PATTERN OF RUNNING-RELATED SELF REPORTED MUSCULOSKELETAL INJURIES AMONG KENYAN RUNNERS IN THE NORTH RIFT REGION

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DECLARATION

I declare that this thesis is my original work. I have not submitted it for another degree in any institution of higher learning. Views expressed herein are mine unless stated otherwise, and where such is the case, the reference has been cited. No part of this thesis may be reproduced without prior written permission of the author and /or Moi University. Signatures Date

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DEDICATION

The Researcher dedicates this thesis to all the Kenyan runners, up-coming and elite, active and retired, men and women, who relentlessly strive to make our country proud during regional and international track and field events.

DISCLOSURE

The Researcher did not receive any outside funding or grants in support for this study. Neither he nor a member of his immediate family received payments or other benefits thereof or commitment or agreement to provide such benefits from a commercial entity.

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ABBREVIATIONS AND ACRONYMS

AAA	Amateur Athletics Association
IREC	Institutional Research and Ethics Committee
MSS	Musculoskeletal System
MTRH	Moi Teaching and Referral Hospital
MTSS	Medial Tibial Stress Syndrome
NR	North Rift
RRMI	Running Related Musculoskeletal Injuries

DEFINITION OF TERMS

ACUTE INJURY when a single traumatic event is identified as a cause of RRMI.

ELITE RUNNER an athlete who has managed to reach the highest level in his/her running career.

FOOT ARCHES the degree of curvature of the sole of the foot.

LIMB LENGTH DISCREPANCIES a difference in the lengths of the two limbs (significant if >2cm).

MTSS pain/discomfort arising from the postero-medial aspect of the tibia (shin splints).

OVERUSE INJURY when no such event above can be identified or an injury occurring as a result of repetitive movements involving a particular joint or tissue.

PATELLA TENDINOPATHIES pain/discomfort arising from the point of attachment of patella tendon on the tibia (jumpers' knee).

PATELLOFEMORAL SYNDROME pain/discomfort arising from the articulating surfaces between the femur and patella (runners' knee).

Q- ANGLE the degree of displacement of the patella or misalignment of the quadriceps. (Depends on gender but normal is 11˚ to 20˚ on standing and abnormal when >8˚ in a sitting position).

RRMI any injury of the musculoskeletal system sustained by a runner during a race or training and that which may affect the runners' performance.

RUNNER an athlete involved in running and competes in any of the races.

SMOKADIABESITY condition associated with the disorders of smoking, diabetes and obesity.

ABSTRACT

Background: Running-Related Musculoskeletal Injuries (RRMI) may be defined as the acute or overuse injuries that a runner develops during or after participating in running activities. The North Rift region of Kenya, known to many as "the home and source of champions", harbours many runners who participate in running competitions both regionally and internationally. Unfortunately, there is a dearth of data on the RRMI in general. This study therefore aimed to demonstrate the various injuries, their treatment as well as associated risk factors so as to develop future strategies on prevention and management of RRMI.

Objective: To determine the types, associated risk factors and treatment of RRMI among the runners in the North Rift region of Kenya.

Methods: This was a cross-sectional descriptive study of Kenyan runners carried out at various training camps within the North Rift region of Kenya. Purposive sampling technique was used to select Uasin Gishu, Elgeyo Marakwet and Nandi counties within the North Rift region. Through convenience sampling, training camps with similar climatic characteristics in Kaptagat, Iten, Kapsabet and Kapng'etunyi were selected then all runners available at the particular time of visit were recruited. The study proposal was approved by IREC. An interviewer-administered questionnaire was used to collect data. Collected data included bio data, runners' training schedules, injury history, treatment and physical examination. Data analysis was done using R statistical package.

Results: A total of 108 runners were interviewed with a male to female ratio of 5:1. Two hundred and twelve injuries had been sustained by 93.5% of the runners. The most common location of injury encountered were; 43(39.8%) posterior thigh (hamstring), 33(30.6%) knee, 30(27.8%) Achilles tendon and 24(22.2%) groin injuries. Hip injuries were common in females while males sustained more groin injuries. About 67% of the participants trained more than 15 hours per week while 75% ran over 150km weekly without recommended rest. There was poor health seeking behaviour with only 19% of the RRMI being seen in hospitals while the rest undergoing massaging within the camps for almost all the injuries. Lack of proper follow-up plan and an early return to running before complete healing were noted.

Conclusion: A high rate of injury at 93.5% in the last 3 years was recorded which was predominated by hamstring injuries. Most runners practised overtraining, used medicated ointments for first aid then underwent physiotherapy within the camps without proper investigations and thereafter returned to training before full recovery.

Recommendations: Establishing a Sports Care Centre that will institute measures aimed at reducing the high rate of injuries including preventive strategies through health literacy as well as early diagnosis and management of RRMI by sports physicians.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION

1.1 Background:

Running may be defined as the act of walking only at a faster rate. This locomotive action allows humans and other animals to move faster on foot. The purpose of running varies according to the individual performing it. It may be running to school, as a form of exercise of even competition.

Running-related musculoskeletal injuries (RRMI) are the injuries affecting especially the lower limbs during or following a running event. These injuries can be acute or chronic presenting mostly as pain or discomfort around specific anatomical regions of the lower limbs. Usually fist aid is initiated following these injuries thereafter proper evaluation is conducted for diagnosis and definitive treatment ensured. His is usually accompanied by rehabilitation period before return to training.

The North Rift region of Kenya harbours most of the elite Kenyan runners. This region attracts runners from other neighbouring countries and even abroad because of its conducive climate and terrain. It has eight counties which are Nandi, UasinGishu, Elgeyo Marakwet, Pokot, Trans Nzoia, Mount Elgon, Turkana and Baringo. Training is performed within camps in this region that are mostly concentrated around towns like Iten, Kapsabet, Nandi hills and Kaptagat.

Running as a form of sport started through hunting fighting skills that were required to feed and protect the primitive man which later developed into contests (Snook, 1984).

In Kenya, written in the book “The Racing Past; History of mid and long distance running in the first Kenyan Runner”, running competitively begun in the 1950s during the intercontinental races under the British Colonial Rule. In this rich history, we meet Lazaro Chepkwony participating in the 1954 AAA six miles race. In the same year,

Nyandika Maiyoro also captured the books of history. The first Kenyan Olympiad was Arere Anentia in 1956. These individuals set the stage for the "tsunami" of Kenyan long-distance runners like Kipchoge Keino, Paul Targat and the current World long distant champion Eliud Kipchoge. The first gold medallist was Naftali Temu in 1968 after winning the 10,000m race in Mexico while Wilson Kiprugut won bronze in the 800m race to become the first Olympic medallist.

Since then, running has been a key socio-economic activity especially in the North Rift region where most of the prominent athletes come from (Onywera, 2006). However, several other regions in Kenya have had their share in training and nurturing of upcoming athletes including the regions around Mount Kenya and Nairobi (athleticskenya.or.ke, 2014).

With the onset of competition in this field, so did the risk and development of running-related musculoskeletal injuries (RRMI) emerged. This statement seems contradictory as the researcher has initially elaborated how beneficial running is as a form of exercise. "Different sports result in qualitatively and quantitatively different stresses to different somatic locales of the human body therefore causing different injuries" (DeHaven & Lintner, 1986). Varying incidences of RRMI have been quoted in literature ranging from 26% to 92.9% (Kluitenberg et al., 2015; Lysholm & Wiklander, 1987; Satterthwaite, Norton, Larmer, & Robinson, 1999).

Hence, this study, due to limited data available on RRMI, might be the first in Kenya to go into the depth of describing the characteristics of the RRMI the athletes sustain during their training sessions or even as they compete in the different races.

The action of running may be described in three phases (Lopes, Hespanhol Junior, Yeung, & Costa, 2012). The heel strike (hind foot) is the first part of the body to be in

contact with the ground and absorbs up to three times the total body weight. This is followed by the stance phase where the sole of the foot is in transient contact with the ground. The last phase is the push-off where the distal parts of the foot (fore foot) leave the ground. The biomechanics involved in these phases may also explain the risk and distribution of RRMI among the athletes (Nicola & Jewison, 2012). However, several studies including Nicola's above have indicated and proposed that well trained runners should have the first phase of running as the fore foot so as to reduce the impact of weight bearing forces.

1.2 Problem Statement:

With increasing numbers of participant runners so shall the rates of injuries expected to rise. It is evident from literature that there is a dearth of data involving RRMI not just in Kenya, but other countries in Africa as well. Currently, the pattern of RRMI for example the commonest injuries affecting runners and where or how they are treated is not known. Some of these injuries bear serious complications in terms of morbidity and costs of medical care if not managed as soon as they occur. In Kenya and in particular at MTRH (the largest referrral hospital in the region), where the researcher was undertaking his MMED degree, no single athlete had been treated there for any RRMI for a period of at least one year. It is therefore necessary to acquire knowledge on the characteristics of the runners as well as the injuries they sustain so as to understand and even plan on how to manage them.

1.3 Justification:

There is enough evidence from literature that in the past 3 decades, more people are participating in running as sports (Maughan & Miller, 1983). Unfortunately, such data is lacking locally hence this study will try to shed light on the demographic parameters of RRMI in the NR region and in Kenya as a whole.

Secondly, the information on RRMI from this study may be used as a guide to prepare the care givers especially our local sports clinicians in anticipation of the most common RRMI sustained by the athletes and how to aptly and efficiently manage them.

Furthermore, the data collected may assist in strategising standardised policies and treatment protocols of the runners. This will improve the outcome following RRMI and in the long run boost the performance of these athletes. As seen earlier, the North Rift has the largest proportion of these athletes in Kenya who have been known to participate in athletics as part of their livelihood. This means a sustained maintenance of their health will encourage maximum participation in athletics and stabilise the region as well as the country economically.

Lastly, establishing a database of demographics, causes and risk factors of RRMI and management options of these athletes will enrich and avail information to the students and academic staff at Moi University. This will provide a foundation for future studies and a basis of designing protocols aimed at professionally managing RRMI sustained by the athletes preferably in the department of sports medicine at MTRH.

1.4 Research Question:

What is the pattern and treatment of RRMI among the athletes as seen in the NR region of Kenya?

1.5 Objectives:

1.5.1 Main Objective:

To determine the pattern and treatment of RRMI among athletes in the North Rift region of Kenya.

1.5.2 Specific Objectives:

To determine the characteristics of RRMI sustained by the athletes.

To assess the associated risk factors of RRMI.

To find out the treatment modalities used by the athletes following RRMI.

CHAPTER TWO: LITERATURE REVIEW

2.1 The history of sports and sports injuries.

In "The History of Sports medicine", Snook, discussed how sports emerged as a practice for hunting and during wars so as to maintain and propagate a man's family and tribe. Later this activity developed into contests and thereby, the advent of sports related injuries.

The first recorded sports injury was in the Book of Genesis (32:24-25) where Jacob wrestled with a man and sustained a thigh injury. The Hindus in the Book of Artheva-Veda and The Book of Kung Fu by the Chinese in 1000BC recorded the use of exercise as treatment. The first textbook on Athletic Training was written by Iccus of Tarentum, a former triathlon champion in 444BC. In addition, the first team physician was Claudius Galen of Perganum and Rome who was appointed physician to the gladiators in second century AD. The promotion of rehabilitation from injuries was seen in the tenth century by Hakim-Ibn-e-Sina popularly/historically known as Avecenna through the use of medical gymnastics, massage, warm baths etc.

Merging of sports with medicine was evident in ancient Greece through the teachings of Hippocrates and Hirodicus who pioneered the transfer of athletic care from the hands of the priests to physicians (Popkin, Gundry, Larson, & Murnaghan, 2013). This, together with the desire to compete and win gave birth to sports medicine physicians to treat and improve performance (Appelboom, Rouffin, & Fierens, 1988). In America, the first sports medicine physician was Edward Hitchcock in 1954 and others later followed (Bibliography, 1985).

Running in particular, as a form of sports, can be dated back to 490 BC in Greece, when Pheidippides ran from Marathon to Athens and shortly thereafter died from exertion hence the coining of the term "marathon" (Lopes et al., 2012).

2.2 Reasons for running.

A number of studies accentuate the fact that running is not only practised for competition purposes but also for seeking healthier lifestyles at a low cost (Lopes et al., 2012; van Gent et al., 2007; W. van Mechelen, H. Hlobil, H. C. Kemper, W. J. Voorn, & H. R. de Jongh, 1993; M. Van Middelkoop, J. Kolkman, J. Van Ochten, S. M. A. Bierma-Zeinstra, & B. Koes, 2008b). Running has even been termed as "a phenomenon of mass participation" by (R. J. Maughan, 1983). There was a period in America between the years 1970 and 1980 which was also referred to as the "era of exercise boom" when running was favoured because of its convenience, health benefits and economic nature (Taunton et al., 2002). Physical inactivity on the other hand was mentioned by Prof. Steven Blair to be "one of the most important public health challenges of the twenty first century" (Lopes et al., 2012). This was later emphasized by Prof. Karim Khan in the same article that "low fitness may be responsible for a larger attributable fraction of mortality than smokadiabesity".

Blair, (2009) describes the importance of exercises in reducing the risk of mortality and even recommended the incorporation of fitness tests during routine check-ups. Furthermore, there are recent studies which clearly give evidence for prescribing exercise as therapy for up to twenty six different chronic diseases affecting at least all body systems including musculoskeletal system for oateoarthritis, neurological system for multiple sclerosis and others (Pedersen & Saltin, 2015). The article explains the

benefits of exercise through growth stimulation of nerve cells, increased insulin sensitivity and its disease modifying effect on cartilage and reduction of pain.

