreement with this notion as 25% of athlete's restricted fat intake in their diets seemingly for purposes of weight control. Other studies have reported low fat intake among elite male Kenyan athletes (Christensen *et al*., 2002 & Onywera *et al*., 2004). Christensen *et al.,* (2002) posits that most African diets are low in fat and this would explain the low intakes among the athletes and non-athletes. Additionally fat is expensive and in the school meals it is used sparingly with the aim of cutting costs hence may be a contributing factor for the low intakes. Nonetheless, dietary fat provides energy for growth needs of children and adolescents and contributes essential fatty acids to their diet. In addition, the young athlete might be able to afford a slightly higher fat intake than the sedentary counterpart, because of the increased energy expenditure during training (Butte, 2000).

Restricting energy intakes or eliminating food groups from the diet has an effect on micronutrient intakes (Woolf & Manore, 2006). Apart from folate micronutrient intakes were below the recommended amount for the majority of the students. According to Onywera *et al.,* (2004) Kenyans tend to eat a limited variety of foods, and that was certainly the case with the students. Additionally the dietary diversity score was low indicative of limited variety of food groups and consequently low micronutrient intakes. The lack of significant differences in mean micronutrient intakes between the groups can be explained in part by the fact that the meals taken were similar in amounts and nutrients.

For female athletes, calcium intake is of particular concern. Excessive training exceeding seven hours per week may cause hormonal declines in young girls that can stop menstruation (Clarkson & Haymes, 1995). Like in other previous studies that indicated adequate intakes in adolescent athletes (Berning *et al.*, 1991; Mc Culloh *et al.*, 1992), calcium intakes were within the recommended ranges for over three quarters of the students. Inadequate intakes were reported in 24% of the students. Greer and Krebs, (2006) reported inadequate calcium intakes in adolescent girls. Inadequate calcium intakes in female athletes is of concern not only because peak adult bone mass may not be accrued but also because low bone density increases the risk of stress fractures.

Of concern however is the small percentage of athletes that were restricting dairy products which are a good source of calcium. There is thus need to educate the athletes on the sources of calcium for healthy bone development. Zhu and Prince, (2012) in a review of literature on calcium and bone development during childhood conclude that adequate calcium intake in adolescents is crucial for peak bone mass. Likewise Sasson and Carpenter, (2013) indicate that calcium requirements are greater during adolescence due to growth and intensive bone and muscular development, hence achievement of peak bone mass in women is critically dependent on adolescent calcium intake. However a variety of genetic, gender, ethnic and environmental factors have also been shown to influence peak bone mass accrual (Eric *et al.,* 2001; McGuigan *et al.,* 2002)

Puberty increases the requirement for iron due to increases in haemoglobin mass, tissue deposition, growth spurt, and onset of menstruation in females (FNB, 2001). Iron depletion and deficiency have been observed in endurance athletes (Malczewska *et al*., 2000) with dietary surveys of athletes often reporting iron intakes to be inadequate (Gropper *et al*., 2003). Similar to this study and other two studies that found inadequate iron intakes among school children in Kenya, (Shell-Duncan and Mc Dade, 2005; Leenstra *et al*., 2004), iron intakes were below the recommended in 58.2% of the students in this study. Mean iron intakes below the RDA have also been found in other adolescent and young adult athletes (Moen *et al*., 1991; Short & Short, 1993).

Low iron intake, particularly during the adolescent years of females when the menstrual cycle has started, may be a cause of poor athletic performance (Petrie, 2004). Chronic inadequate intake can lead to low stores of iron that impair muscle metabolism (Beard, 2001). Athletes use iron stores more quickly than non-athletes and, considering the neurologic effects of anaemia on children and teens who engage in rigorous sports, adequate intake of iron is quite important (Gropper *et al*., 2003). The low iron intake in this study could be in part due to low dietary intake (meat consumed only twice a week), restricted caloric intakes to maintain a low body weight and possibly consumption of legumes and cereals that are low in iron. Unpublished results on iron intakes in elite athletes in Nairobi (Kibata, 2011) also reported low iron intakes due to low dietary intake. Fogelholm *et al*., (1992) doing a research review on iron in athletes and non-athletes, concluded that the prevalence of low ferritin levels was significantly greater among female athletes than non-athletes.

Exercise can cause a loss in magnesium hence there is need to increase intakes. Magnesium intakes are largely dependent on the total energy intakes (Manore, 2002) and if energy intake is restricted, magnesium intakes can be low. Results of this study support findings that non-athletes reporting a higher energy intake will subsequently report a higher magnesium intake than the athletes. Like other cross-sectional studies based on self reported dietary records (Bazzare *et al*., 1993; Deuster *et al*., 1996; Fogelholm *et al*., 1992; Stein *et al*., 1995) results of this study indicated sufficient magnesium intakes within the dietary recommended allowance for over half of the student population. Athletes who fell below the required amounts, were those either attempting to maintain a low body weight or with caloric restriction.

Surveys have shown that most athletes consume adequate amounts of riboflavin (Short, 1994). Riboflavin is mainly found in dairy products. Results of this study also indicated intakes above the recommended intakes in both groups for riboflavin. These high intakes could be probably due to the high intakes of whole grains and cereals that are rich in riboflavin and made up the day to day meals of the students.

During exercise pyridoxine is needed for gluconeogenesis and glycogenolysis in which it serves as a co-factor to glycogen phosphorylase. Approximately 1.5 to 2.3 mg/day of pyridoxine is required to maintain good pyridoxine status (FNB, 2004). Few studies have examined the B_6 status in physically active people. Three surveys reported that 40-60% of athletes have reduced B_6 based on the enzyme stimulation test (Guilland *et al*., 1999; Manore, 2002; Manore, 1994). Similarly this study reported intakes lower than the RDA in 70% of the students. Inadequate intakes could be possibly explained by the low intake of meat (especially organ meats). No students reported consumption of nuts, fish and pork which are good sources of B6.

Folate serves as a co-enzyme in the metabolism of nucleic and amino acids. A deficiency will cause abnormal cell replication and result in megaloblastic anaemia. Surveys of female athletes before 1989 indicated that a significant percentage of female athletes did not consume adequate amounts of folate (Lukaski, 2004). Likewise the majority of athletes and non-athletes in this study consumed less than the dietary recommended intakes. Ugali the main dish is made from whole milled maize grain. Fortified flours are available but these are too expensive and the schools opt to mill their own grain. There is however limited data on the folate intake of athletes for comparison.

Zinc plays an important role in many metabolic pathways since it is essential for the functioning of many enzymes. Although currently, limited data is available on the zinc intakes of athletes, results of this study indicated intakes within the recommended ranges. Other studies (Haralambie, 1981; Lukaski, 2004; Lukaski, 1997) have found plasma zinc concentrations within the normal range.

5.3.1.5 Dietary Diversity among Athletes and Non-athletes in Secondary schools

Studies have shown that an increase in dietary diversity is associated with increased energy availability (Hoddinot & Yohannes, 2002; Hatloy *et al*., 2000). Diets in developing countries and especially in Africa have been described as monotonous, cereal-based and comprised of foods low in energy with few animal products, fruits, and vegetables (Leyna *et al*., 2010; Kennedy *et al*., 2007). The nutrients essential for meeting nutritional requirements are not all usually found in a single food item but are present in a diet composed of a number of foods (Boy *et al.*, 2009).

Since there are no agreed cut-off points in terms of number of food groups to indicate adequate or inadequate individual dietary diversity, a cut-off point of 6 food groups was used based on previous studies in adolescents (Mirmiran *et al*., 2004; Vakili *et al*., 2013) to indicate adequacy. The mean number of food groups taken was 4, indicating low diet diversity. A recent study on the dietary diversity in semi arid agro-ecological zones in Eastern Kenya (Bukania *et al*., 2014) found a similar mean of four food groups out of a possible nine food groups. In this population therefore, where energy and micronutrient requirements were largely un-met, low dietary diversification may have been the contributing factor. No significant differences were noted between the athletes and non-athletes in the total food groups taken within the two week period the dietary logs were kept.

However as expected, we found statistically significant differences in the number of food groups taken by the type of school. Those attending day schools recorded a higher number of food groups consumed. This was expected since the boarding school meals are regulated, follow a particular pattern from week to week and have limited variety. Additionally most of the boarding schools did not have canteens where the students could get extra food and those that had, bread was the only commodity sold. On the other hand the day schooling student has access to a wider variety of foods and snacks outside the school since meals at home and not be as regulated as in boarding schools.

5.2.1.6 Perception of Body Weight in young Athletes and Non-athletes

Slightly over half of all the students in this study wanted to lose weight. This could probably explain the high scores in the cognitive dietary restraint subscale and it is likely that the students were restricting food intake in order to lose weight. Similarly a nationally representative sample of American high school students revealed that 59.3% of girls and 30.5% of boys were trying to lose weight (Centre for Disease Control and Prevention [CDC], 2010). Further according to a nationwide 2007 CDC Youth Risk Surveillance, among the 14,041 students sampled approximately 60% of female high school students reported a desire to lose weight (Eaton, Kann & Kinchen, 2008). It is also important to observe that most young women in Kenya today believe that the ideal body is slender and fat free (Shah, 2006). The increasing portrayal of the Western beauty ideal in the media may play a role desiring weight loss.

It is assumed that the majority of the athletes frequently regulated their weight to meet the demands of a sport. Reduction in body mass or body fat has been shown to enhance performance in sports that emphasize leanness such as distance running (Currie, 2010).

Davis and Cowles (1989) examined weight, diet concerns, and personality factors in two groups of female athletes: those in sports requiring a thin build (gymnastics, synchronized swimming, ballet, figure skating, and running) and those in sports with no such requirements (field hockey, basketball, volleyball, and downhill skiing). The results indicated that the athletes in the thin-build sports were significantly thinner, demonstrated an increased drive for thinness, and expressed a greater desire to lose weight compared to the athletes in the normal-build sports.

Endurance running is also considered a sport where a thin physique is seen as an advantage as less weight needs to be carried (Houtkooper, 2000). For the athlete an ideal body image was slender and fat free as indicated by the choice of the silhouettes in the figure rating scale. This ideal image was synonymous with excelling in sport. More non-athletes however were concerned with appearance and health benefits of weight loss. Studies indicate that social networks play a decisive role in the attitude formation of youth towards body image and weight control (Mikulan & Piko, 2012).

Athletes and non-athletes had distinct influencers in regard to source of pressure to maintain a lean physique. Many athletes were influenced by coaches and training partners. A study by Biesecker and Martz (1999) found a body weight pre-occupied coaching style to increase body image anxiety and fear of fatness. Friends also played a role in influencing weight loss for both groups. Socially, peers mostly become an adolescent’s most important point of reference and source of influence, and they begin to compare themselves with others who are of the same age (Carney & Scott, 2012).

Results from the figure rating scale indicated a common desire for a smaller body size among athletes and non-athletes. This result is in agreement with numerous studies that have shown that adolescent females are dissatisfied with their shape and weight, and prefer a thinner body figure (Demarest & Allen, 2000; Gardner, Friedman & Jackson, 2000). Results of this study show an increasing desire for a smaller body size similarly to a study done in black, mixed race and white school girls in South Africa that indicated that although body image problems were less severe in black girls; they were not uncommon (Caradas, Lambert & Charlton, 2001). More athletes were satisfied with their body size and this could be because the athletes already had a lean body physique due to increased physical activity.

5.2.2 Menstrual Function in Adolescent Athletes and Non-athletes

Menstrual function is the most recognizable of all the triad components (ACSM, 2007). The prevalence of amenorrhea in athletes differs between various sports, the rates are often quite high, affecting from 12 to 79% of athletes (Warren & Perlroth, 2001). Similar to other studies, athletes reported more menstrual dysfunction than non-athletes (Torsveit & Sundgot-Borgen, 2005; O'Donnel & De Souza, 2004). More athletes than non-athletes (32.7% vs. 12.2 %) reported menstrual dysfunction, with 13.1% and 19.7% reporting primary amenorrhea and secondary amenorrhea respectively. None of the athletes reported oligomenorrhea and both groups had the same age of menarche which is in contrast to what has been found among Caucasians athletic vs. non-athletic girls (Malina, 1994). Nichols, Rauh and Lawson, (2006) reported 23.5% menstrual dysfunction in a group of high school athletes. However, the most prevalent form of menstrual dysfunction was oligomenorrhea (17.1%) which was not the case in this study. They also reported secondary amenorrhea and primary amenorrhea in 5.3% and 1.2% of the athletes respectively.

Contrary to what Nichols *et al*., (2006) report, the difference in prevalence in both studies could be attributed to the definitions used for menstrual irregularity. While they defined primary amenorrhea as the absence of menses by age 16 and oligomenorrhea as menstrual intervals of longer than 35 days; this study used a lower cut off age of 15 years for primary amenorrhea and oligomenorrhea defined as menstrual intervals of longer than 45 days which is based on the criteria of American College of Obstetricians and Gynaecologist (ACOG) Committee, (2006). Both studies however used the same definition for secondary amenorrhea. Low energy availability might be a possible reason for the reported menstrual dysfunction in the students as a mismatch between energy intake and energy expenditure is associated with functional hypothalamic amenorrhea (Loucks, 2007). It is however acknowledged that self-reported menstrual function is a limitation to this study and sub-clinical menstrual abnormalities, such as anovulatory cycles and luteal phase deficiency, may also be present among students but could not be measured due financial constraints. In their study De Souza *et al*., (2010) reported a high prevalence (52%) of subtle menstrual disturbances in presumed normal cycles in physically active women through the assessment of ovarian steroids in daily urine samples.

Although a similar prevalence between athletes and non-athletes was found for subclinical energy availability and disordered eating, more athletes had clinically low energy availability and menstrual dysfunction than non-athletes. This finding confirms results from other studies that have reported low energy intakes and negative energy balance in athletes (Nattiv *et al*., 2007; Ziegler *et al*., 2001; Fudge *et al*., 2006; Lun *et al*., 2009) as well as menstrual irregularities in athletes (Warren and Perlroth, 2001; Torsveit & Sundgot-Borgen, 2005; O'Donnel & De Souza 2004). Although a weak relationship was reported, results confirm that body dissatisfaction would be a risk factor for low energy availability as demonstrated by the odds ratio result.

5.2.3 Bone Mineral Density in Athletes and Non-athletes

Physical activity and exercise is mostly positively associated with BMD in athletes. If energy intake is insufficient and energy expenditure is increased due to exercise a reduction in BMD may result (Barrack *et al*., 2010; De Souza *et al*., 2008; Nattiv *et al*., 2007). Furthermore, amenorrhea has been linked to BMD loss due to low levels of ovarian hormones reducing bone apposition and increased rates of bone loss (Rencken, Chestnut and Drinkwater 1996). There is also evidence that a combination of disordered eating practices and menstrual dysfunction can exacerbate bone loss (Beals & Manore, 1998). Disordered eating may result in low energy availability and consequently menstrual dysfunction which impairs bone health by indirectly or directly suppress hormones that promote bone formation (Nattiv *et al*., 2007). Peak bone mass is largely established by the end of adolescence and if hypoestrogenism should occur at this point of the lifecycle irreversible bone loss can occur (Goodman and Warren, 2005). Results of this study could not diagnose low BMD in this study as ultrasound was used to measure heel BMD and the reference group against which results were compared was postmenopausal Caucasian women. The BMD measurements do however, give us an indication of the BMD of this group of adolescents and show how the BMD differed between athletes and non-athletes.

As expected athletes had approximately 6% higher BMD compared to non-athletes as has been demonstrated by various studies (Torstveit & Sudgot-Borgen, 2005; Nichols, Bonnick & Sanborn, 2000; Nichols *et al*., 2007). Hanekom and Klyuts, (2003) also reported higher calcaneus BMD in white adolescent endurance runners (0.6126 g/cm^3) compared to age matched inactive controls (0.5329 g/cm^3). Similarly Wright *et a.l*, (2012) reported higher BMD values in white and black athletes compared to non-athletes using DEXA. High BMD in athletes might be due to the protective role of exercise, as regular physical activity has been directly associated with bone health due to the positive effect of mechanical loading on bone (Nichols, Bonnick & Sanborn, 2000).