Individuals in Kenya, and to be precise, in the NR region, usually run as a means of transport from a tender age to and from school (Vincent O. Onywera, 2006). Some of them take up running as sports and compete in different races both locally and internationally as a form of livelihood.

2.3 What is known about RRMI including local literature

Concerning running related injuries, it is currently evident that there is still a dearth of information about the characteristic pattern of these injuries (Brubaker & James, 1974; Owoeye, 2010b; Taunton et al., 2002). In a systemic review of literature on incidences and/or prevalence of RRMI that included prospective and retrospective as well as cross-sectional studies that had a clear definition of the RRMI, confirmed that literature does not clarify the epidemiology of the RRMI which translates to improper or lack thereof of resource-channelling structures towards prevention and rehabilitation of RRMI (Lopes et al., 2012).

Some studies defined athletic injuries as “an event that forces an athlete to either stop the current training/race or prevent the return of the athlete to training or racing” (Korkia, Tunstall-Pedoe, & Maffulli, 1994).

Others defined RRMI as “injury to muscle, tendon, joints with or without bone involvement of the lower extremities including hip, groin, thigh, knee, leg, ankle, foot or toes that the runner attributed to running and that will cause reduction in speed, distance, duration and frequency of running” (Macera et al., 1989).

Taunton et al., (2002) defined running injury as:-

i. pain or symptoms during or immediately after a race,
ii. pain or symptoms within the approximate time span of beginning a race,
iii. injury was felt to be related to running or
iv. injury was significant enough to force the runner to stop running or
v. significantly reduce their running mileage and
vi. Seek medical assistance.

As shown above, it is clearly evident that the definition of RRMI varies remarkably from study to study (Rachun, 1976). The fact that most examination methods used to define or diagnose these injuries have not been scientifically evaluated hence may not be reproducible was explained in a sports medicine book (Michael Kjaer et al., 2003). Nevertheless, almost all studies agree that most RRMI are of overuse in nature, affecting the musculoskeletal system of the lower limbs and especially the knee (W. van Mechelen, H. Hlobil, H. C. G. Kemper, W. J. Voorn, & H. R. de Jongh, 1993).

Running injuries can further be categorized according to preferred event, type of injury and mode of treatment and disposition (Brubaker & James, 1974).

In reference to local literature, the demographic characteristics of elite Kenyan runners has been described as being composed of a group of people from the Rift Valley province of Kenya, of the Kalenjin ethnicity, Nandi sub-tribe and from the Nilotic origin who mainly used running as the mode of travel to school (Vincent O. Onywera, 2006). A study done through MTRH found that there was a lower incidence of lower limb overuse injuries among habitually barefoot individuals as compared to the shod (Makokha, 2012b)

2.4 Epidemiology of RRMI including risk factors

It has been found that running is intermediate between contact and non-contact sports activities in terms of causing injury (Raskin & Rebecca, 1983). Overall, it takes the fourth place in terms of sports injury risks (Willem van Mechelen et al., 1993). The annual rates of RRMI range between 24% and 65% (Taunton et al., 2002). Other studies have quoted annual rates of lower extremities injuries from 19% to 75% (Jakobsen BW, 1994; Macera et al., 1989; Maughan & Miller, 1983; Van Middelkoop et al., 2008b).

The injuries can further be divided into "acute" (simple traumatic event to hinder integrity of MSS) or "overuse" (when no such event is identified). These have also been classified as either "macro-trauma" or "micro-trauma" respectively (Michael Kjaer et al., 2003). Most RRMI have been reported to be of the overuse nature ranging from 40% to 75% (Brubaker & James, 1974; Lopes et al., 2012; Taunton et al., 2002; W. van Mechelen et al., 1993).

Men have been linked to more RRMI than females (ratio of up to 4:1) in most of the studies (DeHaven & Lintner, 1986; Korkia et al., 1994; Owoeye, 2010a). It has been noted recently that females are tending to become more athletically active than men and hence with increasing number of injuries (DeHaven & Lintner, 1986). On the other hand, some studies have shown that women are more prone to sustaining RRMI (Lysholm & Wiklander, 1987; Taunton et al., 2002). Men seem also to have an increased risk of developing hamstring and calf injuries while most women sustain hip injuries (Satterthwaite et al., 1999). This article also adds that long distance running has more RRMI incidences than shorter distances. Rates of injury of up to six times higher have been reported during racing as compared to during training while higher educational level was associated with being protective against RRMI (M. Van

Middelkoop, J. Kolkman, J. Van Ochten, S. M. Bierma-Zeinstra, & B. W. Koes, 2008a).

In reference to the incidences of RRMI, a systemic review by Lopes et al., (2012) explains how many studies usually report a very large variation of the references. He states that the variations are mainly because of the differences in both the subject characteristics and the definition of the RRMI. In this review, the incidence ranges from 18.2% to 92.4% or 6.8 to 59 injuries for every 1000 hours of exposure to running. An incidence of 37%-56% and a higher prevalence in females (68%) than men (59%) was reported by (Gallo, Plakke, & Silvis, 2012). Other authors put it as yearly incidences for example 37%-56% (W. van Mechelen et al., 1993). In Kenya, a 90% incidence was reported in a website (athleticskenya, 2014).

The most commonly injured anatomical site is the lower extremities in particular the knee where patellofemoral syndrome and patella tendinopathies as well as medial tibial stress syndromes have been identified (Lopes et al., 2012; Taunton et al., 2002; van Gent et al., 2007; W. van Mechelen et al., 1993).

It has also been noted that training errors account for up to 60%-72% of the injuries (Gallo et al., 2012; James, Bates, & Osternig, 1978; Lehman, 1984; Lysholm & Wiklander, 1987). This explains why experienced runners are less prone to injuries, a condition that has been termed “survival phenomenon” (Satterthwaite et al., 1999). The article by James et al., (1978) tries to explain how the forces on the foot while running are translated to the knee hence the higher injury rates to the knee. He also coined the term “mileage mania” as an assumption by runners that the more distance they run during training the better their performance which in contrast, as seen earlier has been linked to higher incidences of RRMI.

Other risk factors that have been associated with RRMI include greater age, training hours, speed, history of previous injuries and biomechanical factors like limb length discrepancies, Q-angle abnormalities and foot arch malpositions (Hoeberigs, 1992; Makokha, 2012a; Murphy, Connolly, & Beynnon, 2003; Taunton et al., 2002).

In a systemic review of risk factors for RRMI, van Gent et al., (2007) classifies the risk factors into four:

i. Systemic factors; runners' age was both protective and as a risk factor while heavier runners had less foot injuries. A height of more than 1.7m in males was a risk factor while BMI of more than 26kg/m^2 was protective.
ii. Running/ training factors: a longer training distance/week was protective for knee injuries while longer hours/week was a risk for thigh injuries.
iii. Health factors: history of previous injuries was a risk for RRMI.
iv. Lifestyle: smoking and alcohol were found to be associated with RRMI

On the other hand, it has been stated that RRMI are commonly multifactorial due to either intrinsic or extrinsic factors (Kannus, 1997). The intrinsic factors are inborn and include age and musculoskeletal abnormalities like foot abnormalities (Daniel E. Lieberman, 2015). Extrinsic factors include training errors, poor equipments like shoe types and the training environment.

2.5 Management of RRMI

Four stages/steps of preventing RRMI have been described (Willem van Mechelen et al., 1993). Initially one should establish the severity/incidence of the RRMI then identify the aetiology and mechanism of injury. This should be followed by appropriate

interventions and finally the evaluation of these interventions. Jakobsen et al., (1994) compared a group of runners who had had a preventive training regime to a non-interventional group and found that there was a significantly lower rate of injury in the interventional group.

Not many studies included treatment modalities due to the mere fact that these vary greatly according to the injury types and the physicians' choice of management. Macera et al., (1989) reports that 12%-44% of RRMI require medical attention while a more recent study by Rolf (1995) indicated that up to 70% of runners would need treatment of the injuries because of their dire consequences as seen earlier. Overall, more injuries were treated conservatively than surgically (Brubaker & James, 1974). Under conservative, rest was the preferred choice followed by physiotherapy. Other modes of treatment included use of analgesics, steroids, orthotics, cryotherapy, bandaging and massage (Gallo et al., 2012; Owoeye, 2010a; Sandmeier & Renström, 1997). Caution should be taken especially with the use of local steroid injections as these may cause rupture of tendons after prolonged use (Fredberg, 1997).

A book by Peter Brukner and Karim Khan; Clinical Sports Medicine, 3rd edition, summarizes the treatment modalities in the following list:-

i. RICE- the use of rest, ice, compression and elevation assists in decreasing extent of injuries.
ii. Immobilization/ early mobilization techniques
iii. Therapeutic drugs like GTN (Glyceryl TriNitrate) patches, sclerosing agents, glucosamine and others.
iv. Heat and cold application

v. Electrotherapeutic modalities like ultrasound, TENS(Transcutaneous Electric Nerve Stimulation), laser(light amplification by stimulated emissions of radiation) and magnetic therapy.

vi. Electrocorporal shock waves

vii. Manual therapy on joints, muscles and nerves.

viii. Acupuncture

ix. Dry needling

x. Hyperbaric oxygen therapy

xi. Surgery may be open or arthroscopic for both acute or overuse RRMI and will be discussed later in this chapter.

The book also emphasizes on effectiveness of treating RRMI as it contradicts many who believe that most RRMI may require no treatment after all because of the aphorism "time heals and the physician sends the bills" or in other terms "therapeutic nihilism". Of course this has been overruled by the overwhelming evidence for exercises (physical activity) as a determinant of healthy living as described previously.

As seen earlier, RRMI increase with increased training (James et al., 1978; Macera et al., 1989; Willem van Mechelen et al., 1993). This is usually as a result of breakdown of tissues following intense workout hence the need for adequate recuperation time to regenerate and strengthen in a "balanced" fashion (Orlando, Levitan, Mittleman, Steele, & Shrier, 2011). This article demonstrates that injuries are prone to occur immediately post-break and that longer breaks do not reduce the incidences. It recommends a one day weekly break for every four to six weeks in order to prevent injuries. In one study, muscle flaps were used to demonstrate the ability of skeletal muscles to regenerate given the adequate environment including recuperation time (Carlson & Faulkner, 1983).

A Cochrane review that compared interventions for preventing RRMI found that exercises including stretching, training schedules and footwear had no positive evidence while orthoses especially patellofemoral braces were associated with reduced anterior knee pain (Yeung, Yeung, & Gillespie, 2011).

Some studies propose the need for multidisciplinary approach including thorough investigations to prevent permanent disabilities arising from injuries (Muschaweck, Gollwitzer, & Conze, 2015). This was seen especially in the management of groin injuries where misdiagnosis may lead to periarthritic hip diseases sometimes leading to arthrodesis of the hip. Ultrasonography has been indicated in the evaluation of muscular injuries and may be used to predict indications for surgery (Fornage, Touche, Segal, & Rifkin, 1983).

Surgery in most cases is the last option especially for overuse injuries (Sandmeier & Renström, 1997). Acute injuries like complete tendon ruptures may prompt urgent repair with success rates of up to 85%. Surgical management options include arthroscopic and open approaches. Arthroscopy is done for removal of loose bodies within joints and repair, removal or reconstruction of torn structures. Open surgery is done following acute trauma to recreate pre-injury anatomy and also for treating overuse RRMI especially following failed conservative management for example fasciotomy for MTSS with excellent outcomes reported (Mubarak, Gould, Lee, Schmidt, & Hargens, 1982). Arthroscopic surgical procedures are nowadays favoured in sports medicine because of low complication rates though they are currently very costly in this part of the world (Khan, 2008).

CHAPTER THREE: METHODOLOGY

This chapter outlines the methods used in conducting the study in terms of study design, study site, study population, sampling technique, eligibility criteria, sample size and data management and analysis.

3.1 Study Design

This was a cross-sectional descriptive study whereby the investigator visited the different training camps and met each of the runners so as to collect data.

3.2 Study Site

The study was carried out at the various training camps within the North Rift (NR) region of Kenya. The North Rift used to be part of the Rift Valley Province which lies in the western part of Kenya. It is bordered by Sudan in the north and Uganda in the west. Eight counties are found within NR including, Nandi, UasinGishu, Elgeyo Marakwet, Pokot, Trans Nzoia, Mount Elgon, Turkana and Baringo. It is a region of rugged terrain, spectacular landforms, great differences in altitude and climate and a wide variety of peoples and cultures. Several camp sites for athletes are distributed throughout the region including Iten, Kapsabet, Nandi hills, Kaptagat and other areas within Uasin Gishu but most of them are concentrated within and around Eldoret town. The sites' altitudes vary greatly from as low as 1500m above sea level in the environs of Kapsabet to as high as 2500m to 3000m in Iten and Marakwet. So does the climate which changes abruptly from regions of cool and wet climate to those of hot and dry (John.E.B.Williams, 2013). The specific training camps where data was collected have been described under sampling technique to follow.

Most of the training camps were found to be rental houses in the form of several single or double rooms within a compound. These rooms were used for resting/sleeping as well as for massage purposes and as gymnasiums. The camps were strategically close

to the long and winding tracks that were used by the locals as pathways. These tracks were rough and rugged going through and around the hilly terrains. Only a few of the camps were specifically structured for training being either sponsored facilities by donors or as cost sharing establishments by some of the elite veterans in the field of running. Some of the training camps are well known worldwide such as the Rosa and Lornah Kiplagat Clubs. A photograph of a typical training camp is attached in this thesis as appendix 10.

3.3 Study Population

The study was targeting the runners available at that particular time of visit to the camps. These runners were both men and women of different ages, experiences in terms of number of years in the field and preferences in the types of races.

3.4 Sampling Technique

A purposive sampling technique was used to determine the camps to be visited which included 4 camps in UasinGishu, 3 in Nandi Hills (Kapsabet), and 3 in Elgeyo Marakwet (Iten) counties due to the fact that they have the highest numbers of runners training there. The rest of the counties in NR were left out because they were far and had widely spaced camps with few runners that would mean inadequate returns for effort. Information that had been gathered from a pilot study indicated that about 10-15 runners trained in each of the 10 camps above. Thereafter, all the runners found within the selected camps were interviewed following an eligibility criterion.

3.5 Eligibility Criteria

3.5.1 Inclusion Criteria

All athletes found at the selected training camp sites during data collection were included in the study.

3.5.2 Exclusion Criteria

i. Runners below 16 years of age (limiting the study to senior athletes only and excluding the juniors).

ii. Non-Kenyan athletes.

iii. Runners with disabilities (considered under Special Para-Olympics).

3.6 Sample Size:

An estimate of the number of runners to be interviewed was arrived at following a pre-study survey of the selected camps as mentioned above. Approximately 150 runners train in the selected camps and this will therefore be used as the estimated sample size.

In order to be 95% sure that the prevalence of running related musculoskeletal injuries among the athletes in the North Rift Region is within plus or minus 5% of the population prevalence of 24% (Taunton et al., 2002). The researcher estimated the sample size using the following formula (Cochran, 1963);

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta} \right)^2 \times P(1-P)$$

$$= \left(\frac{1.96}{0.05} \right)^2 \times 0.24 \times 0.76$$

$$= 281$$

Where,

$Z_{1-\alpha/2}$ is the $\left(1-\alpha/2\right)\times 100\%$ quantile of the standard normal distribution, P = 24% is the prevalence of running related musculoskeletal injuries, $\delta = 5\%$ is the margin of error.

Correcting for finite population size of 150 (10 camps x 15 runners) gave a sample size of

$$n \Big/ 1+\frac{n}{N} = 281 \Big/ 1+\frac{281}{150} = 98$$ As the minimum number that can be recruited.

3.7 Data Collection and Management:

Following approval by IREC (letter attached in appendix 11; approval no. 0001502), to conduct the study and signing of an informed written consent by the runners, an interviewer-administered questionnaire was used to collect data from the runners. All questionnaires were filled by the principal investigator Dr. Mbarak Abeid during the visits to the various camps. This process was undertaken in a span of eight weeks during the month of January to March 2016 after the December holidays considered by many of the runners as rest days.

A sample questionnaire is attached with this thesis in appendix 1. It entailed three sections as per the objectives of this study which included the demographics of the runners, the RRMI pattern and treatment modalities used. Measurements such as height and weight were taken and recorded using the standard weighing machine and heightometer provided by COBES offices of Moi University.

Q-angle abnormalities were predicted by using the 8˚ angle template that had been cut-out by the researcher with the use of a goniometer. During use, the apex of the template was placed at the centre of the patella of the left knee along an imaginary line from the anterior superior iliac spine then position of tibial tubercle confirmed. This was performed on a sitting subject. Angles greater than the template were considered abnormal while those within the size of the template were normal.

Foot arch abnormalities were only observed since a study of the same had recently been conducted at MTRH (Makokha, 2012b). This was done while the runner was standing barefoot on the weighing machine. Exaggerated arches more than 5 centimetres in height were marked as high arched while flat feet were marked as low arched. All those in between were considered normal arched feet.

Collected data was entered into a database. The data was de-identified and the databases encrypted to ensure confidentiality is maintained. Data was accessed by the principal investigator only. The data collection tools were kept in safe cabinets under lock with key kept by the investigator to ensure safety and confidentiality. The databases were also backed up to avoid loss of data.

Data was analyzed using software for statistical analysis and computing known as R version 3.2.4 (R-CORE, 2016). Categorical variables were summarized as frequencies and the corresponding percentages. Continuous variables that assumed the Gaussian distribution were summarized as mean and the corresponding standard deviation (SD) or (Mean ± SD) while those that violated the Gaussian assumptions were summarized as median and the corresponding inter quartile range (IQR). Gaussian assumptions were assessed empirically using Shapiro-Wilk test for normality. Comparison of mean differences was done using two sample t-test while association between categorical variables was assessed using Fisher's exact test. Results were presented using tables and graphs.

3.8 Ethical Consideration

Approval to carry out the study was sought from the Institutional Research and Ethics Committee (IREC) as per attached approval letter no. 0001502 in appendix 11. All athletes' reports were kept confidential and the data obtained was password coded. Informed consent was sought from the athletes and they were assured of their confidentiality. No coercion or inducement of the athletes was done and the runners were made to understand that they were free to withdraw at any time without any repercussions. Collected data was only available to the investigator and the supervisors.

The research was compiled into a thesis report which has been submitted in partial fulfilment of the MMED orthopaedic program. The researcher is also intending to publish this report through sports and orthopaedic journals locally and internationally.

3.9 Limitations of the Study

This being a cross-sectional study, biases especially of the recall nature were prone (up to 12%) within 1 year of injury as quoted by Lopes et al., (2012), though the researcher hypothesised that due to the fact that most of these athletes hold dearly their running as a livelihood/occupation (Vincent O. Onywera, 2006), it will be unlikely for the athlete to forget the injuries he/she sustained.

It was also almost impossible to obtain more information from the health facilities visited by the runners as they did not visit a specific facility and that the facilities could be far and wide.

The bias was however mitigated through the use of the following quality control measures:

i. Use of credible medical records: if available, records such as X-ray films and discharge summaries to show diagnosis and/or treatment given.
ii. Athlete's running history: Since injuries tend to reduce athletes' running mileage (Taunton et al., 2002).
iii. Limiting injuries to the last three years (only injuries occurring within the period of county governance following the Kenyan general elections of year 2013 were considered so as to improve recall).
iv. Physical examination for presence of surgical marks that may suggest surgical interventions done.

CHAPTER FOUR: RESULTS

4.1: RESULTS ON SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE RUNNERS

Table 1: Socio-Demographic characteristics

Variable		Mean ± SD or Median (IQR)or n (%)
Age (years)		26.5 ± 4.1
Males		91 (84.3%)
Females		17 (15.7%)
Occupation	Military	4 (13.3%)
(n = 30)	Farmer	11 (36.7%)
	Business	2 (6.7%)
	Police	8 (26.7%)
	Salonist	1 (3.3%)
	Physiotherapist	1 (3.3%)
	Student	2 (6.7%)
	Football	1 (3.3%)
Education level	Primary	28 (25.9%)
	Secondary	61 (56.5%)
	College	19 (17.6%)
Married		45 (41.7%)
Have children		49 (45.4%)
Number of children (n = 49)		2.0 (1.0, 2.0)
Weight (Kgs)		56.8 ± 6.5
Height (meters)		1.7 ± 0.1
BMI (Kgs/m^2)		19.4 ± 1.6

A total of 108 participants were included in the study. Of this number, 91 (84.3%) were male. Only 30 (27.7%) were performing activities other than running most of whom were civil servants 12 (40.0%) followed by farmers 11 (36.7%). More than half had secondary level of education. 45 (41.7%) were married and 49 (45.4%) had children. The median number of children was 2.0 (IQR: 1.0, 2.0). The median weight and height were 56.0 (IQR: 52.8, 60.3) kilograms and 1.7 (IQR: 1.6, 1.8) meters respectively. While BMI was 19.4 (IQR: 17.8, 21.0) Kgs/m^2.

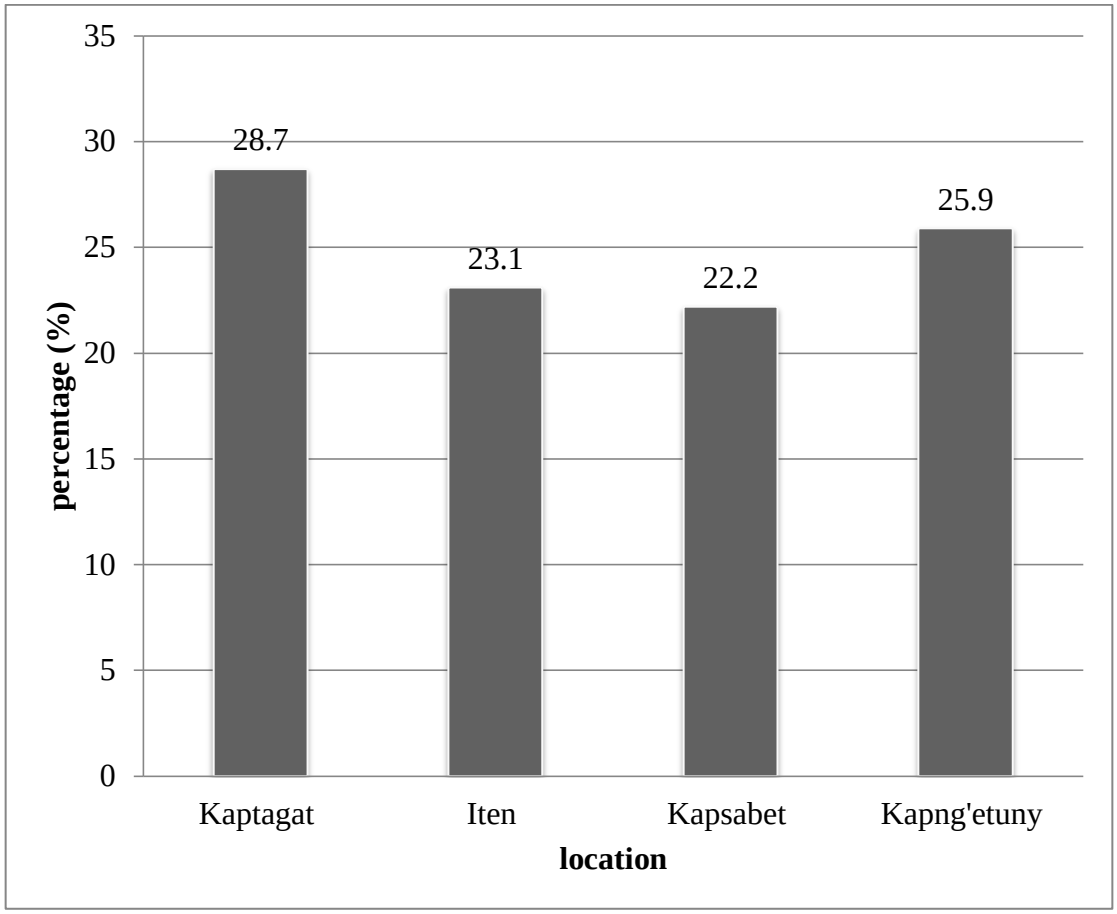

Figure 1: Number/percentage of runners in each location of training

Relatively similar proportions were training in the four locations that were visited.

Table 2: Training camp sites visited

County	Location		Site/ Club	n (%)
Uasin Gishu	Kapng'etuny	28 (25.9%)	Kapng'etuny	28 (100.0%)
	Kaptagat	31 (28.7%)	Kony club	18 (58.1%)
			Global	7 (22.6%)
			One for one	6 (19.4%)
Elgeyo-Marakwet	Iten	25 (23.1%)	Main club	17 (68.0%)
			Iten club	4 (16.0%)
			St. Patrick/Kimbia club	4 (16.0%)
Nandi	Kapsabet	24 (22.2%)	Rosa club	11 (45.8%)
			Global mbio/ Adidas/ Nike	8 (33.3%)
			Mosoriot club	5 (20.8%)

The training camp that had the highest number of runners was in Kapng'etuny where about a quarter of all the subjects in this study were found. The rest of the camps in the different locations within NR region were scattered with varying numbers of runners.

The camps were mostly rental houses close to the town centers. Most of the runners, if in case were coming from far, would stay within the camps for more than a week before going back home. Once the runners converge in the camps, they would perform their routine training schedules as a group from the time they wake up at 5 or 6 o'clock in the morning, go for the morning running and return by 8 or 9 o'clock to perform stretching exercises including massaging when and where available. This would be followed by a strict-diet breakfast of mostly porridge then either going back for a late morning run or rest till the afternoon run depending on the camp's routine. Their diet lunch was mostly boiled maize and beans sometimes with rice.

Running was performed on the footpaths that lead the runners into the interior of the towns and which were also being used by the locals as pathways. The pathways were uneven, rugged and muddy through the hilly terrains of the regions. A photograph of a typical camp is attached in appendix 10.