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

The continuing research on the Triad components and recent calls by researchers and the IOC on investigating the Triad components among minority groups and non-Caucasian populations at large formed the basis of this study. Volunteer middle and long-distance athletes and non-athletes were recruited from four boarding schools and two secondary schools in Iten, Rift valley Province, Kenya. The study was carried out for five months between January and June 2013. The study was approved by the Kenyatta University's Ethical Research Committee, the National Council of Science Technology and Innovation and the District Education Officer. Students and head teachers of schools (the legal guardians of the students) gave written informed consent. Inclusion criteria were athletes that had competed at regional or higher level in the previous year (2012) or were scheduled to compete in 2013. The comparative group were non-athlete students not involved in any organized sport and are referred to as non-athletes.

Students completed a series of questionnaires under supervision of the researcher. Self-reported menstrual function gathered information on age of menarche, frequency and characteristics of menses during the preceding twelve months. Disordered eating was assessed using the Eating Disorder Inventory-3; drive for thinness, bulimia and body dissatisfaction subscales as well as the cognitive dietary restraint subscale of the Three-

Factor Eating Questionnaire. Diet records were kept for a period of five days from which energy intake was extracted in kilocalories. Training and exercise logs were kept alongside diet records. The logs together with diet records allowed for calculation of energy availability in the students.

The primary findings of this study indicated that adolescent Kenyan runners and non-athletes presented clinical and subclinical components of the Triad. Majority of the students presented with subclinical low energy availability which could be attributed to sub-optimal energy intakes. The sub-optimal energy intake of athletes in the current study may be due to a combined effect of high carbohydrate diet and training sessions. A high percentage of students in this study presented with subclinical disordered eating and no significant differences were noted between the groups. The large percentage of students identified with subclinical disordered eating and scoring high on the EDI-3 bulimia subscale raises concerns for clinical disordered eating in high school population. Clinical menstrual dysfunction was high in athletes than non-athletes. Despite low energy intakes and menstrual dysfunction, BMD was higher in athletes than non-athletes probably as a result of the force load sustained in the heel during running. However it is possible that the effect of an energy deficiency and/or menstrual dysfunction on BMD had most likely not yet transpired in these adolescent students.

6.2 Conclusions

Based on the study hypothesis, the following was concluded:

Energy intake and availability is below the recommended daily intakes in both athletes and non athletes. Athletes however reported significantly low energy availability than non-athletes. Based on this result, the first null hypothesis that indicated that there were no significant differences in energy availability between athletes and non-athletes is rejected. Additionally disordered eating presented in both athletic and non-athletic secondary school students thus the second null hypothesis is accepted since no significant differences were noted in the two groups.

When adolescent long distance athletes were compared to age-matched non-athletes, a significantly higher incidence of menstrual abnormalities was noted by presence of primary and secondary amenorrhea in the athletic group hence the third null hypothesis that stated that no significant differences existed is rejected. There were no major significant differences noted in nutrient intakes between athletes and non athletes probably due to intake of common meals; however the athletes eating habits were significantly different from the non-athletes. Calcaneus BMD was noted to be higher in athletes than non-athletes probably due to the protective effect of exercise on bone. To conclude adolescent students present with one or more subclinical and/or clinical components of the Triad.

This is the first among limited studies to investigate subclinical and clinical components of the Triad among elite Kenyan adolescent athletes. The findings of this study give insight into the energy status and the presence of subclinical and clinical components of the Triad among African adolescent athletes. The results also contribute to the limited body of knowledge on the components of the Triad among athletes from minority groups.

6.3 Recommendations

6.3.1 Recommendations for Practice and Policy

The research findings provide important information for policy-makers and other stakeholders in the athletic field.

1. Given the health and performance consequences of the Triad, the energy availability in the student athletes could be increased by giving more energy to meet the energy expended. The education sector may need to implement a policy to provide upcoming athletes with special meals/diets in schools to cater for their increased energy demands. Results of this study show that the junior athletes take the same meals as the non-athletes despite high energy expenditures.
2. Adolescent girls engaged in athletic activities should be closely for menstrual disturbance since exercise-induced amenorrhea can be an indicator of an energy drain.
3. Both athletic and non-athletic secondary school girls should be closely monitored for development of eating disorders that could have a negative effect on their growth patterns

6.3.2 Recommendations for Research

Based on the findings of this study, the following gaps were identified for further research:

1. Further exploration of menstrual dysfunction using reproductive hormone biomarkers will undoubtedly provide a better perspective regarding menstrual function.
2. Future research examining the prevalence of eating disorders should include clinical interviews to confirm presence of eating disorders.
3. Investigate BMD with a DXA scan which gives a better indication of bone density, as this study used ultra sound which is mostly used to evaluate BMD of postmenopausal women.
4. A follow up study of the junior athletes in their athletic life would be necessary in order to determine at what point the athletes are at a greater risk for the Triad components.
5. Further research could also explore the risk of the Triad components in a group of senior athletes and junior athletes and determine if there are age or level of competition related differences in the occurrence of the Triad.

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APPENDIX 1: Letter of Introduction and Consent

Dear respondent,

My name is Esther Nduku from Kenyatta University, Department of Foods, Nutrition and Dietetics. I am undertaking a research on the ***"assessment of disordered eating, amenorrhea and low bone mineral density among junior female long distance runners in Iten, Kenya"*** leading to the production of a thesis for my PhD.

I would be glad if you would spare some time and provide me with the information required. Any information given will be treated with utmost confidentiality and will only be used for the purpose of this study. Before agreeing to participate in the research, it is important that you read the information below. This statement describes the purpose, procedures, benefits, risks, discomforts and precautions of the study. Feel free to ask any questions that you may have.

A. **Purpose of study**: Assess disordered eating, amenorrhea and low bone mineral density among junior female long distance runners particularly in Iten. The study is also being conducted as a requirement for the award of a Doctor of Philosophy degree in Foods, Nutrition and Dietetics and possibly for publication in academic journals and presentations at academic conferences.

B. **Procedures**. In this study you will be required to answer some questions that are written down in questionnaire form with the help of an assistant to guide you in areas that you may not understand what is being asked. There will be some questions on demographic data such as age, ethnicity, class and questions on your training regimes such as how many training sessions you have in a week and also the intensity of these training sessions and as well keep a 5 day record on your training regime during the period of the study. During training you may be asked to wear a pedometer, which is a simple gadget worn/strapped across the waist and records your physical activity. Questions on your dietary intakes are also included will and at the same time you will be required after training to keep a 5 day dietary record where you will be required to write down all the foods you consume within the five day period. This together will the record from the gadget worn will help me determine whether your taking enough food compared to your training sessions

There is also a questionnaire on body perceptions, how you feel about your body shape and size and how your feelings on your body influence what you eat. A menstrual history questionnaire is also included which requires you to write at what age you began your menses, how regular are your menstrual cycles and if you notice any changes during the periods your training for competition. You will also be required to provide history of injuries that you may have suffered during competitive training or competition.

I will also take your weight and height as well as measurements on your triceps and biceps. These measurements will be taken in minimal clothing. At the end of the study we will do a simple scan on the heel which serves to give us the bone mineral density. The procedure is painless and non invasive.

C. **Duration**. There is no limit time on how long you will take in responding to the questions. We will organize that you respond to the questionnaire and take all other measurements during your own free time so that it does not disrupt the normal school hours. We should be through with all data collection within a span of 3 months. If you decide to stop participating in between, there will be no penalty to you and your decision will be respected

D. **Risks or discomforts**. It is unlikely that you will face any risks in participating in this study. In taking of the weights, heights and triceps you may feel uncomfortable with minimum clothing, but all measurements will be taken in an enclosed room and by a trained female assistant. The scan is a non-invasive procedure that will done in ones clothing. The scan will be done by Hologic-certified technicians

E. **Confidentiality**: confidentiality will be assured on all information provided and for that matter the participant identification will be done by use of unique identifier only known to the principal investigator. Data access will be limited to the principal investigator and researchers working directly on this study. All data will be destroyed responsibly after the required retention period (usually 3 years). Your privacy will be maintained in all published and written data resulting from this study. Your name or other identifying information will not be used in my reports or published papers.

F. **Benefits of this study**: you will receive no direct benefit from participating in this study; however your participation will help you get to know your bone mineral density which is very important for any athlete. I will also be able to discuss with you and your coach the results and give you advice on all the outcomes of the study and on ways of maintaining adequate food intakes for the athlete. Your participation will also help in understanding the nutrition status of Kenyan athletes and all the three aspects of the female athlete triad.