Table 3a: Type of Running Event

Variable		Median (IQR) or n (%)
Years in the field		5.0 (3.5, 7.5)
Ever competed in any national/international event		101 (93.5%)
Have family history of running		48 (44.4%)
Current Event type	Short distance (<1500m)	8 (7.4%)
	Medium (1500 – 5000m)	12 (11.1%)
	Long (10000 – 42000m)	69 (63.9%)
	Both short and medium	6 (5.6%)
	Both short and long	1 (0.9%)
	Both medium and long	12 (11.1%)
Preferred event	Short distance (<1500m)	0 (0.0%)
	Medium (1500 – 5000m)	13 (12.0%)
	Long (10000 – 42000m)	46 (42.6%)
Performed event	Short distance (<1500m)	13 (12.0%)
	Medium (1500 – 10000m)	67 (62.0%)
	Long (10000 – 42000m)	95 (88.0%)

The participants have been training for a median of 5.0 (IQR: 3.5, 7.5) years, and 101 (93.5%) have competed either nationally or internationally. Majority (63.9%) of the participants participate in long events/races (10000m – 42000m). Most participate in more than one event. All the participants participated in at least one event. However, 58 (53.7%) were able to give their preferred event. Forty eight (44.4%) of the participants have a family history of running.

Table 3b: Accolades

Variable	Median (IQR) or n (%)
Won Medals	41 (38.0%)
Won gold (n = 41)	27 (65.9%)
Number of gold won (n =27)	2.0 (1.0, 3.0)
Won silver (n = 41)	29 (70.7%)
Number of silver won (n = 29)	2.0 (1.0, 2.0)
Won bronze (n = 41)	23 (56.1%)
Number of bronze won (n =23)	1.0 (1.0, 2.0)

Forty one (38.0%) had won medals. Of this number, 27 (65.9%) had won a gold medal. The median number of gold medals won by a participant was 2.0 (IQR: 1.0, 3.0). Of the 41 who have ever won a medal, 29 (70.7%) and 23 (56.1%) won silver and bronze respectively. The median number of silver and bronze medals won were 2.0 (IQR: 1.0, 2.0), and 1.0 (1.0, 2.0) respectively.

Table 4: Training environment/ schedules

Variable		n (%)
Hours of training per week	<15	36 (33.3%)
	>=15	72 (66.7%)
Distance of training per week (km)	<150	26 (24.1%)
	>=150	82 (75.9%)
Have a qualified coach		73 (67.6%)
Train as a team		101 (93.5%)
Train on both hilly/rugged terrain and flat ground (track)		108 (100.0%)
Shoes used	All were Soled shoes	108 (100.0%)

Seventy two (66.7%) of the participants train for more than 15 hours per week while three quarters train for at least 150 kilometers every week.

Two thirds of the participants had qualified coaches training them in teams of between 1 to over 30 runners. 7 athletes trained individually while the rest, 101 (93.5%) train as a team. All the participants trained in a mixed terrain and wore soled shoes for training/ racing.

4.2: RESULTS ON CHARACTERISTICS OF RRMI

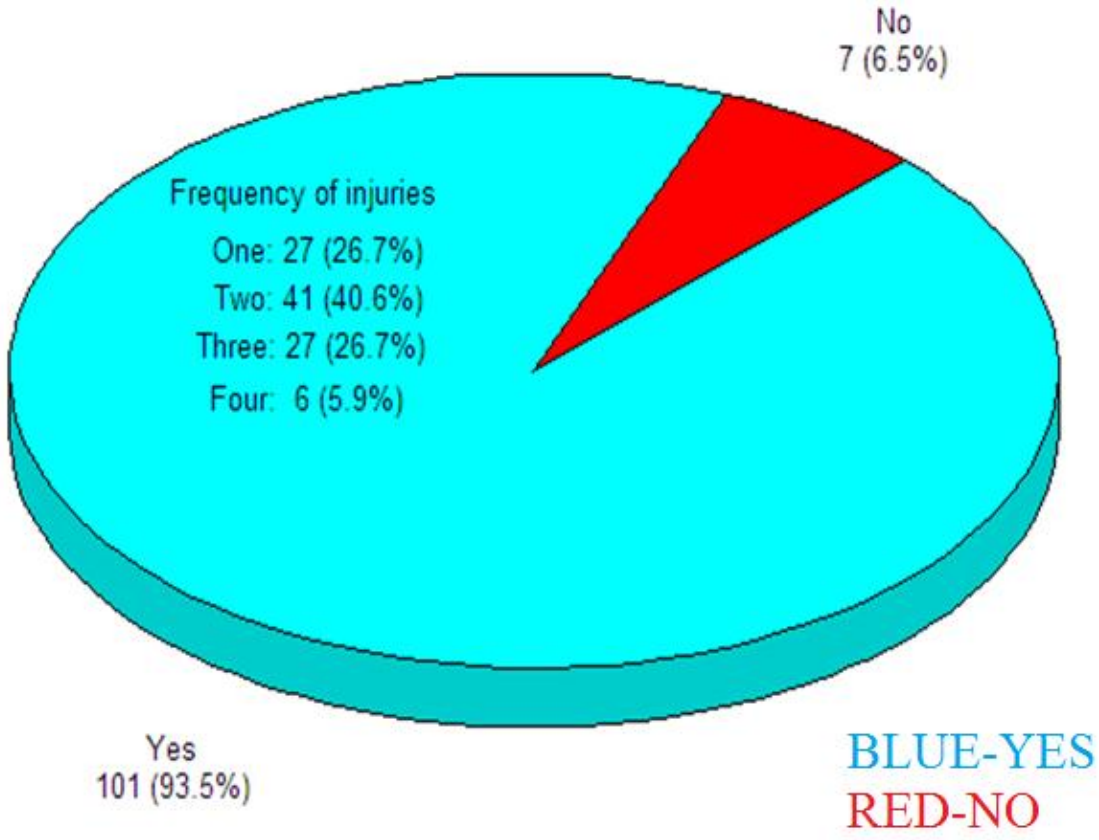

Figure 2: Injury sustenance and frequency of Injuries Sustained

Almost all the participants (93.5%) sustained an injury within the past 3 years with 73.3% of them having experienced multiple injuries.

Table 5: Site of the injury

Occurrence	Anatomical site of the injury	n (%)
1	Posterior thigh (hamstring)	43 (39.8%)
2	Knee	33 (30.6%)
3	Achilles tendon	30 (27.8%)
4	Groin	24 (22.2%)
5	Foot	16 (14.8%)
6	Ankle	14 (13.0%)
7	Hip	14 (13.0%)
8	Medial leg	14 (13.0%)
9	Lower back	9 (8.3%)
10	Anterior thigh (quadriceps)	5 (4.6%)
11	Anterior leg (peroneals)	5 (4.6%)
12	Posterior leg(calf)	4 (3.7%)
13	Medial thigh(adductors)	1 (0.9%)

There were a total of 212 injuries that were reported by the 101 (93.5%) of the participants. The anatomical site mostly injured was the hamstring (posterior of the thigh) sustained by 43 (39.8%). Close to one third of the participants (30.6%) had suffered a knee injury. The Achilles tendon injuries were reported by 30 (27.8%) of the participants while groin injuries 24 (22.2%) were fourth in occurrence. The least injured site was the medial thigh (adductors) reported by 1 (0.9%).

Table 6: Nature of the injury (soft tissue or fracture)

	Sample size	**Nature of injury**	
Site of the injury		**Soft tissue, n (%)**	**Fracture, n (%)**
Lower back	9	9 (100.0%)	0 (0.0%)
Hip	14	14 (100.0%)	0 (0.0%)
Groin	24	24 (100.0%)	0 (0.0%)
Posterior thigh(Hamstring)	43	43 (100.0%)	0 (0.0%)
Anterior thigh(quadriceps)	5	5 (100.0%)	0 (0.0%)
Medial thigh(adductors)	1	1 (100.0%)	0 (0.0%)
Knee	33	33 (100.0%)	0 (0.0%)
Anterior leg (peroneals)	5	5 (100.0%)	0 (0.0%)
Posterior leg(calf)	4	4 (100.0%)	0 (0.0%)
Medial leg	14	14 (100.0%)	0 (0.0%)
Ankle	14	14 (100.0%)	0 (0.0%)
Foot	16	15 (93.8%)	1 (6.2%)
Achilles	30	30 (100.0%)	0 (0.0%)

The participants reported that all the injuries were soft tissue related with the exception of one participant who had a fracture in the foot.

Table 7: Occurrence of the injury (event during injury)

	Sample size	**Occurrence**	
Site of the injury		**Training, n (%)**	**Race, n (%)**
Lower back	9	8 (88.9%)	1 (11.1%)
Hip	14	12 (85.7%)	2 (14.3%)
Groin	24	23 (95.8%)	1 (4.2%)
Posterior thigh (Hamstring)	43	39 (90.7%)	4 (9.3%)
Anterior thigh (quadriceps)	5	4 (80.0%)	1 (20.0%)
Medial thigh (adductors)	1	1 (100.0%)	0 (0.0%)
Knee	33	31 (93.9%)	2 (6.1%)
Anterior leg (peroneals)	5	3 (60.0%)	2 (40.0%)
Posterior leg (calf)	4	3 (75.0%)	1 (25.0%)
Medial leg	14	13 (92.9%)	1 (7.1%)
Ankle	14	14 (100.0%)	0 (0.0%)
Foot	16	15 (93.8%)	1 (6.2%)
Achilles	30	25 (83.3%)	5 (16.7%)
Total	212	191 (90.1%)	21 (9.9%)

Majority of the injuries suffered occurred during training (90.1%). The most common injury site occurring during the races was that of Achilles tendon though in terms of injury site proportions, the highest was anterior leg injury (40%) followed by the calf (25%). Overall, 21 (9.9%) injuries were sustained during the races and 191 (90.1%) during training.

Table 8: Impact of the injury

	Sample size	**Impact of injury on the race/training**	
Site of the injury		**Continuing, n (%)**	**Stopped, n (%)**
Lower back	9	8 (88.9%)	1 (11.1%)
Hip	14	10 (71.4%)	4 (28.6%)
Groin	24	20 (83.3%)	4 (16.7%)
Posterior thigh (Hamstring)	43	34 (79.1%)	9 (20.9%)
Anterior thigh (quadriceps)	5	5 (100.0%)	0 (0.0%)
Medial thigh (adductors)	1	1 (100.0%)	0 (0.0%)
Knee	33	27 (81.8%)	6 (18.2%)
Anterior leg (peroneals)	5	5 (100.0%)	0 (0.0%)
Posterior leg(calf)	4	3 (75.0%)	1 (25.0%)
Medial leg	14	11 (78.6%)	3 (21.4%)
Ankle	14	13 (92.9%)	1 (7.1%)
Foot	16	15 (93.8%)	1 (6.2%)
Achilles	30	19 (63.3%)	11 (36.7%)
Total	212	171 (80.7%)	41 (19.3%)

Most of the runners would continue with the training/racing even after sustaining injuries. The injury with the highest impact to make a runner stop their training/racing was that of Achilles tendon 11(36.7%) followed by hip injury 4(28.6%).

Table 9: Time before resuming usual activities

Anatomical site of the injury	Sample size	Time before resuming usual activities, Median (IQR) in days
Lower back	8	8.0 (4.0, 12.0)
Hip	11	8.0 (4.0, 32.0)
Groin	24	8.0 (4.0, 15.0)
Posterior thigh (Hamstring)	42	8.0 (2.0, 12.0)
Anterior thigh (quadriceps)	4	3.0 (1.8, 29.0)
Medial thigh (adductors)	1	3.0 (3.0, 3.0)
Knee	29	6.0 (3.0, 52.0)
Anterior leg (peroneals)	5	8.0 (6.0, 12.0)
Posterior leg (calf)	4	5.0 (3.5, 8.5)
Medial leg	14	8.0 (6.0, 12.0)
Ankle	13	8.0 (2.0, 52.0)
Foot	14	6.0 (4.0, 8.0)
Achilles	30	4.0 (3.3, 7.5)

Assessing time taken to resume usual activities shows that it took the participants an overall median of 6.0 (4.0, 12.0) days to resume usual training activities.

4.3: RESULTS ON ASSOCIATED RISK FACTORS OF RRMI

Table 10: Comparison of age, and types of events across gender

	N	Female	Male	P – value
Age, mean (SD)	108	24.8 (3.9)	26.7 (4.2)	0.049[t]
Short	15	3 (17.6%)	12 (13.2%)	0.702[f]
Medium	30	7 (41.2%)	23 (25.3%)	0.237[f]
Long	82	11 (64.7%)	71 (78.0%)	0.235[f]

"t" – two sample t-test; "f" – Fisher's exact test

Male participants were significantly older than the female participants, p = 0.049. The statistical power was 100.0%, evidence that the difference in age between male and female participants was the true differences.

Table 11: Comparison of the rates of injuries by gender

Site of injury	**Female (n = 17)**	**Male (n = 91)**	**[†]P-value**
Lower back	2 (11.8%)	7 (7.7%)	0.631
Hip	7 (41.2%)	7 (7.7%)	0.001
Groin	0 (0.0%)	24 (26.4%)	0.012
Posterior thigh (Hamstring)	7 (41.2%)	36 (39.6%)	1.000
Anterior thigh (quadriceps)	2 (11.8%)	3 (3.3%)	0.175
Medial thigh (adductors)	1 (5.9%)	0 (0.0%)	0.157
Knee	5 (29.4%)	28 (30.8%)	1.000
Anterior leg (peroneals)	0 (0.0%)	5 (5.5%)	1.000
Posterior leg (calf)	0 (0.0%)	4 (4.4%)	1.000
Medial leg	1 (5.9%)	13 (14.3%)	0.693
Ankle	1 (5.9%)	13 (14.4%)	0.461
Foot	2 (11.8%)	14 (15.4%)	1.000
Achilles	2 (11.8%)	28 (30.8%)	0.144

[†] - Fisher's Exact test

Female participants sustained more hip injuries compared to the male counterparts (41.2% vs. 7.7%, p = 0.001) while male compared to female suffered a higher rate of groin injuries (26.4% vs. 0.0%, p = 0.012).

Table 12: Comparison of the proportions with a professional coach between those who suffered the various types of injuries and those who did not

	Proportion with a professional Coach		Fisher's Exact test
Site of injury	**Injured**	**Not Injured**	**P-value**
Lower back	8 (88.9%)	65 (65.7%)	0.266
Hip	8 (57.1%)	6 (69.1%)	0.375
Groin	19 (79.2%)	54 (64.3%)	0.220
Posterior thigh (Hamstring)	29 (67.4%)	44 (67.7%)	1.000
Anterior thigh (quadriceps)	4 (80.0%)	69 (67.0%)	1.000
Medial thigh (adductors)	0 (0.0%)	73 (68.2%)	0.324
Knee	24 (72.7%)	49 (65.3%)	0.509
Anterior leg (peroneals)	4 (80.0%)	69 (67.0%)	1.000
Posterior leg (calf)	2 (50.0%)	71 (68.3%)	0.594
Medial leg	13 (92.9%)	60 (63.8%)	0.033
Ankle	8 (57.1%)	64 (68.8%)	0.379
Foot	10 (62.5%)	63 (68.5%)	0.773
Achilles	22 (73.3%)	51 (5.4%)	0.497

There was no statistical significant difference in the proportion of participants who had a professional coach among those who suffered an injury compared to those who did not suffer any injury except for injury of the medial leg. The results tell us that there is a significantly higher proportion of the participants with a professional coach among those who had suffered medial leg injury (92.9%) compared to those who had no injury (63.8%), $p = 0.033$. However, there was no sufficient statistical power to justify the differences, power = 74.7%. Thus the difference can be attributed to chance.

Table 13: Comparison of years of experience between those who suffered the various types of injuries and those who did not

	Years of experience, Median (IQR)		Wilcoxon Rank sum test
Site of injury	**Injured**	**Not injured**	**P-value**
Lower back	6.0 (5.0, 10.0)	5.0 (3.0, 7.0)	0.301
Hip	5.5 (3.0, 11.8)	5.0 (4.0, 7.0)	0.982
Groin	6.0 (4.0, 7.3)	5.0 (3.0, 7.3)	0.334
Posterior thigh (Hamstring)	5.0 (3.0, 6.5)	6.0 (4.0, 10.0)	0.257
Anterior thigh (quadriceps)	4.0 (1.0, 9.0)	5.0 (4.0, 7.0)	0.406
Medial thigh (adductors)	1.0 (1.0, 1.0)	5.0 (4.0, 7.5)	0.100
Knee	5.0 (4.0, 7.0)	5.0 (3.0, 7.5)	0.639
Anterior leg (peroneals)	6.0 (5.0, 13.0)	5.0 (3.5, 7.0)	0.390
Posterior leg (calf)	5.5 (3.0, 8.8)	5.0 (4.0, 7.0)	1.000
Medial leg	5.0 (4.0, 6.8)	5.5 (3.3, 8.0)	0.508
Ankle	5.5 (4.3, 6.8)	5.0 (3.0, 8.0)	0.900
Foot	4.0 (2.8, 5.5)	6.0 (4.0, 8.3)	0.083
Achilles	6.5 (4.3, 11.8)	5.0 (3.0, 7.0)	0.031

There was no statistical significant difference in the years of experience among those who suffered the injuries compared to those who did not except for the injury of the Achilles. The participants who had the injury of the Achilles had a significantly higher median years of experience, 6.5 (IQR: 4.3, 11.8) years compared to those who had not suffered injury of the Achilles, 5.0 (IQR: 3.0, 7.0), $p = 0.031$. The statistical power of the observed differences was however low, 52.8%, rendering the difference as having occurred due to chance.

Table 14: Risk of injury across the different types of events

Injury type	N	Short/Medium (n = 39)	Long (n = 82)	p-value
Lower back	9	6 (15.4%)	6 (7.3%)	0.288
Hip	14	4 (10.3%)	13 (15.9%)	0.584
Groin	24	7 (17.9%)	19 (23.2%)	0.677
Posterior thigh (Hamstring)	43	18 (46.2%)	31 (37.8%)	0.499
Anterior thigh (quadriceps)	5	2 (5.1%)	5 (6.1%)	-
Medial thigh (adductors)	1	0 (0.0%)	1 (1.2%)	-
Knee	33	16 (41.0%)	19 (23.2%)	0.070
Anterior leg (peroneals)	5	2 (5.1%)	3 (3.7%)	-
Posterior leg (calf)	4	0 (0.0%)	4 (4.9%)	0.391
Medial leg	14	3 (7.7%)	11 (13.4%)	0.538
Ankle	14	7 (17.9%)	12 (14.8%)	0.841
Foot	15	5 (12.8%)	12 (14.6%)	1.000
Achilles	30	9 (23.1%)	23 (28.0%)	0.720

There was no statistical significant difference in the risk of injuries between short or medium distant as compared to long distant runners ($p>0.05$), for all the injuries observed.

Table 15: Comparison of age between those who suffered the various types of injuries and those who did not

	Age, Mean (SD)		Two sample t-test
Site of injury	**Injured**	**Not injured**	**P-value**
Lower back	27.2 (3.9)	26.4 (4.2)	0.570
Hip	25.4 (4.5)	26.7(4.1)	0.324
Groin	26.7 (3.6)	26.4 (4.3)	0.787
Posterior thigh (Hamstring)	26.0 (4.3)	26.8 (4.0)	0.290
Anterior thigh (quadriceps)	24.2 (3.3)	26.6 (4.1)	0.181
Medial thigh (adductors)	23.0 (0.0)	26.5 (4.1)	-
Knee	26.6 (4.4)	26.5 (4.0)	0.919
Anterior leg (peroneals)	27.8 (5.4)	26.4 (4.1)	0.598
Posterior leg (calf)	29.3 (4.3)	26.4 (4.1)	0.272
Medial leg	27.1 (3.0)	26.4 (4.3)	0.410
Ankle	26.1 (4.0)	26.4 (4.1)	0.754
Foot	25.4 (4.3)	26.7 (4.1)	0.301
Achilles	27.2 (4.8)	26.2 (3.9)	0.290

There was no statistical significant difference in the mean age of those who suffered the injury compared to those who did not ($p>0.05$), for all the injuries observed.

Table 16: Comparison of BMI between those who suffered the various types of injuries and those who did not

	BMI, Mean (SD)		Two sample t-test
Site of injury	**Injured**	**Not injured**	**P-value**
Lower back	19.8 (2.1)	19.3 (1.6)	0.525
Hip	19.4 (2.1)	19.4 (1.5)	0.924
Groin	19.2 (1.8)	19.4 (1.6)	0.564
Posterior thigh (Hamstring)	19.1 (1.2)	19.5 (1.8)	0.133
Anterior thigh (quadriceps)	19.3 (0.7)	19.4 (1.6)	0.780
Medial thigh (adductors)	19.5 (0.0)	19.4 (1.6)	-
Knee	19.6 (1.6)	19.2 (1.6)	0.242
Anterior leg (peroneals)	19.9 (1.7)	19.3 (1.6)	0.527
Posterior leg (calf)	18.7 (0.9)	19.4 (1.6)	0.217
Medial leg	18.7 (1.5)	19.5 (1.6)	0.095
Ankle	19.0 (1.3)	19.4 (1.6)	0.291
Foot	19.0 (1.1)	19.4 (1.7)	0.229
Achilles	19.7 (1.8)	19.2 (1.5)	0.209

There was no statistical significant difference in the mean BMI for the participants in the two groups ($p>0.05$), for all the injuries observed.

Table 17: Comparison of rates of specific injuries across the locations of the camps

	Proportion of Injured in camp locations				
Site of injury	**Kaptagat (n =31)**	**Iten (n = 25)**	**Kapsabet (n = 24)**	**Kapng'etunyi (n = 28)**	**†P-value**
Lower back	4 (12.9%)	6 (16.0%)	0 (0.0%)	1 (3.6%)	0.111
Hip	2 (6.5%)	5 (20.0%)	3 (12.5%)	4 (14.3%)	0.515
Groin	8 (25.8%)	4 (16.0%)	8 (33.3%)	4 (14.3%)	0.331
Posterior thigh(Hamstring)	9 (29.0%)	11 (44.0%)	12 (50.0%)	11 (39.3%)	0.435
Anterior thigh(quadriceps)	3 (9.7%)	0 (0.0%)	1 (4.2%)	1 (3.6%)	0.465
Medial thigh (adductors)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.6%)	0.713
Knee	10 (32.3%)	12 (48.0%)	6 (25.0%)	5 (17.9%)	0.117
Anterior leg (peroneals)	1 (3.2%)	2 (8.0%)	1 (4.2%)	1 (3.6%)	0.867
Posterior leg (calf)	2 (6.5%)	0 (0.0%)	0 (0.0%)	2 (7.1%)	0.334
Medial leg	4 (12.9%)	3 (12.0%)	6 (25.0%)	1 (3.6%)	0.156
Ankle	2 (6.7%)	3 (12.0%)	5 (20.8%)	4 (14.3%)	0.507
Foot	3 (9.7%)	6 (24.0%)	2 (8.3%)	5 (17.9%)	0.370
Achilles	10 (32.3%)	10 (40.0%)	4 (16.7%)	6 (21.4%)	0.257

† - Fisher's Exact test

There was no statistical significant difference in the rates of injuries among the training sites ($p>0.05$)

4.4: Results on Treatment Modalities Used By The Runners Following RRMI

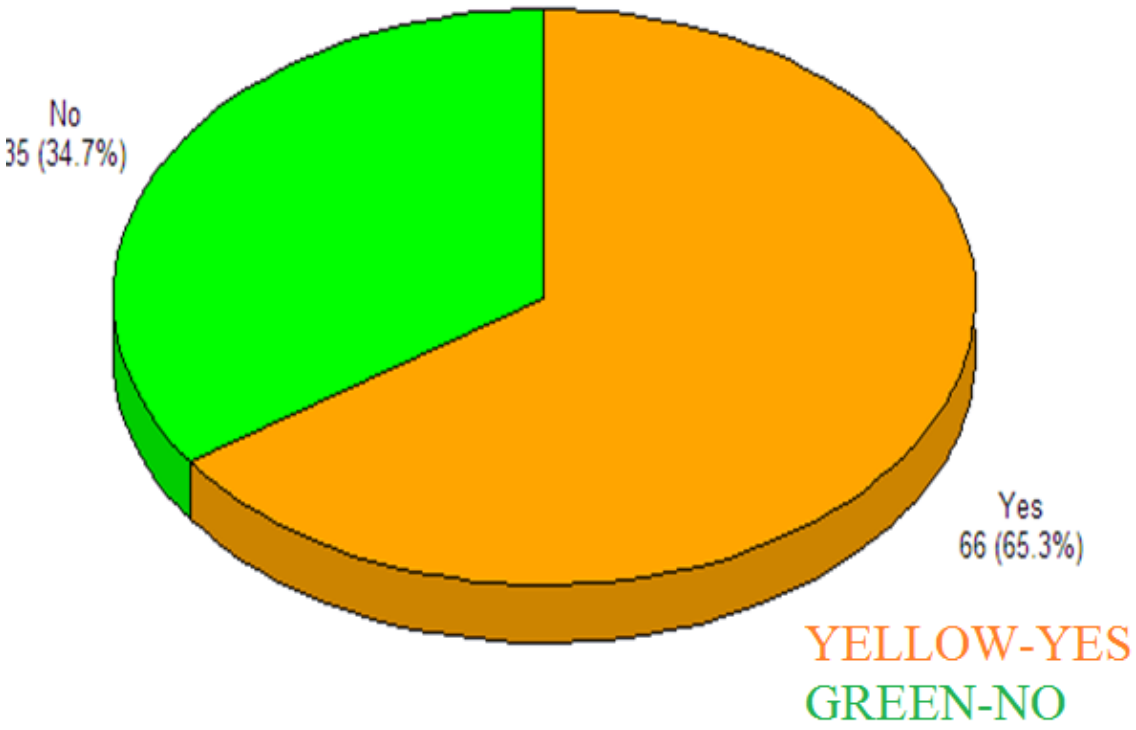

Figure 3: Runners who performed first aid

Close to two thirds (65.3%) of the participants who suffered an injury performed first aid on themselves or done by fellow runners and/ or physiotherapist if available at the place of injury.