G. **Payment for research related injuries**: There are no expected injuries as a result of participating in the study or for questions related to the study.

Contact information

If you have any questions you may contact the following

- Dr. Vincent Onywera Tel: 0721 813114
- Dr. Elizabeth Kuria Tel: 0721 433619
- Kenyatta University Ethical Review Committee Secretariat on kuerc.secretary@ku.ac.ke

Participant Oral Consent:
Do you have any questions about the above information?
(YES/NO)
Do you wish to participate in this study?
(YES/NO)

Guardian Written Consent

I have read and understood the above information. I agree that the student participate in the research study

School Principal
Name__________________________________Date__________________________
Signature/Thumb print ____

Participant Ascent

I have read and understood the above information. I agree to participate in the research study

Participant
Name__________________________________Date__________________________
Signature/Thumb print ____

Investigators Statement

I, the undersigned have explained to the volunteer in a language she understands, the procedures to be followed in this study and the risks and benefits involved.
Name of Interviewer ____

Interviewer signature ____

APPENDIX 2: Demographic, Health and Physical activity Questionnaire

Dear participant

Please note: I kindly ask that you complete this form as thoroughly as possible. You are welcome to take your time to complete the form. Your honest input in this questionnaire is of utmost importance so i can give you the best and appropriate feedback.

Please be assured that all details provided in this questionnaire will remain completely confidential and will not be linked to you as an individual at any stage of the research project.

I will provide feedback to you in person after analysis of the data and we will not share any results with the coach or trainer unless you give specific consent for this.

SUBJECT NUMBER ______________ Date ____________________________

Demographic information and Socio-economic Information

Name ______________________________ Age (in yrs)______________

Class ________________ Ethnicity ________________

Home Area_______________________ School__________________

Are you in a boarding or day school?

☐ Boarding ☐ Day school

Who is the household head in your family

☐ Father ☐ Mother ☐ Grand Parent ☐ Elder Brother/Sister

How many siblings (brothers and sisters) do you have? ___________

Marital status of the Household head

☐ Single parent ☐ Married ☐ Divorced ☐ Widowed ☐ Other (specify)______________

What is your Fathers main occupation

☐ Employed (salaried) ☐ Merchant ☐ Weaving/basketry ☐ Masonry/carpentry

☐ Unemployed ☐ Livestock Herding ☐ Agricultural Labour

☐ other (explain):

What is your Mothers main occupation

☐ Employed (salaried) ☐ Merchant ☐ Weaving/basketry ☐ Masonry/carpentry

☐Housewife ☐ Livestock Herding ☐ Agricultural Labour

☐ other (explain):

What is your fathers highest level of education

☐ Primary ☐ Secondary ☐ College ☐ University ☐ Adult Education

☐ No formal education ☐ Don't Know

What is your mothers highest level of education

☐ Primary ☐ Secondary ☐ College ☐ University ☐ Adult Education

☐ No formal education ☐ Don't Know

Who pays your school fees

☐ Parent ☐ Guardian ☐ Bursary ☐ Other_______________(specify)

Are you an athlete?

☐ Yes ☐ No

Lifestyle information

Do you currently smoke or use tobacco?
☐ Yes ☐ No

Have you smoked in the past?

☐ Yes ☐ No

If yes, please give more information:
For how long have you been smoking/using tobacco?
____
How many cigarettes do/did you smoke per day?
____
How many times a day do/did you use tobacco (excluding cigarettes)?
____

Do you use alcohol?
☐ Yes ☐ No ☐ Sometimes

If yes / sometimes, please give more information regarding alcohol use:

How often do you use alcohol?
☐ Daily ☐ Weekly ☐ Monthly ☐ Yearly ☐ post event/game

What do you usually drink?
☐ Wine ☐ Beer ☐Spirits

Athletes ONLY:

Do you use alcohol during season?

☐ Yes ☐ No

How often do you use alcohol?

☐ Daily ☐ Weekly ☐ Monthly ☐ Yearly ☐ post event/game

What do you usually drink?

☐ Wine ☐ Beer ☐Spirits

Non-Athletes go to page 7

ATHLETES ONLY:
CURRENT Sports Participation

If you participate in a competitive sport please identify what season you are currently in (choose one).
☐ Pre-season

☐ In season
☐ Championships/Competition
☐ Off-season

What was the highest sporting level you have ever reached?
☐ Regional/ School
☐ District
☐ Provincial
☐ National
☐ International
☐ not applicable

Which of the following athletic activities are you involved in? (can tick more than one)

☐ 1500m ☐ 3000m ☐ 5000m ☐ 10,000m ☐ Marathon

For how long have you been an athlete? ___________yrs ______________ months

CURRENT Sport Participation (continue)

Please list the sport/s you are *currently* are involved in: (A) at your school and (B) outside of the school (*activities you do on your own, not part of your organized training*). For each sport you list, please check the *hours per week* you spend training and/or competing in your sport and the *total number of years* you have participated (including pre-university if applicable)

Section A: School Sports

Sport	*Hours per week*	*Nr. of years*
1.		
2.		
3.		

Section B: Outside school Sports and/or Activities *(in addition to organized training at school)*

Sport	*Hours per week*	*Nr. of years*
1.		
2.		
3.		
4.		

Current Sport / Activity			
Please list each sport or activity in which you are currently participating on a very *regular* basis. For each activity, please indicate the average length of each training or practice session, the number of sessions per week, and the average intensity of your training.			
Sport	Length of training/practice session	Sessions per week	Intensity of sessions
1.	__________minutes	☐ 1 ☐ 6 ☐ 2 ☐ 7 ☐ 3 ☐ 8 ☐ 4 ☐ 9 ☐ 5 ☐ 10	☐ Very easy ☐ Easy ☐ Moderate ☐ Hard ☐ Very hard
2.	__________minutes	☐ 1 ☐ 6 ☐ 2 ☐ 7 ☐ 3 ☐ 8 ☐ 4 ☐ 9 ☐ 5 ☐ 10	☐ Very easy ☐ Easy ☐ Moderate ☐ Hard ☐ Very hard
3.	__________minutes	☐ 1 ☐ 6 ☐ 2 ☐ 7 ☐ 3 ☐ 8 ☐ 4 ☐ 9 ☐ 5 ☐ 10	☐ Very easy ☐ Easy ☐ Moderate ☐ Hard ☐ Very hard

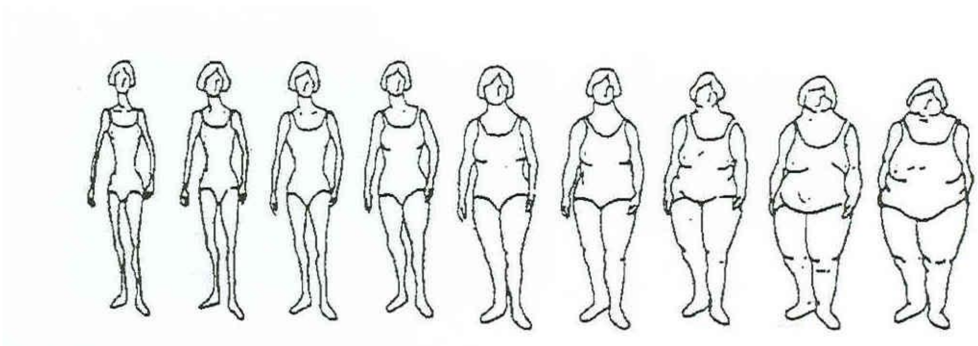
EVERYONE MUST COMPLETE

Past Sport and Physical Activity Participation					
Did you participate in sport before this year? ☐ Yes ☐ No					
If YES, please list the sports or activities you played in the past: (A) In school (e.g. organized sport) and (B) Outside of school in your free time (e.g., club, team). For each sport you list, please check the *hours per week* you spend training and/or competing in your sport and the *number of years* you have participated. *Section A*: School Sports					
Sport	*Hrs/wk*	*Wks/mnth*	*Mnths/yr*	*Number of yrs*	*Yrs (ie. 1999-2000)*
1.					
2.					
3.					

4.					
Section B: Outside School Sports (teams, clubs) and/or Activities (in addition to organized sport at school)					
Sport					
1.					
2.					
3.					
4.					

Body Weight Information

Which of the following are you currently trying to do about your weight? (check one) ☐ lose weight ☐ gain weight ☐ maintain weight ☐ I am doing nothing
If you are trying to change your weight, what is the ***primary*** reason? (check one) ☐ Sports performance ☐ Appearance ☐ Health ☐ None ☐ Other (explain):
Do you feel pressure to achieve/maintain a lean body shape? ☐ YES ☐ NO
If you checked YES, from whom do you feel pressure? (check all that apply) ☐ Yourself ☐ Coach ☐ Friends ☐ Parents ☐ Media ☐ Training partners ☐ None ☐ other (explain):
On a scale from 1 to 10, please rate the intensity of pressure you feel to achieve/maintain a lean body shape? (1 = least pressure, 10 = most pressure) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10



1 2 3 4 5 6 7 8 9

In the picture above, how do you think your body outline looks like (1-9)? _____

In the picture above, what outline drawing would you prefer to look like (1-9)? _____

ATHLETES ONLY: What do you consider to be your "ideal or competitive" weight? _____ kg.
Do you gain or lose weight regularly to meet the demands or weight requirements for your sport? ☐ YES ☐ NO
If you checked YES, how many times per year do you make weight (lose weight to compete) for your sport? _______times/year

Menstrual History	
Have you ever had a menstrual period?	☐ YES ☐ NO
How old were you when you had your first menstrual period?	______ years
How many menstrual periods have you had	a. in the past 12 months______ b. in the past 6 months_______ c. in the past 3 months_______
Have you ever gone for more than 3 months without	☐ YES ☐ NO

having a menstrual period?	
If you checked YES for the previous question… **Was this due to pregnancy?** ☐ YES ☐ NO	
If you have gone for more than 3 months without having a menstrual period but it was not due to pregnancy, please answer the following questions:	
a. How old were you when you first missed ≥ 3 menstrual periods?	_______ years
b. How many months or years did you go without a menstrual period?	_______ months OR _______ years
c. Did you see a doctor during this time period?	☐ YES ☐ NO
d. Was the time before you started to skip your periods a very stressful time or did a stressful event take place?	☐ YES ☐ NO
ATHLETES ONLY! If you participate in sports or activities competitively, did you have your first menstrual period before or after you began training for your sport or activity?	☐ Before ☐ After ☐ I have not yet had my menstrual period

Current Menstrual Status
Currently, how would you describe your menstrual cycle? In order to determine the number of days your cycle lasts, begin with the first day of bleeding and count the number of days until the next month when you began bleeding again (A normal cycle length is ± 26 – 35 days) ☐ I am very regular (every 26-35 days) ☐ I am somewhat regular (every 21-25 days) ☐ I am very irregular (every 36-45 days) ☐ I do not have a menstrual cycle (no cycle for longer than 3 months) When was your last cycle? ______________________________ If you do not have a menstrual cycle, choose all the possible reasons that could be the cause: ☐ Training intensity ☐ Contraceptive use ☐ Reproductive disorder ☐ I don't know ☐ Other, please specify

____
How would you describe your menstrual bleeding over the last few months ☐ the same as always ☐ lighter than usual ☐ heavier than usual ☐ No cycle for > 3 months
ATHLETES ONLY:
Does your menstrual cycle/bleeding change with your training? ☐ YES ☐ NO ☐ Not applicable
If you checked YES, choose all that apply: ☐ Longer cycle (>35 days) ☐ Skipping a cycle ☐ Shorter cycle (<21 days) ☐ Heavier bleeding ☐ Lighter bleeding ☐ Absence of 3 or more consecutive cycles
Does your menstrual cycle change during your *competition* season? ☐ YES ☐ NO ☐ Not applicable
If you checked **YES**, choose one of the following: ☐ Longer cycle (>35 days) ☐ Skipping a cycle ☐ Shorter cycle (<21 days) ☐ Heavier bleeding ☐ Lighter bleeding ☐ Absence of 3 or more consecutive cycles ☐ Other, please specify:____________________

Injury and Medical Assessment

1. Have you experienced injuries in your ***lifetime***? ☐ Yes ☐ No
2. **If YES,** please check the injuries below
3. For each injury you checked, please complete additional questions regarding the injury.

Injury	Please check if the injury was diagnosed by a	When did the injury occur? Date	What were you doing when the injury occurred?	If you were playing a sport when the injury	Did the injury occur during practice or competition? (Practice can mean

	physician.	(mo/yr)		occurred, what sport were you playing?	either training with a team or on your own.)
Anterior Cruciate Ligament (ACL)					
☐ Contact	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Non-Contact	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
Stress Fracture					
☐ Tibia	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Femur	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Foot	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Spine	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition

Other					
☐ Sprain, strain, dislocation	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Tendinitis, tendinosis, bursitis	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Broken bone	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Meniscal or Posterior Cruciate Ligament (PCL) injury	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition
☐ Iliotibial (IT) band syndrome	☐	___/___	☐ Sport ☐ Other		☐ Practice ☐ Competition

Eating Habits

Are you a vegetarian? ☐ YES ☐ NO If YES, please indicate type: ☐ vegan ☐ lacto/ovo ☐ lacto ☐ other ___________
Do you limit/restrict the ***amount*** of food you eat to control your weight? ☐ YES ☐ NO
Do you limit/restrict the ***types*** of food you eat to control your weight? ☐ YES ☐ NO
If **YES**, please check the groups of food you limit/restrict. ☐ dairy (milk, cheese) ☐ red meat ☐ other meat/protein (chicken, turkey, fish, eggs) ☐ carbohydrates rich foods (breads, pasta, rice, potatoes, mageu) ☐ sweets (ice cream, cookies, candy) ☐ Fats (butter, oil, cream sauces, salad dressings, mayonnaise, etc.) ☐ fast food (hamburgers, hot dogs, quarter loaf, fries etc) ☐ sweetened beverages (soda, juices, energy drinks etc) ☐ alcoholic beverages

Appendix 3: Eating behaviour and attitude Questionnaire

Subject number:_____________________

These are questions regarding your feelings and attitude towards food and your own body, there are no right or wrong answers, please complete the questions as honestly as possible.

Please check the answer that most applies to you for each of the following questions.

1.	When I have eaten my quota of kilojoules, I am usually good at not eating anymore. ☐ True ☐ False
2.	I deliberately take small servings as a means of controlling my weight ☐ True ☐ False
3.	Life is too short to worry about dieting. ☐ True ☐ False
4.	I have a pretty good idea of the number of kilojoules in common food. ☐ True ☐ False
5.	While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it. ☐ True ☐ False
6.	I enjoy eating too much to spoil it by counting kilojoules or watching my weight. ☐ True ☐ False
7.	I often stop eating when I am not really full as a conscious means of limiting the amount that I eat. ☐ True ☐ False
8.	I consciously hold back at meals in order not to gain weight. ☐ True ☐ False
9.	I eat anything I want, any time I want. ☐ True ☐ False
10.	I count kilojoules as a conscious means of controlling my weight. ☐ True ☐ False
11.	I do not eat some foods because they make me fat. ☐ True ☐ False
12.	I pay a great deal of attention to changes in my figure.

	☐ True ☐ False

Please circle ***one*** response for each of the following questions.

Sample Question:
How likely are you to take small helpings as a means of controlling your weight?

1	2	(3)	4
Rarely	Sometimes	Usually	Always

13.	How often are you dieting in a conscious effort to control your weight? 1 Rarely, 2 Sometimes, 3 Usually, 4 Always
14.	Would a weight fluctuation of 2.5 kg affect the way you live your life? 1 Not at all, 2 Slightly, 3 Moderately, 4 Very much
15.	Do your feelings of guilt about overeating help you to control your food intake? 1 Never, 2 Rarely, 3 Often, 4 Always
16.	How conscious are you of what you are eating? 1 Not at all, 2 Slightly, 3 Moderately, 4 Extremely
17.	How frequently do you avoid 'stocking up' on tempting foods? 1 Almost never, 2 Seldom, 3 Usually, 4 Almost always
18.	How likely are you to shop for low kilojoule foods? 1 Unlikely, 2 Slightly unlikely, 3 Moderately likely, 4 Very likely
19.	How likely are you to consciously eat slowly in order to cut down on how much you eat? 1 Unlikely, 2 Slightly unlikely, 3 Moderately likely, 4 Very likely
20.	How likely are you to consciously eat less than you want? 1 Unlikely, 2 Slightly unlikely, 3 Moderately likely, 4 Very likely
21.	On a scale of 0-5, where 0 means no restraint in eating (eating whatever and whenever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake and never 'giving in'), what number would you give yourself? Please circle the applicable number. 0 Eat whatever you want, whenever you want it

	1 Usually eat whatever you want, whenever you want it 2 Often eat whatever you want, whenever you want it 3 Often limit food intake, but often 'give in' 4 Usually limit food intake, rarely 'give in' 5 Constantly limiting food intake, never 'giving in'

Thoughts about your body, your eating patterns, your feelings…

Please check ***<u>one</u>*** response for each of the following questions.

Sample Question:
I think that my stomach is too big.
☐ Always ☐ Usually ☒ Often ☐ Sometimes ☐ Rarely ☐ Never

1.	I eat sweets and carbohydrates without feeling nervous ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
2.	I think that my stomach is too big. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
3.	I wish that I could return to the security of childhood. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
4.	I eat when I am upset. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
5.	I stuff myself with food. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
6.	I wish that I could be younger. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
7.	I think about dieting. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

8.	I get anxious when I have intense feelings. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
9.	I think that my thighs are too large. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
10.	I feel ineffective as a person. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
11.	I feel extremely guilty after overeating. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
12.	I think that my stomach is just the right size. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
13.	Only outstanding performance is good enough in my family. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
14.	The happiest time in life is when you are a child. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
15.	I am open about my feelings. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
16.	I am terrified of gaining weight. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
17.	I trust others. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
18.	I feel alone in the world. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
19.	I feel satisfied with the shape of my body. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
20.	I feel generally in control of things in my life. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
21.	I get confused about what emotion I am feeling. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
22.	I would rather be an adult than a child. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

23.	I can communicate with others easily. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
24.	I wish I were someone else. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
25.	I exaggerate or magnify the importance of weight. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
26.	I can clearly identify what emotion I am feeling. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
27.	I feel inadequate. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
28.	I have gone on eating binges (overeating) where I have felt that I could not stop. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
29.	As a child, I tried very hard to avoid disappointing my parents and teachers. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
30.	I have close relationships. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
31.	I like the shape of my buttocks. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
32.	I am preoccupied with the desire to be thinner. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
33.	I don't know what's going on inside me. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
34.	I have trouble expressing my emotions to others. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
35.	The demands of adulthood are too great. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
36.	I hate being less than best at things. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
37.	I feel secure about myself. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

38.	I think about bingeing (overeating). ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
39.	I feel happy that I am not a child anymore. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
40.	I get confused as to whether or not I am hungry. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
41.	I have a low opinion of myself. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
42.	I feel that I can achieve my standards. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
43.	My parents have expected excellence of me. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
44.	I worry that my feelings will get out of control. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
45.	I think my hips are too big. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
46.	I eat moderately in front of others and stuff myself when they’re gone. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
47.	I feel bloated after eating a small meal. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
48.	I feel that people are happiest when they are children. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
49.	If I gain a kilogram, I worry that I will keep gaining. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
50.	I feel that I am a worthwhile person. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
51.	When I am upset, I don’t know if I am sad, frightened, or angry. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
52.	I feel that I must do things perfectly or not do them at all. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

53.	I have the thought of trying to vomit in order to lose weight. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
54.	I need to keep people at a certain distance (feel uncomfortable if someone tries to get too close). ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
55.	I think that my thighs are just the right size. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
56.	I feel empty inside (emotionally). ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
57.	I can talk about personal thoughts or feelings. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
58.	The best years of your life are when you become an adult. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
59.	I think my buttocks are too large. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
60.	I have feelings I can't quite identify. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
61.	I eat or drink in secrecy. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
62.	I think that my hips are just the right size. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
63.	I have extremely high goals. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
64.	When I am upset, I worry that I will start eating. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
65.	People I really like end up disappointing me. ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
66.	I am ashamed of my human weaknesses ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
67.	Other people would say that I am emotionally unstable

	☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
68.	I would like to be in control of my bodily urges ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
69.	I feel relaxed in most group situations ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
70.	I say things impulsively that I regret having said ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
71.	I go out of my way to experience pleasure ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
72.	I have to be careful of my tendency to abuse drugs ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
73.	I am outgoing with most people ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
74.	I feel trapped in relationships ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
75.	Self-denial makes me feel stronger spiritually ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
76.	People understand my real problems ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
77.	I can’t get strange thoughts out of my head ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
78.	Eating for pleasure is a sign of moral weakness ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
79.	I am prone to outbursts of anger and rage ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
80.	I feel that people give me the credit I deserve ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
81.	I have to be careful of my tendency to abuse alcohol ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
82.	I believe that relaxing is simply a waste of time ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

83.	Others would say that I get irritated easily ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
84.	I feel like I am losing out everywhere ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
85.	I experience marked mood shifts ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
86.	I am embarrassed by my bodily urges ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
87.	I would rather spend time by myself than with others ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
88.	Suffering makes you a better person ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
89.	I know that people love me ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
90.	I feel like I must hurt myself or others ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never
91.	I feel that I really know who I am ☐ Always ☐ Usually ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

In the past 3 months, how often have you…..
Gone on eating binges (eating a large amount of food while feeling out of control)? ☐ Never ☐ one a month or less ☐ 2-3 times/month ☐ once a week ☐ 2-6 times/wk ☐ once or more a day
Made yourself sick (vomited) to control your weight? ☐ Never ☐ one a month or less ☐ 2-3 times/month ☐ once a week ☐ 2-6 times/wk ☐ once or more a day
Used laxatives to control your weight or shape? ☐ Never ☐ one a month or less ☐ 2-3 times/month ☐ once a week ☐ 2-6 times/wk ☐ once or more a day
Exercised 60 minutes or more to lose or control your weight? ☐ Never ☐ one a month or less ☐ 2-3 times/month ☐ once a week ☐ 2-6 times/wk ☐ once or more a day
In the past 6 months, you have lost 10 kg or more? ☐ Never ☐ one a month or less ☐ 2-3 times/month ☐ once a week ☐ 2-6 times/wk ☐ once or more a day

Appendix 4: 5-Day Dietary Record Form

Participant Number: ________

Dear Participant,

Thank you very much for taking part in this study. Please record your dietary intake as well as your physical activities/exercise training for the 5 days/dates that are stipulated on the form.

DIETARY INFORMATION:

It is essential that you eat as you normally do, don't change your eating patterns or choices just because you are keeping a record. When filling in the form, please consider the following points and refer to the example on the next page:

- Record the **approximate time** that you ate/drank the food/beverage and remember to stipulate if it was a snack or a meal.
- Please give **a detailed description of the food/beverage** consumed:
    - record the type of food/beverage and use brand names if possible (e.g. *kimbo*, kasuku)
    - state how the food was prepared (boiled, fried, roasted etc.);
    - record if the meat was fatty or lean;
    - specify the part of the chicken, and state if it was eaten with or without the skin;
    - when eating mince, estimate in terms of cups, tablespoons or ladle spoons (refer to pictures in handout);
    - state what type of milk or yoghurt was used (fresh, permented, full cream or skim/fat free);
    - record the type of margarine used as well as the quantity (e.g. 1 tsp) OR describe as a thin scraping, medium or thick (can see tooth marks). *This applies to all spreads used;*
    - remember to mention any sauces eaten with any of your meals and estimate the quantity in terms of tablespoons or cups;
    - Remember to record any additions to food such as cream, sugar, butter etc;
    - When using sports drinks or energy products, specify the *brand name*, the exact amount and if possible, place the label in the envelope;
    - When recording the **quantity or amount** of food consumed, consider the following points:

- if weighing is not possible, use the picture album provided to help estimate the portion size (250 ml, 1/2 cup, 1 teaspoon etc.)
- also mention if it if is a heaped or level spoon and what type of spoon (i.e. teaspoon, tablespoon, dessert spoon etc. – refer to pictures);
- when describing fruit, estimate in terms of small, medium or large;
- when describing food that you are uncertain about, please use the pictures of top view/cross section to guide you.

Day ______________ (example Day 1, 2) **Date __________________**

Time	**Meal/ Snack**	**Type of food or fluid**	**Brand/ Preparation**	**Quantity served (cup, tsp, tbsp, ml)**	**Quantity of left over's**

Appendix 5: Individual dietary diversity score sheet

Participant NO________________________

(To be filled by researcher and assistants)

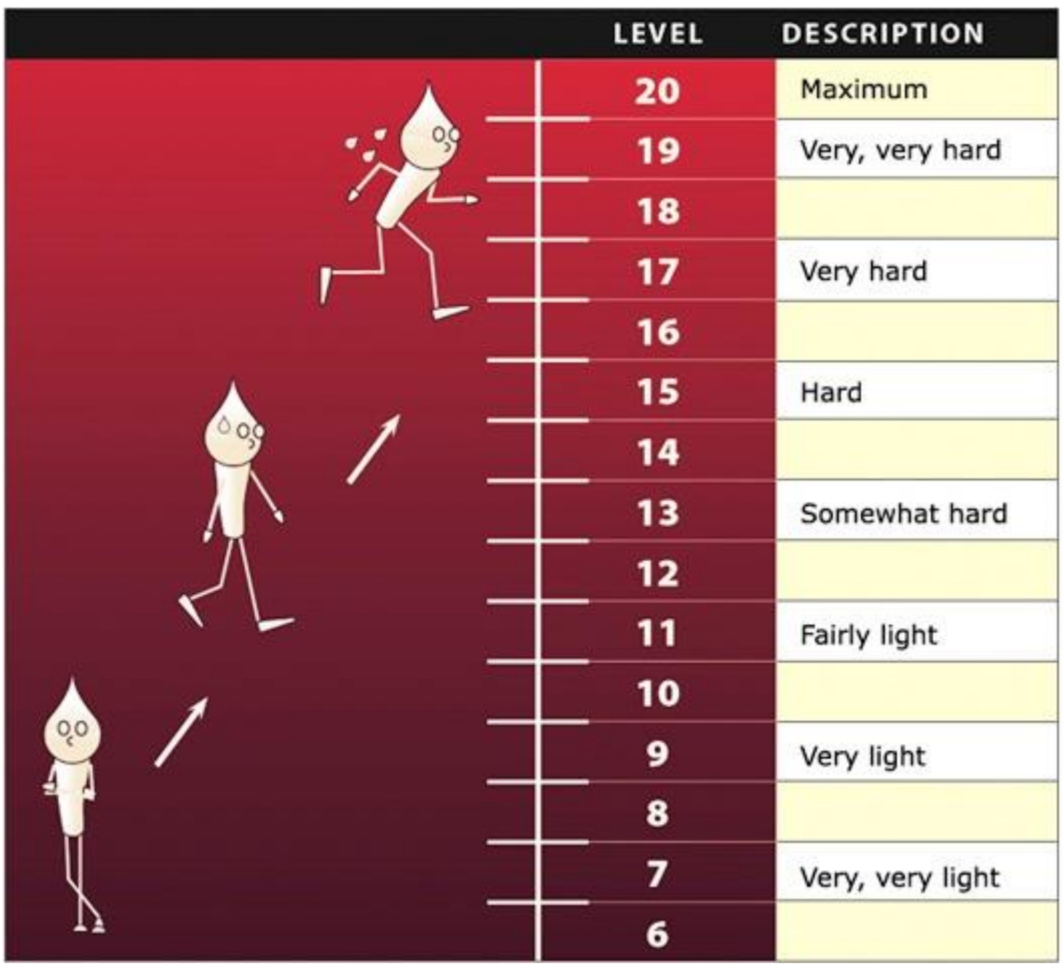
Question Number	Food group	Examples	YES=1 N0=0
1	Cereals, roots and tubers	corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + insert local foods e.g. ugali, githeri, porridge or pastes or other locally available grains white potatoes, white yams, white cassava, or other foods made from roots	
2	Carotene rich fruits, vegetables and tubers	pumpkin, carrots, or sweet potatoes that are orange inside + other locally available vitamin-A rich vegetables (e.g. red sweet pepper). Ripe mangoes, cantaloupe, apricots (fresh or dried), ripe papaya, dried peaches + other locally available vitamin A-rich fruits	
3	Other fruits	other fruits, including wild fruits	
4	Other vegetables	other vegetables (e.g. tomato, onion, eggplant) , including wild vegetables	
5	Legumes, pulses, nuts and Seeds	beans, peas, lentils, nuts, seeds or foods made from these	
6	Meat, Poultry, fish	Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds, liver, kidney, heart or other organ meats or blood-based Foods, chicken, duck, guinea hen or any other fresh or dried fish or shellfish	
7	Dairy	milk, cheese, yogurt or other milk products	
8	Oils and fats	oil, fats or butter added to food or used for cooking	
9	Eggs	Eggs	

Appendix 6: Activity/Exercise Log

It is essential that you exercise as you normally do, if you are an athlete. Don't start exercising just because you are keeping a record. Please **do not record your typical daily activities** such as cleaning, climbing the stairs or walking to class. Only record exercise (e.g. a run, spinning class, aerobics, tennis etc.) you do for your sport or exercise you do to keep fit (if you are an athlete).

When filling in the form, please consider the following points and refer to the example on the next page:

- Specify the type of exercise (e.g. running, cycling etc.)
- Write down the duration of exercise in minutes;
- Rate how hard you perceive your workout, according to the borg scale on the back page.



PARTICIPANT NO__________________________________DAY ______________(e.g day 1, 2)					
Type of activity /workout	Time	Borg scale Value	Type of activity/workout	Time	Borg scale Value
	6.OOAM-6.15AM			11.OOAM-11.15AM	
	6.15AM-6.30AM			11.15AM-11.30AM	
	6.30AM-6.45AM			11.30AM-11.45AM	
	6.45AM-7.OOAM			11.45AM-12.OOPM	
	7.OOAM-7.15AM			12.OOPM-12.15PM	
	7.15AM-7.30AM			12.15PM-12.30PM	
	7.30AM-7.45AM			12.30PM-12.45PM	
	7.45AM-8.OOAM			12.45PM-1.OOPM	
	8.OOAM-8.15AM			1.OOPM-1.15PM	
	8.15AM-8.30AM			1.15PM-1.30PM	
	8.30AM-8.45AM			1.30PM-1.45PM	
	8.45AM-9.OOAM			1.45PM-2.OOPM	
	9.OOAM-9.15AM			2.OOPM-2.15PM	
	9.15AM-9.30AM			2.15PM-2.30PM	
	9.30AM-9.45AM			2.30PM-2.45PM	
	9.45AM-10.OOAM			2.45PM-3.OOPM	
	10.OOAM-10.15AM			3.OOPM-3.15PM	
	10.15AM-10.30AM			3.15PM-3.30PM	
	10.30AM-10.45AM			3.30PM-3.45PM	
	10.45AM-11.OOAM			3.45PM-4.OOPM	

Continued					
Type of activity /workout	Time	Borg scale Value	Type of activity/workout	Time	Borg scale Value
	4.OOPM-4.15PM			7.00PM-7.15PM	
	4.15PM-4.30PM			7.15PM-7.30PM	
	4.30PM-4.45PM			7.30PM-7.45PM	
	4.45PM-5.OOPM			7.45PM-8.00PM	
	5.OOPM-5.15PM			8.00PM-8.15PM	
	5.15PM-5.30PM			8.15PM-8.30PM	
	5.30PM-5.45PM			8.30PM-8.45PM	
	5.45PM-6.OOPM			8.45PM-9.00PM	
	6.OOPM-6.15PM				
	6.15PM-6.30PM				
	6.30PM-6.45PM				
	6.45PM-7.OOPM				

Appendix 7: Anthropometric Measurements

Participant No________________________

Site	**Measurement 1**	**Measurement 2**	**Measurement 3**	**Average**
Basics				
Height (cm)				
Weight (kg)				
Skin Folds				
Triceps				
Supraspinale				
Abdominal				
Thigh				

Appendix 8: Checklist

Participant No [ ]

Subject Name:_______

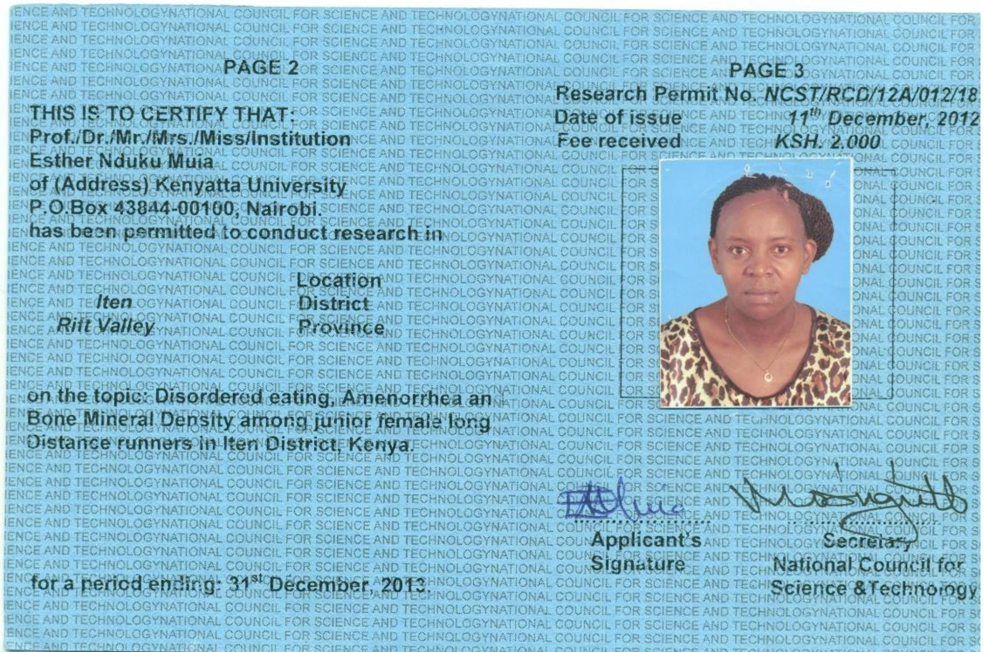
Dear participant

You will be required to complete a number of questionnaires and undergo a few testing procedures at different testing stations throughout the day. Please hold on to this checklist and tick off the appropriate box after you have completed a questionnaire/testing procedure. Also make sure that the fieldworker at each station has signed off the activity before you proceed to the next testing station.

☐	**Anthropometrics**	Fieldworker________________
☐	**Demographic Q**	Fieldworker________________
☐	**Eating behavior Q**	Fieldworker________________
☐	**Exercise log book**	Fieldworker________________
☐	**Diet record**	Fieldworker________________

You will have to hand in this checklist, together with your questionnaires at the recruitment table at the end of the study.
THANK YOU

Appendix 9: NACOSTI Permit



PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Esther Nduku Muia
of (Address) Kenyatta University
P.O.Box 43844-00100, Nairobi.
has been permitted to conduct research in

Location
Iten District
Rift Valley Province

on the topic: Disordered eating, Amenorrhea an
Bone Mineral Density among junior female long
Distance runners in Iten District, Kenya.

for a period ending: 31st December, 2013.

PAGE 3

Research Permit No. *NCST/RCD/12A/012/18*
Date of issue *11th December, 2012*
Fee received *KSH. 2,000*

Applicant's Signature

Secretary
National Council for
Science & Technology

Appendix 10: NACOSTI Approval

REPUBLIC OF KENYA

HARAMBEE

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471,2241349
254-020-310571,2213123, 2219420
Fax: 254-020-318245,318249
when replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref:
NCST/RCD/12A/012/181

Date:
11th December, 2012

Esther Nduku Muia
Kenyatta University
P.O.Box 43844-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application dated ***26th November, 2012*** for authority to carry out research on "***Disordered eating, Amenorrhea and Bone Mineral Density among junior female long distance runners in ~~Iten~~*** KEITO ***District, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Iten District** for a period ending **31st December, *2013.***

You are advised to report to **the District Commissioner and the District Education Officer, Iten District** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR M.K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:

The District Commissioner
The District Education Officer
Iten District.

"The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development".

Appendix 11: Approval from Kenyatta University Graduate School

KENYATTA UNIVERSITY
OFFICE OF THE DEAN, GRADUATE SCHOOL

E-mail: kubps@yahoo.com
dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Our Ref: H87/13269/09

Date: 12th September, 2012

The Permanent Secretary,
Ministry of Higher Education,
Science & Technology
P.O. Box 30040,
NAIROBI.

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION

I write to introduce **Ms. Esther N. Muia** who is a Postgraduate Student of this University. She is registered for a Ph.D degree programme in the Department of Foods, Nutrition & Dietetics in the School of Applied Human Sciences.

Ms. Muia intends to conduct research for a thesis entitled, **"Disordered Eating, Amenorrhea and Bone Mineral Density Among Junior Female Long Distance Runners in Iten District - Kenya."**

Any assistance given to her will be highly appreciated.

Yours faithfully,

KENYATTA UNIVERSITY OFFICE OF DEAN
12 SEP 2012
GRADUATE SCHOOL
P.O. Box 43844 - 00100, NAIROBI

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL

JMO/bkk

Committed to Creativity, Excellence & Self-Reliance

Appendix 12: Approval from Ministry of Education

MINISTRY OF EDUCATION

Telegram: ....

Telephone: Iten

When replying please quote

REF: KYO/298/VOL.II/65

DISTRICT EDUCATION OFFICE
KEIYO DISTRICT.
P.O. BOX 214- 30700
ITEN.

Date: 16th January, 2013.

TO WHOM IT MAY CONCERN

RE: PERMISSION TO CARRY OUT A RESEARCH

The holder of this letter is Ms Esther N. Muia. She is a registered student taking a PhD Degree programme in the Department of Foods, Nutrition and Dietetics in the school of Applied Human Sciences, Kenyatta University.

She has permission to carry out a research for a thesis entitled, Disordered Eating, Amenorrhea and Bone mineral Among Junior Female Long Distance Runners in Keiyo District, Kenya.

I request you to accord her the necessary assistance.

DISTRICT EDUCATION OFFICER KEIYO DISTRICT 17 JAN 2013

MAGARA Y. O.
DISTRICT EDUCATION OFFICER
KEIYO DISTRICT

Appendix 13: Kenyatta University Ethical Review Committee Consent

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Fax: 8711242/8711575
Email: kuerc.chairman@ku.ac.ke
kuerc.secretary@ku.ac.ke
Website: www.ku.ac.ke

P. O. Box 43844
Nairobi, 00100
Tel: 8710901/12
Tel: 8710901/12

Our Ref: KU/R/COMM/51/98

Date: November 9th 2012

Esther Nduku Muia
School of Applied Human Sciences
Kenyatta University
P. O. Box 43844, Nairobi.

Dear. Ms. Muia,

APPLICATION NUMBER **PKU/072/I64** OF 2012 – **'DISORDERED EATING, AMENORRHEA AND BONE MINERAL DENSITY AMONG JUNIOR FEMALE LONG DISTANCE RUNNERS IN ITEN DISTRICT, KENYA' –** ***VERSION 2***

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic, **Disordered Eating, Amenorrhea and Bone Mineral Density among Junior Female Long Distance Runners in Iten District, Kenya** - ***version 2*** dated 6th November 2012.

2. APPLICANT

Esther Nduku Muia
School of Applied Human Sciences
Kenyatta University
P. O. Box 43844, Nairobi.

3. SITE

Iten District, Kenya.

4. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines, and is of the view that against the following elements of review,

(i) Scientific design and conduct of study,
(ii) Recruitment of research participant,
(iii) Care and protection of research participants,
(iv) Protection of research participant's confidentiality,
(v) Informed consent process,
(vi) Community considerations.

AND APPROVED **that the research may proceed for a period of ONE year from** 9th November, 2012

5. ADVICE/CONDITIONS

i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.

ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.

iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.

iv. Submit an electronic copy of the revised proposal to KU-ERC.

When replying, kindly quote the application number above.

If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

PROF. NICHOLAS K. GIKONYO
CHAIRMAN ETHICS REVIEW COMMITTEE

I ...ESTHER NDUKU MUIA... accept the advice given and will fulfill the conditions therein.

Signature.................................. Dated this day ...9... of...November... 2012.

cc. Vice-Chancellor
Director: Institute for Research Science and Technology