Table 18: First aid treatment for the injury

Site of injury	First Aid	Sample size	Percent who did first aid	n (%)
Lower back	Rub	9	2 (22.2%)	2 (100.0%)
Hip	Sprays			1 (16.7%)
	Rub	14	6 (42.9%)	3 (50.0%)
	Ice			1 (16.7%)
	Hot water			1 (16.7%)
Groin	Cold packs			1 (7.7%)
	Rub	24	13 (54.2%)	10 (76.9%)
	Ice			2 (15.4%)
Posterior thigh(hamstring)	Sprays			1 (4.2%)
	Rub	43	24 (55.8%)	22 (91.7%)
	Ice			1 (4.2%)
Anterior thigh(quadriceps)	Sprays			0 (0.0%)
	Rub	5	1 (20.0%)	1 (100.0%)
	Ice			0 (0.0%)
Medial thigh(adductors)	Rub	1	1 (100.0%)	1 (100.0%)
Knee	Cold packs			2 (13.3%)
	Rub	33	15 (45.5%)	11 (73.3%)
	Ice			1 (6.7%)
	Hot water			1 (6.7%)
Anterior leg(peroneals)	Cold packs			1 (50.0%)
	Rub	5	2 (40.0%)	1 (50.0%)
Posterior leg(calf)	Cold packs			
	Rub	4	4 (100.0%)	4 (100.0%)
	Ice			
Medial leg	Cold packs			1 (8.3%)
	Rub	14	12 (85.7%)	12 (91.7%)
	Ice			0 (0.0%)
Ankle	Rub			4 (80.0%)
	Ice	14	5 (35.7%)	1 (20.0%)
Foot	Cold packs			1 (14.3%)
	Rub	16	6 (43.8%)	6 (85.7%)
Achilles	Cold packs			3 (12.0%)
	Sprays	30	26 (86.7%)	2 (8.0%)
	Rub			16 (64.0%)
	Ice			4 (16.0%)

The first aid modality most commonly used by the runners was the use of rubbing medicated ointments over the injury site then followed by use of ice. First aid was done mostly within the training camps performed either by the same individual or by a training mate.

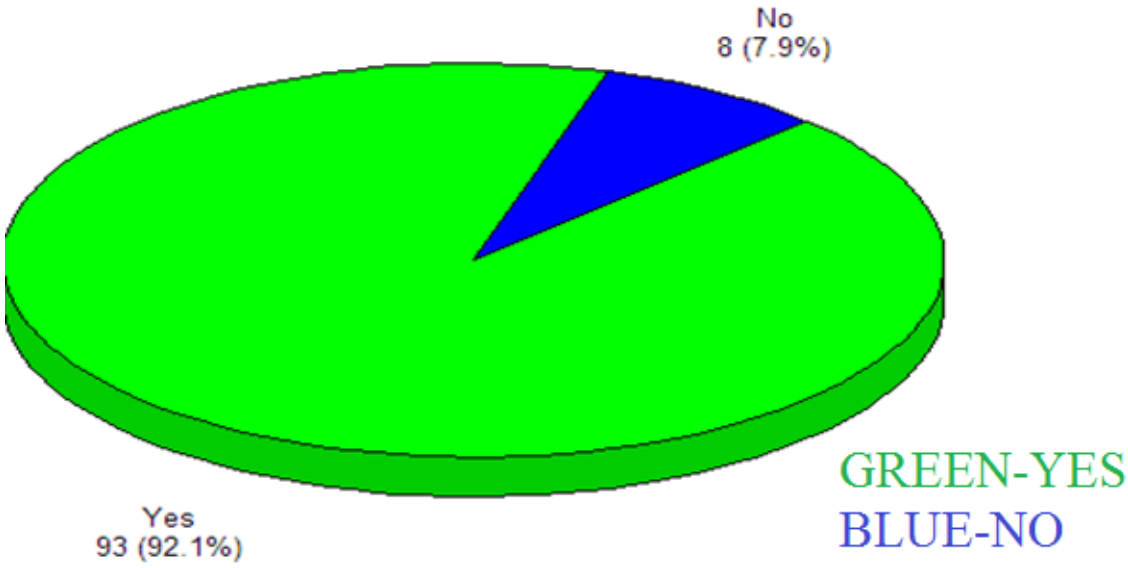

Figure 4: Need for further treatment of the injury
Over 90% of the participants who suffered an injury sought further treatment.

Table 19: Further treatment

Site of injury	Further treatment done	Sample size	n (%)
Lower back	Physiotherapy/massaging	9	9 (100.0%)
Hip	Rest	13	1 (7.7%)
	Physiotherapy/massaging		12 (92.3%)
Groin	Physiotherapy/massaging	17	17 (100.0%)
Posterior thigh(hamstring)	Physiotherapy/massaging	36	36 (100.0%)
Anterior thigh(quadriceps)	Physiotherapy/massaging	5	4 (80.0%)
Medial thigh(adductors)	Physiotherapy/massaging	1	1 (100.0%)
Knee	Physiotherapy/massaging	26	25 (96.2%)
	Surgery		1 (3.8)
Anterior leg(peroneals)	Physiotherapy/massaging	3	3 (100.0%)
Posterior leg(calf)	Physiotherapy/massaging	4	4 (100.0%)
Medial leg	Analgesics		2 (15.4%)
	Physiotherapy/massaging	13	11 (84.6%)
Ankle	Analgesics		1 (9.1%)
	Physiotherapy/massaging	11	10 (90.9%)
Foot	Analgesics		2 (15.4%)
	Physiotherapy/massaging	13	11 (84.6%)
Achilles	Physiotherapy/massaging	29	29 (100.0%)

The main type of treatment the participants received regardless of the anatomical site of the injury was Physiotherapy blended with massage. 5 out of 93 of the participants (5.4%) received analgesics. One of the participants who had an injury of the knee had surgery. Physiotherapy was predominantly done within the camps at non-specific times following injury and was performed by mostly a physiotherapist who was permanently available or one who would often visit then charge a fee per session per runner. Only one camp had physiotherapy equipment to assist the care givers in performing therapeutic and rehabilitative procedures. Almost all of the camps had a gymnasium equipped with home-made cement weights and wooden planks for stretching. About 3 camps had access to sets of metal weights for muscle strengthening and rehabilitative purposes.

Table 20: Place of treatment among those who sought further treatment

Injury	Sample size	Place of treatment Public	Private	Abroad	Camp
Lower back injury	4	0 (0.0%)	0 (0.0%)	2 (50.0%)	2 (50.0%)
Hip injury	3	0 (0.0%)	0 (0.0%)	2 (66.7%)	1 (33.3%)
Groin injury	8	1 (12.5%)	3 (37.5%)	0 (0.0%)	4 (50.0%)
Thigh (hamstring)	14	3 (21.4%)	3 (21.4%)	2 (14.3%)	6 (42.9%)
Thigh (anterior)	1	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Thigh (medial)	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Knee	12	0 (0.0%)	7 (58.3%)	1 (8.3%)	4 (33.3%)
Leg (Anterior)	2	0 (0.0%)	2 (100.0%)	0 (0.0%)	0 (0.0%)
Leg (Posterior)	1	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)
Leg (medial)	7	0 (0.0%)	1 (14.3%)	0 (0.0%)	6 (85.7%)
Ankle	5	0 (0.0%)	3 (60.0%)	0 (0.0%)	2 (40.0%)
Foot	3	0 (0.0%)	2 (6.7%)	0 (0.0%)	1 (33.3%)
Achilles	12	0 (0.0%)	4 (33.3%)	3 (25.0%)	5 (41.7%)
Total	72	4 (5.6%)	25 (34.7%)	11 (15.3%)	32 (44.4%)

A total of 72 injuries were treated either in the camp, abroad, private or public hospitals. Most of the treatment was conducted within the camps 32 (44.4%) followed by the private hospitals 25 (34.7%). The least place sought for treatment was in the public hospitals 4 (5.6%). Only 40(19%) of the total RRMI were treated within a hospital.

Table 21: Approximate cost of treatment

	Sample size	Approximate cost for treatment x 1000 (Ksh.)		
Injury		**<50**	**50 – 100**	**>100**
Lower back injury	2	0 (0.0%)	0 (0.0%)	2 (100.0%)
Hip injury	2	0 (0.0%)	0 (0.0%)	2 (100.0%)
Groin injury	6	3 (50.0%)	0 (0.0%)	3 (50.0%)
Thigh (Hamstring)	11	8 (72.7%)	0 (0.0%)	3 (27.3%)
Thigh (anterior)	1	0 (0.0%)	0 (0.0%)	1 (100.0%)
Thigh (medial)	0	0 (0.0%)	0 (0.0%)	0 (0.0%)
Knee	8	4 (50.0%)	0 (0.0%)	4 (50.0%)
Leg (Anterior)	2	0 (0.0%)	1 (50.0%)	1 (50.0%)
Leg (Posterior)	1	1 (100.0%)	0 (0.0%)	0 (0.0%)
Leg(Medial)	4	3 (75.0%)	0 (0.0%)	1 (25.0%)
Ankle	4	4 (100.0%)	0 (0.0%)	0 (0.0%)
Foot	3	1 (33.3%)	0 (0.0%)	2 (66.7%)
Achilles	9	6 (66.7%)	0 (0.0%)	3 (33.3%)
Total	53	30 (56.6%)	1 (1.9%)	22 (41.5%)

Of the participants injured, 35 (34.7%) provided the approximate treatment cost. This represented 53 (25%) of the total injuries reported by all the runners. The rest either were not able to recall the exact amount spent or were still indebted. The cost of treatment was more than Ksh. 100, 000 for 22 (41.5%) of the 53 injuries that had further treatment sought.

Table 22: Return to usual activities

	Sample size	**Return to usual activities**	
Injury		**Before complete healing**	**After**
Lower back injury	9	9 (100.0%)	0 (0.0%)
Hip injury	12	11 (91.7%)	1 (8.3%)
Groin injury	23	23 (100.0%)	0 (0.0%)
Thigh (Hamstring)	38	37 (97.4%)	1 (2.6%)
Thigh (Anterior)	5	5 (100.0%)	0 (0.0%)
Thigh (medial)	1	1 (100.0%)	0 (0.0%)
Knee	31	27 (87.1%)	4 (12.9%)
Leg (Anterior)	4	2 (50.0%)	2 (50.0%)
Leg (posterior)	4	4 (100.0%)	0 (0.0%)
Leg (medial)	13	12 (92.3%)	1 (7.7%)
Ankle	13	13 (100.0%)	0 (0.0%)
Foot	14	13 (92.9%)	1 (7.1%)
Achilles	29	27 (93.1%)	2 (6.95)
Total	196	184 (93.9%)	12 (6.1%)

Almost all the participants who suffered the injuries got back to usual training activities before completely healing, that is, they still had symptoms of pain and discomfort.

Table 23: Physical examination

Physical exam		**n (%)**
Have therapeutic marks		1 (0.9%)
Have limb length discrepancies		0 (0.0%)
Degree of foot arches	Low	1 (0.9%)
	Medium	107 (99.1%)
	High	0 (0.0%)
Q-angle measurement	Normal (<8˚)	108 (100.0%)

Physical examination revealed that one of the participants had therapeutic marks on the knee following surgery abroad. None had limb length discrepancies. Except one runner who had low arched foot, all the participants had medium foot arch and all of the participants had normal Q-angle measurements.

CHAPTER FIVE: DISCUSSION

5.1. DISCUSSION ON SOCIO-DEMOGRAPHICS OF THE RUNNERS

5.1.1 Socio-Demographic characteristics of the runners

The mean age of 26.6 years in this study suggests that most of the participants were a little older as compared to other regions like in the USA which had a mean age of 21.6 years (DeHaven & Lintner, 1986). Runners younger than 34 years of age have been found to be more prone to sustaining injuries (Taunton et al., 2002). This was originally termed as "survival phenomenon" whereby older athletes sustain fewer injuries due to their experience level (Satterthwaite et al., 1999).

In terms of gender, the male to female ratio of approximately 5:1 is almost similar to 4:1 ratio reported in other studies (DeHaven & Lintner, 1986; Korkia et al., 1994; Owoeye, 2010a). Very few studies have reported female runners being more than male runners (Lysholm & Wiklander, 1987; Taunton et al., 2002). This study also showed that male participants were significantly older than the female participant runners. There was no single study that had shown such finding during the literature review. This could be explained by the fact that most female athletes would abandon running as a career at an earlier point in life than men so as to start up families. Most of the runners (72.2%) had athletics as their sole occupation. This meant that the runners had ample time and concentration during training. The rest were mostly state officers in the military and police as well as farmers.

Over half of the runners (56.5%) had reached secondary level of education. Higher education level has been found to be a protective factor in RRMI (Van Middelkoop et al., 2008a). This might be attributed to the fact that educated individuals can easily be coached and trained hence are likely to avoid injuries unlike uneducated ones.

Less than half of the runners (45.4%) had children and an even lower number (41.7%) were married. This could be explained by the fact that the runners concentrate on training throughout the year while being secluded in the training camps and hence have little or no time whatsoever for socialization. There is also a possibility of extramarital pregnancies and or affairs to produce the statistics above though the researcher came across no other study to confirm this finding.

The mean height, weight and BMI in this study were 1.7 ± 0.1 meters, 56.8 ± 6.5 kgs and 19.4 ± 1.6 (Kgs/m^2) respectively. It was reported by van Gent et al., (2007) that a height more than 1.7 metres in males was a risk factors for RRMI while an increase in weight and a BMI more than 26 (Kgs/m^2) were protective factors. Taunton et al., (2002) on the other hand it mentions that a BMI of less than 21 (Kgs/m^2) is a risk factor for spinal injuries. This study found that there was no significant evidence supporting BMI as a risk factor probably because majority of the runners had BMI lower than 20 (Kgs/m^2).

It seemed that the density population of runners was evenly distributed in the four locations visited by the researcher. Similarly, there was no difference in the prevalence of the RRMI in terms of the camp sites or locations. These locations were of similar characteristics including high altitude (over 2000m) and cool temperatures (12˚-20˚C at the time of the visits). These are conditions that favour athletes to build up oxygen carrying capacity and even attract foreigners to visit the area for training purposes (athleticskenya, 2014; Williams, 2013).

5.1.2: Runners' profile, coaching and schedules.

The median number of years of experience in running was 5.0 (3.8, 7.3). Studies abroad showed a less experienced majority of runners of not more than 4 years (Korkia et al.,

1994). This will also reflect on the injury susceptibility and pattern in that less experienced runners are more prone to sustaining RRMI (Hoeberigs, 1992). It is therefore expected that in this study with more experienced runners, less RRMI are sustained.

Most of the runners (63.9%) seemed to have a predilection for long distance running (10,000m-42,000m). This could be explained by the mean age of the runners discussed above of 26.6 years in that, there is a trend in running whereby the younger runners tend to favour short distance running while the older runners go for the long ones. Long distant runners have a higher rate of injury as compared to sprinters (Brubaker & James, 1974). In this study on the other hand not a lot can be deduced in terms of risk of injury across the different event types because almost all the runners were performing more than one event type while some had even gone for all the three events. This would impact on their training schedule and even propensity of injuries as it shall be discussed later.

Majority of the runners train as a team and about two thirds have a coach for training though it was seen that each coach would have to train a big group of runners hence he/she will not have ample time to spend with each runner. The recommended coach to runners' ratio is not clear in literature though most articles agree that the ratio depends on the characteristics of the runners including age, event type, experience and so on (Khan, 2008).

Evidently from this study, two thirds of the runners train for more than 15 hours per week while more than three quarters run more than 150km every week. Training more than 60 km per week has been associated with RRMI (Macera et al., 1989; Van Middelkoop et al., 2008a). Furthermore, it has been suggested that a weekly distance of

more than 62 km, a pace less than 5 min per km or running more than 6 to 7 times every week are associated with increased risk of RRMI (Rasmus Oestergaard Nielsen, Ida Buist, Henrik Sørensen, Martin Lind, & Sten Rasmussen, 2012). Long training sessions have also been implicated in producing the same effect (Maughan & Miller, 1983; Willem van Mechelen et al., 1993). The resultant effect of this training habit shall be discussed under the injury patterns to follow.

5.2: DISCUSSION ON CHARACTERISTICS OF RRMI

5.2.1: Frequency of injuries

Results show that only 6.5% of the runners did not suffer any RRMI in the past 3 years. The researcher believes that the high rates of injury are as a result of poor training techniques as described earlier. Of those who sustained any injury, 73.3% had had more than one injury which is consistent with the hypothesis that there is a higher chance of sustaining another injury following any RRMI (van Gent et al., 2007). The rates of re-injury vary between 30% reported by Willem van Mechelen et al., (1993) and 58% (Maughan & Miller, 1983). It was difficult to establish the rate of re-injury in this study due to its retrospective nature.

5.2.2: Predominant sites of injury

It is well documented that almost all (100%) of RRMI are predominantly of the lower extremities (Jakobsen BW, 1994; Maughan & Miller, 1983; Taunton et al., 2002; Van Middelkoop et al., 2008b). The same scenario is seen in this study. Of all the injuries, the knee has been reported to suffer the most as compared to other sites of the lower limbs (DeHaven & Lintner, 1986; Raskin & Rebecca, 1983; Satterthwaite et al., 1999; Van Middelkoop et al., 2008b). Prevalence of knee injury ranging between 29% and 32% has been reported by James et al., (1978) and Maughan & Miller, (1983) respectively. One study, a systemic review by Lopes et al., (2012) found that the knee injuries were fourth in occurrence after MTSS, Achilles tendinitis and plantar fasciitis. In this study on the contrary, it was found that the thigh specifically posterior thigh (hamstring) injuries were most common at 39.8% followed by the knee at 30.6%. A comparison with some of the other studies mentioned above is demonstrated in table 24 below:

Table 24: Comparison of common RRMI among different studies.

INJURYSITE/ OCCURENCE	**THIS STUDY**	DE HAVEN	LOPES	VAN GENT	VAN MECHELEN
1	**Hamstring (Thigh)**	Knee	MTSS	Knee	Knee
2	**Knee**	Ankle	Achilles tendinitis	Leg	Foot
3	**Achilles tendinitis**	Thigh	Foot	Foot	Thigh
4	**Groin**	Foot	Knee	Thigh	Achilles tendinitis
5	**Foot**	-	Thigh	-	-

Hamstring and tendon injuries are usually seen in sprinters due to their fast running pace (Brubaker & James, 1974; Lysholm & Wiklander, 1987). A similar picture was seen in this study where hamstring injuries dominated as a result of training with a fast pace. This is evidently seen during the different racing competitions whereby these runners end up breaking international records throughout the year.

Thigh injuries have been associated with increased training hours/week while increased training distance/week is protective against sustaining knee injuries (van Gent et al., 2007). This is the picture seen in our results whereby most runners were spending more hours in training hence sustaining particularly hamstring injuries whilst getting less knee injuries due to running long distances. The urge to over train and run long distances with the assumption that it will improve one's performance was coined as "mileage mania" by James et al., (1978) and is practised by many athletes.

Another explanation of the differences in injury occurrences is the fact that different studies have their own definitions of RRMI as well as study population with different characteristics and running/training environments hence this may produce the above picture.

Hamstrings have been found to be most susceptible to injury during the swing phase of running (Chumanov, Heiderscheit, & Thelen, 2011). This phase corresponds to the point where the muscles are at their maximum length and load. The researchers used electromyographic kinematics to recognize this relationship. They also concluded by emphasizing the importance of establishing effective muscle injury prevention and rehabilitation programs.

A morphometric analysis of the proximal musculotendinous junctions (MTJ) of the hamstring muscles was conducted by Storey, Meikle, Stringer, & Woodley, (2015) with the use of anatomic and MRI investigations. They found that the most commonly injured muscle is the biceps femoris long head especially at the MTJ due to both shorter tendon as well as its MTJ. This was as a result of point concentration of tensional forces on the smaller MTJ with a difference in compliance between the muscle and tendon fibres. The book on clinical sports medicine by Brukner and Khan, (2008) agreed with this and added that the biceps femoris muscle because of its dual innervation by the two main branches of the sciatic nerve may be more prone to injuries as a result of mistimed firing of these nerves.

It will then be prudent to analyze these hamstring injuries to compare the origin of the strain and which muscle is mostly affected in our set up. This will guide towards rehabilitation and even be incorporated into the preventive programs.

Hamstring injuries remained dominant in respect to gender, event type and even age. The other injuries would vary in occurrence though the study did not show any statistical significance except for the fact that men were found to be older than female runners.

The second most common injury site was found to be of the knee (30.6%) though the exact injury sustained was not established as to whether it was ligamentous, tendinous, capsular or bone related, since they were not adequately investigated for. As stated earlier, this has been initially known to be the most common injured site due to the forces acting on the foot where up to three times of body weight is transmitted through the leg and dissipated on the knee which is at the same time being acted upon by the thigh muscles (James et al., 1978). The most common knee injuries include patellofemoral syndrome and patella tendinopathies referred by names like jumpers' knee and runners' knee respectively though these terms could be misleading as described by (Lopes et al., 2012).

Achilles tendon injuries were third (27.8%) though it is difficult to state whether these injuries were tendinitis (inflammation of the tendon) or paratenonitis (inflammation of the tendon sheath) without a proper imaging modality. Repeated strains on tendons by forces between 4% and 8% has been associated with overuse injury while strain forces beyond 8% cause ruptures that may need surgery (Kannus, 1997).

An interesting finding in this study was that of groin injuries (22.2%). Most other studies have reported far lower rates or no interest at all concerning these injuries. A systemic review by de SA et al., (2016) gave a male to female ratio of 4:1 with an equal intra-articular versus extra-articular causes of groin pain. The most common pathology was femoro-acetabular impingement. These injuries have also had different "diagnostic labels" like osteitis pubis, athletic pubalgia and sportsperson's hernia as described in the book by (Khan, 2008). It also describes four clinical entities associated with this injury which include relations to the adductors, iliopsoas, abdominal wall muscles and pubic bone stress. Hence further investigations like imaging and thorough examination

should be carried out on the athletes because most of them are misdiagnosed. Muschaweck et al., (2015) insisted on the need for multidisciplinary approach for managing these injuries due to the fact that the "innocent periarthritic disease" may actually cause permanent debilitating hip disease and even joint fusion and be rendered career ending.

5.2.3: Injury susceptibility during training versus race competitions

It has been reported that most injuries occur during training rather than in competitions due to training errors (James et al., 1978). Some give rates as high as 72% (Lysholm & Wiklander, 1987). In contrast, a more recent study by Van Middelkoop et al., (2008a) mentioned that a runner has up to six times the risk of sustaining an injury during race participation. In this study, most of the injuries suffered occurred during training (90.1%) which would mean these injuries are mostly as result of training errors. The predominant site of injury during race competitions on the other hand was the anterior leg (peroneal compartment) at 40% followed by posterior leg (calf) at 25%. The researcher though that this finding may be explained by the mere fact that during competitions, the adrenaline drive leads to physical exertion which has a toll on the confined compartments of the leg and hence resulting to RRMI of the leg. Though no study has proven this theory, Maughan & Miller, (1983) found that more injuries during racing are sustained around the foot as compared to the knee.

5.3: Discussion on Associated Risk Factors of RRMI

The risk factors assessed in this study included age, gender, BMI, event types being performed by the runners, years of experience in the field and availability of a coach. This study depicted that two of the RRMI had a gender predilection. These were groin injuries that were more common in males and hip injuries that were more common in females. This was agreeing especially for the female factor with a study by Satterthwaite et al., (1999) who found that women were at a higher risk of sustaining hip injuries than men while men had a higher risk for hamstring and calf injuries. Murphy et al., (2003) suggested hormonal influence on the joints in female runners may bring about this behaviour. For the groin injuries in men, this study is consistent with that of de SA et al., (2016) which reports a ratio of 4:1 in favour of men sustaining more groin injuries than women though no attributable cause has yet been found. The researcher thought that the differences in anatomy of the pelvis could explain this in that the males usually have a smaller pelvis hence shorter groin distance as compared to the wider female pelvis which has a bigger space to accommodate the contents of the groin region including the inguinal ligament as well as both superficial and deep muscles.

In terms of age, men were found to be older than female runners. This was confirmed to be a true difference with 100% statistical power. This finding can be explained by the obvious high male to female ratio of 5:1 hence the mean age of the female runners could be limited by their few numbers.

Injury assessment in relation to the event types, proved difficult to analyze due to the fact that most of the runners are involved in more than one race type. It has been reported by Lysholm & Wiklander, (1987) that short distance runners suffer mostly hamstring and tendon injuries while long distance runners get foot injuries. It would

have been educative to know which injuries are prone to the strict short or long distance runners though from this study, and as expounded earlier, since most of the participants were long distance runners who suffered mostly hamstring injuries, then it can be hypothesised that the picture is contradicting the above study.

The rest of the other factors assessed did not yield any statistical significance differences hence a different study design may be used in future to ascertain the associations.

5.4: Discussion on Treatment Modalities used by Runners

5.4.1: Treatment modalities used by the runners who sustained RRMI

Majority of the injured runners (63.5%) used first aid treatment following an injury. Rubbing with medicated ointments was the commonest first aid modality used probably due to its availability over the counter and being affordable. The runners would then mostly continue with the race or training despite the injury. Only a few of the runners would stop completely their activities especially when the injury was either Achilles tendinitis or hip injury. The researcher came across no study discussing the impact of the injuries in terms of causing the most discomfort to force runners to stop their activities.

It was seen that most runners would resume their training schedules within the first week following an injury with a median number of 6 days (4.0, 12.0). This is a short period for recuperation and facilitation of muscle regeneration as demonstrated by (Carlson & Faulkner, 1983; Murphy et al., 2003). Most studies encourage ample rest depending on the injury especially for tendon/muscle injuries that have not been fully investigated and characterised (Gallo et al., 2012).

Almost all the injured runners 93 out of 101 (92.1%) sought further treatment and this was mostly in the form of physiotherapy either within the training camps, at home or in the health facilities. This was in contrast with other studies like those of Brubaker & James, (1974) and Gallo et al., (2012) whereby “rest” was predominantly used as first choice treatment modality followed by others like physiotherapy, analgesic use and surgery. A study by Orlando et al., (2011) recommends a day of rest every week for 4 to 6 weeks before a break. It also cautions runners of the injury prone post-break period

hence gradual intensity training schedules on return should be used. Interestingly, the article demonstrates that longer breaks do not reduce rates of RRMI.

Other treatment modalities vary depending on many factors including injury site, severity and available resources including physicians' preference (Sandmeier & Renström, 1997). An African study done in Nigeria by Owoeye, (2010a) reported cryotherapy as the more commonly used treatment modality for injuries as compared to bandaging and physiotherapy. As seen earlier in the literature review, there are far more options of treatment being utilised in other countries including better therapeutic drugs, electrotherapeutic modalities as well as use of hyperbaric oxygen therapy which would otherwise assist these runners once they are made available locally.

This study showed that only one runner underwent a surgical procedure for a knee injury which concurs with the study by Brubaker & James, (1974) that higher treatment rates are seen following knee injuries as compared to other RRMI. In this case, a rate of 50% was reported though no explanation was given. The low rate of surgery as a treatment option in this study might be so because not all the injuries were sufficiently investigated and diagnosed and so probably more runners would have needed surgery. For example, 13% of runners had MTSS and most of them had physiotherapy while some took analgesics then resumed activities before full recovery after just a week. In the same context, Mubarak et al., (1982) reported excellent outcomes of surgery (fasciectomy) following adequate investigations and diagnostic procedures for such injuries.

The fact that the hamstring injuries topped the RRMI list in this study suggested that their treatment and prevention methods should be well understood by local clinicians. Pain or discomfort arising from the back of a runner's thigh is usually as a result of

hamstring muscles overuse injuries particularly from the biceps femoris as earlier explained. If not properly managed, fibrous adhesions develop between the tendons and the sciatic nerve to produce chronic irritation that has been referred to as the "hamstring syndrome" in the book by (Khan, 2008). It is important to diagnose these injuries during the acute phase as it may be referred pain from the sacroiliac joint or lumbar region of the spine. The book also suggests need for adhesiolysis as a treatment option for these injuries.

Management of knee injuries varies as well from use of analgesics to surgical options both open and arthroscopic. The use of knee orthoses has been successful in management of knee injuries especially patellofemoral braces (Yeung et al., 2011).

5.4.2 Place of treatment

The place of treatment was found to be dependent on factors like cost in that the elite and more experienced runners sought treatment mostly in private hospitals and abroad. The up-coming younger runners on the other hand, had to endure prolonged administration of physiotherapy with a higher likelihood of early return to training before full recovery. Korkia et al., (1994) found that the habit of continued training with injury would exacerbate and complicate the condition.

Lastly, it was a concern as to why the public hospitals saw the fewest number of runners seeking treatment for RRMI in this region considering that they charge the least amount of medical fee as compared to the rest of the facilities. This was a question that needed to be addressed by the Government of Kenya through its ministry of health as well as the clinicians practising within the local health facilities including MTRH.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1: Conclusion

6.1.1: On socio-demographic characteristics of the runners

There were more male than female runners. The mean age of all the runners was 26.6 years which is higher as compared to other countries as reported in most studies. Most of these runners favoured long distance running though almost all of them had participated in more than one event type in their careers. The coach to runners' ratio was found to be high which forced the runners to train as a group following the same training schedules regardless of the runners' event types. Overtraining was being performed by most of the runners going for more than 15 hours per week or cover more than 150 km per week.

6.1.2: On the characteristics of the RRMI sustained by the runners

The rate of injury in this study was found to be high at 93.5% in a period of three years. Most of the injuries were of the lower extremities dominated by the hamstring group of muscles at 39.8% followed by the knee at 30.6% and Achilles tendon injuries at 27.8%. Assessing impact or severity of the RRMI proved to be difficult due to early return training by the runners which would also exacerbate the condition of injury.

6.1.3: On associated risk factors of RRMI

Two RRMI had a gender predilection. These were groin injuries that were common in men and hip injuries that were common in women. It was however difficult to assess the associations of event types as a risk factor for RRMI because most of the runners were involved in more than one race event.

6.1.4: On treatment modalities used following RRMI

First aid treatment was used by most runners following RRMI especially the use of rubbing with medicated ointments followed by treatment of almost all injuries with physiotherapy within the training camps. Most of these RRMI were not adequately investigated on hence making accurate diagnoses difficult. It was also seen that early return to training before full recovery was practised by many of the runners.

6.2: Recommendations

1. More females should be encouraged to participate in running as well as increasing the numbers of professional coaching staff.
2. Preventive exercises, warm up and cool down techniques as well as adequate resting periods should be advocated for through health literacy programs.
3. Further prospective studies to establish incidences and associated risk factors should be done.
4. Setting up an all-round well-equipped sports centre in the NR region to provide early diagnosis of RRMI and a teaching opportunity to urgently train sports medicine doctors.

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APPENDICES

The following documents are attached as appendices to this research Thesis.

Appendix 1: Data Collection Tool- Questionnaire

DEMOGRAPHIC DATA

Sr. No. .....

Camp site .....

Age (years) .....

Gender (M/F) .....

Occupation .....

Education level (primary/secondary/college)

Marital status (single/married)

No. of children .....

Height (m) .....

Weight (kg) .....

EVENT (RUNNING) TYPE

No. of years in the field .....

Have you ever competed in any national/international event (Y/N)? .....

If yes, state the event/s.....

Any family history of running (Y/N) .....

Event type (tick where applicable)

Any medal won? (Y/N).....

If yes, state whether gold/silver/bronze/others.....

	PREFERRED	PERFORMED
SHORT DISTANCE(<1500m)		
MEDIUM (1500m-5000m)		
LONG (10000m-42000m)		

DATA ON TRAINING

Hours per week of training (hrs) .....

Distance/week of training (km) .....

Do you have a qualified coach for training (Y/N) .....

Do you train as a team or individual? (T/I) .....

Do you train on a flat ground (track) or hilly/rugged terrain? (F/R) .....

Do you use shod (flat) or soled shoes? .....

INJURY PROFILE (use table to fill)

Have you ever sustained any injury? (Y/N)

If yes, how many? (list down in the table)

State the anatomical site of injury.

Lower back (LB) ☐

Hip (H) ☐

Thigh anterior/posterior (TA/TP) ☐

Knee (K) ☐

Leg antero-lateral/posterior/medial (LAL/LP/LM) ☐

Ankle (A) ☐

Foot (F) ☐

What nature was the injury, soft tissue(ST) or/and a fracture(Fr)?

Did the injury occur during training(T) or race(R)?

What was the immediate impact following the injury, did you continue(C) with the activity or stopped(S)?

How long did you take before resuming to usual activities?

Less than 1 week ☐

1 to 3 weeks ☐

3 to 6 weeks ☐

More than 6 weeks ☐

TREATMENT (use table to fill)

Did you perform first aid? (Y/N)

If yes, what did you use?

Cold packs ☐

Sprays ☐

Others.....

Did the injury require further treatment? (Y/N)

If yes, how else were you treated?

Rest ☐

Analgesics ☐

Bandages/braces ☐

Physiotherapy including massaging ☐

Surgery.....(specify procedure done)

Where were you treated?

Public hospital ☐

Private hospital ☐

Outside the country ☐

Others.....

Approximately how much (KSH) did you spend for treatment?

Less than 50,000 ☐

50,000 to 100,000 ☐

More than 100,000 ☐

Did you return to usual activities before or after complete healing (asymptomatic)?

Do you have records of treatment available? (Y/N)

If yes which ones? .....

PHYSICAL EXAMINATION

Presence of therapeutic marks (Y/N)?

Presence of limb length discrepancies (Y/N)?

Degree of foot arches LOW/MEDIUM(NORMAL)/HIGH

Q angle measurement (degrees).

TABLE 3: QUESTIONNARE

NO.	SITE	NATURE	OCCURENCE	IMPACT	RESUMPTION	FIRST AID	TREATMENT	HOSPITAL	KSH	RETURN TO ACTIVITY

Appendix 2: Consent Form: English

My name is Dr MbarakAbeid. I am a qualified doctor, registered by the Kenya Medical Practitioners and Dentists Board (Registration number A7165). I am currently pursuing a Masters degree in Orthopaedic surgery at Moi University. I would like to recruit you into my research which involves studying of Running Related Musculoskeletal Injuries among Kenyan athletes in the North Rift region.

INFORMATION ABOUT RRMI.

RRMI are injuries/pain/discomfort sustained by runners while undergoing training or during a race that will either immediately, soon or later reduce the running capacity or even prevent the runner from his/her activities. This information will be useful for us as medical experts and even the policy makers to understand and manage the problem.

Your information will be kept confidential and you will be informed of the results and what they mean. Treatment does not depend on your participation in this study. In case of treatment, appropriate consultation may be advised.

This study has been approved by the Institutional Research and Ethics Committee (IREC) of Moi University/Moi Teaching and Referral Hospital.

If you need further clarifications please contact IREC using the address below.

The Chairman IREC,

Moi Teaching and Referral Hospital,

PO Box 3,

Eldoret.

Tel: 33471/2/3 VI

Appendix 3: Consent for Runners Above 18 Years Of Age

I have been adequately informed that I am being recruited into a study on determining the Running Related Musculoskeletal Injuries among Kenyan athletes in the North Rift region. The investigator has also informed me that my participation in this study is voluntary and even if I were to opt out, my confidentiality will be respected.

Sign:

……

Name:

……

Date:

……

CONSENT FOR PARENTS/GUARDIAN OF RUNNERS BELOW 18 YEARS OF AGE

I have been adequately informed that my son/daughter is being recruited into a study on determining the Running Related Musculoskeletal Injuries among Kenyan athletes in the North Rift region. The investigator has also informed me that his/her participation in this study is voluntary and even if he/she were to opt out, his/her confidentiality will be respected.

RUNNER'S PARENT/GUARDIAN:

Sign:

……

Name:

……

Date:

……

Appendix 4: Assent for Runners Below 18 Years Of Age

I have been adequately informed that I am being recruited into a study on determining the Running Related Musculoskeletal Injuries among Kenyan athletes in the North Rift region. The investigator has also informed me that my participation in this study is voluntary and even if I were to opt out, my confidentiality will be respected.

Sign:

……

Name:

……

Date:

……

Appendix 5: Consent Form: Kiswahili

Majina yangu ni Dr.Mbarak Abeid. Nimehitimu kama daktari na kusajiliwa na Bodi ya Madaktari ya Kenya (nambariya usajili-A7165). Kwa sasa ninasomea shahada ya juu (masters) ya udaktari wa upasuaji wa magonjwa ya mifupa (orthopaedic surgery) katika chuo kikuu cha Moi. Ningependa ujiunge na uchunguzi ninao fanya ambao unahusu majeraha wanayopata wanariadha Wakenya katika eneo la North Rift.

MAELEZO KUHUSU RRMI

RRMI ni majeraha/maumivu/hali yoyote isiyo ya kawaida yanayotokea kwa mkimbiaji wakati wa mazoezi au katika mashindano ambayo huweza kupunguza uwezo wa huyo mwanariadha katika kukimbia au hata kutoweza kushiriki mashindano baadaye. Maelezo haya yatakuwa muhimu kwetu madaktari napia washikadau wasekta hii katika kupanga, kusuluhisha na hata kutibu shida hii.

Maelezo utakayotoa yatahifadhiwa vyema na utajulishwa maana yamatokeo yake. Kujiunga kwako hakutategemea matibabu yako na iwapoutahitaji matibabu, utaelezwa ipasavyo jinsi ya kusaidika.

Uchunguzi huu umeidhinishwa na Kamati ya uchunguzi wa wasomi na haki za wanaochunguzwa (Institutional Research and Ethics Committee-IREC) ya chuo kikuu cha Moi na hospitali kuu ya Moi.

Unapohitaji maelezo zaidi, wasiliana na IREC kupitia anwani ifuatayo:

Mwenyekiti IREC,
Moi Teaching and Referral Hospital,
S.L.P. 3
Eldoret,
Nambariyasimu 33471/2/3

Appendix 6 :Idhini Ya Mwanariadha Aliyezidi Miaka 18

Nimeelezwa ipasavyo kwamba ninashirikishwa katika uchunguzi huu wa majeraha wanayopata wanariadha Wakenya katika eneo la North Rift. Mchunguzi amenieleza pia kuwa kushiriki kwangu ni kwa hiari na iwapo ningependelea kujitoa katika uchunguz ihuu, maelezo yangu yatahifadhiwa vyema.

Sahihi.....

Jina.....

Tarehe.....

Appendix 7:Idhini Ya Mzazi Wa Mwanariadha Aliyechini Ya Miaka 18

Nimeelezwa ipasavyo ya kuwa mwanangu anashirikishwa katika uchunguzi huu wa majeraha wanayopata wanariadha Wakenya katika eneo la North Rift. Mchunguzi amenieleza pia kuwa kushiriki kwa mwanangu ni kwa hiari na iwapo angependelea kujitoa katika uchunguzi huu, maelezo yake yatahifadhiwa vyema.

MZAZI WA MWANARIADHA:

Sahihi.....

Jina.....

Tarehe.....

Appendix 8:Idhini Ya Mwanariadha Aliyechini Ya Miaka 18

Nimeelezwa ipasavyo kwamba nina shirikishwa katika uchunguzi huu wa majeraha wanayopata wanariadha Wakenya katika eneo la North Rift. Mchunguzi amenieleza pia kuwa kushiriki kwangu ni kwa hiari na iwapo ningependelea kujitoa katika uchunguzi huu, maelezo yangu yatahifadhiwa vyema.

Sahihi.....

Jina.....

Tarehe.....

Appendix 9: Photographs Of Naftali Temu And Chepkwony In A Kenyan Newspaper Edition.

The Ethiopians possess an incredible finish that has prevented Kenya winning an Olympic gold in the 10,000m metres since 1968. But it is as if they (Ethiopians) learnt a lesson from Kenya's tactically best ever, Naftali Temu, who annihilated Mamo Wolde in Mexico City Games

TEMU: THE BEST 10,000M STAR WE EVER HAD

Appendix 10 : Photographs of A Typical Training Camp In The NR Region Of Kenya.

Appendix 11: IREC Approval letter

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2015/130
Approval Number: 0001502

11th September, 2015

Dr. Mbarak Abeid,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
11 SEP 2015
APPROVED

Dear Dr. Mbarak,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Pattern of Running Related Musculokeletal Injuries among Kenyan Athletes in North Rift."

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1502*** on 11th September, 2015. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 10th September, 2016. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

For

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc Director - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD