NEUROMUSCULAR CONDITIONING STRATEGIES USED, INCIDENCE, SEVERITY, AND FACTORS ASSOCIATED WITH MUSCULOSKELETAL INJURIES SUSTAINED BY PROFESSIONAL RUNNERS IN NORTH RIFT, KENYA

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF MEDICINE IN ORTHOPAEDIC SURGERY AT MOI UNIVERSITY

DECLARATIONS

Declaration by candidate:

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DEDICATION

I dedicate this work to the hardworking Kenyan track athletes who inspired this work.

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ABSTRACT

Background: Professional runners are prone to sustaining musculoskeletal injuries in training and competition. Factors that predispose them to sustaining these injuries are unclear with training errors being implicated in most injuries. Neuromuscular conditioning is the performance of exercises that improve proprioception, flexibility, strength and balance. These have the potential of mitigating the injuries that runners sustain. Literature on the neuromuscular conditioning strategies used by professional runners in North Rift Kenya is limited.

Objective: To describe the neuromuscular conditioning strategies used, and to determine the incidence, severity, and factors associated with musculoskeletal injuries sustained, by professional runners in North Rift, Kenya.

Methods: A prospective study was conducted at training camps in North Rift, Kenya. Randomly sampled, 89 professional runners were interviewed at the beginning of the season and their anthropometric measurements taken. Participants were provided with training diaries. Follow up interviews by phone were conducted two monthly for one year to collect data on injuries, training and potential risk factors for injury. Neuromuscular conditioning strategies used were summarized in tables, injury incidence was calculated as injuries per 1000 hours, and severity as time lost in days. Tests of significance were used to calculate associations between variables and injury incidence and severity. For categorical variables such as neuromuscular conditioning strategies used, gender and BMI, Chi square and Fisher's exact tests were used. Wilcoxon rank sum tests were used for continuous variables such as runners' experience in years.

Results: Per week on average, 88 runners spent 174 minutes on slow distance endurance training, 83 spent 87 minutes on stretches, 40 spent 42 minutes on plyometric strength training, and 45 spent 14 minutes on single leg balance training. Injury incidence was 42.40 injuries per 1000 hours of training (95% CI: 33.33, 51.47). Of the 57 (64.04%) runners who sustained injuries, 43 (75.44%) suffered time loss injuries. Median time lost was 5 days (IQR: 1, 14). Neuromuscular conditioning strategies used, age, gender, running experience, injury history, BMI, lower limb flexibility, were not significantly associated with the incidence of injury. Runners who practiced single leg balance training and those who practiced plyometric strength training sustained significantly more slight to mild injuries than moderate to severe injuries ($p = 0.005$, $p = 0.026$ respectively).

Conclusion: Professional runners in North Rift spent most of their training time on endurance and flexibility training with the least time spent on strength and balance training respectively. They sustained largely moderately severe injuries at a rate of 42.4 injuries per 1000 hours of training. Differences in neuromuscular conditioning strategies used, athletic experience, demographic and anthropometric factors were not significantly associated with the incidence of injuries. Runners who did single leg balance or plyometric strength training tended to have less severe injuries.

Recommendations: Runners should perform single leg balance training and plyometric strength training to mitigate the severity of running injuries they may suffer.

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DEFINITION OF TERMS

Calisthenics – A form of strength training comprising rhythmic body movements of varying intensity done with little or no equipment e.g. squats, sit-ups.

Cross training – A training routine utilizing different sports or exercises to improve one's fitness or performance in their main sport e.g. a runner training in swimming.

Fartlek training – A form of endurance training in running where periods of fast runs are intermixed with periods of slow runs in unstructured intervals.

Injury severity - The number of days that have elapsed from the day after the onset of the incident to the day of the athlete's return to full participation in athletics training and become fully available for competition.

Interval training – A form of endurance training in running where periods of intense fast paced runs are followed with periods of less intense recovery periods in structured intervals.

Neuromuscular conditioning – Training regimen that incorporate physical exercises aimed at improving proprioception, neuromuscular control, flexibility, jumping and landing skills, strength and balance.

Plyometric exercises – A form of strength training that utilizes quick, powerful movements that start with an eccentric (muscle-lengthening) action and is immediately followed by a concentric (muscle-shortening) action. E.g. jumping exercises.

Professional/ elite athlete – Athlete who receives payment for their performance.

Repetition training – A form of endurance training for speed where one does multiple sets of runs of a predetermined distance at high speed followed by complete recovery.

Single leg exercises – A form of balance training where calisthenic exercises are done with the support and power of just one leg e.g. single leg squats.

Slow distance training – A form of endurance training involving running at a constant pace of low to moderate intensity over an extended distance or duration.

Running injury - A physical complaint or observable damage to body tissue produced by the transfer of energy experienced or sustained by a runner during participation in athletics training or competition, regardless of whether it received medical attention or its consequences with respect to impairments in connection with competition or training.

Strength training – A type of physical exercise specializing in the use of resistance to induce muscular contraction which builds the strength, anaerobic endurance, and size of skeletal muscles.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Running has grown from being merely a leisure activity to being a professional undertaking with socioeconomic significance. The sport has enjoyed a growth in popularity with a steady rise in global participation. Running events account for 20% of participants in the Olympic Games, the largest of all sporting disciplines (Engebretsen et al., 2013; Junge et al., 2009). Kenyan professional runners are regarded as some of the best in the world having dominated distance running events over the past 5 decades (Onywera, 2009). A majority of these runners hail from the North Rift region, particularly the counties of Uasin Gishu, Elgeyo Marakwet and Nandi. This region is also home to a good number of athletic training camps. Youth here see running as a real avenue of acquiring wealth (Onywera et al., 2006; Wirz, 2006).

Running carries a risk of injury. A physical complaint or observable damage to body tissue produced by the transfer of energy experienced or sustained by a runner during participation in athletics training or competition is considered a running injury. The modern professional runner is at a particularly high risk of injury as they deal with ever increasing competition, saturated events calendars and intense training schedules (Schwellnus et al., 2016). Injuries are bound to happen with this increased load to an athlete’s body. Previously researchers regarded only time loss injuries as reportable injuries. Recent consensus statements recommend that injuries be considered regardless of the consequences with respect to impairments in connection with competition or training (Timpka et al., 2014).

Musculoskeletal injuries from running are very common, occurring mostly during training with an annual cumulative incidence ranging between 18.2% and 92.4% (Lopes et al., 2012). Generally, overuse injuries affecting the lower limbs are the most common types of injuries seen in middle and long distance runners while field athletes and sprinters suffer more acute injuries (Bennell & Crossley, 1996; Hreljac, 2004). The severity of these injuries vary from slight injuries that may cause a minor discomfort to the athlete and reduce their performance to more severe injuries that may disrupt or end the career of a runner. It is a big blow to athletes when sidelined from competition and/or training following injury thus the importance of employing sport injury prevention strategies (Timpka et al., 2014). Increased surveillance during running competitions by sports bodies such as the International Association of Athletics Federations (IAAF) has brought to the fore the importance of protecting athletes' health. Safety is now a major priority in running (Alonso et al., 2012).

Some risk factors for running injuries have been suggested, including anatomical or biomechanical factors, training errors, history of running injury and running experience (Saragiotto et al., 2014). Various prevention strategies have been proposed for preventing sport injuries e.g. proper footwear with shock-absorbing insoles, joint supports, strength and conditioning exercises, cross training, and sports taping among others (Sari et al., 1998). Despite their experimental success, there is varied uptake of these methods by athletes in the real world of training and competition. The injury burden remains high (Bates, 2010). An ideal preventative strategy would be one that is accessible to runners, effective and at the same time would not threaten the competitive appeal of the sport nor hinder the performance of runners. Neuromuscular conditioning is an attractive option.

Neuromuscular conditioning involves a training regimen of physical exercises aimed at improving proprioception, flexibility, neuromuscular control, jumping and landing skills, strength and balance. This includes programs that incorporate weight training, plyometric exercises, agility and stretching as well as balance exercises (Hübscher et al., 2010). Since training errors are implicated in many running injuries this method is a promising strategy to reduce running injuries. Neuromuscular conditioning as a strategy to prevent injury has an advantage over other strategies since it does not threaten the appeal of the sport and may even improve performance. This makes it acceptable to athletes, fans and sporting bodies alike. Runners and trainers may knowingly or unknowingly engage in neuromuscular conditioning but this has not been quantified and its influence on injury experience in runners has not been studied.

This study seeks to observe the neuromuscular training programs that professional runners in North Rift, Kenya engage in, and determine the incidence, severity and factors associated with the musculoskeletal injury they suffer.

1.2 STATEMENT OF THE PROBLEM

Runners in Kenya are prone to musculoskeletal injuries. This is evidenced by the frequent team changes that are made to Kenyan running teams due to player injuries and the no-shows by these runners in individual races (Huaxia, 2020; Olobulu, 2020; Rutto, 2019; Walker et al., 2020). A cross-sectional study on Kenyan marathon runners in Eldoret revealed an injury prevalence of 70% (Chesergon, 2017). The incidence, severity and factors associated with these injuries are not well known. Severe injuries may cause a runner to miss training and competition or even end their running career. Minor injuries in the professional level are also important since they inhibit the performance of the runner causing them to fail to achieve their targets

(Soligard et al., 2017). Previous studies on running injuries have used time loss as a criteria for defining injuries thus these minor but significant injuries are underreported. A true picture of the incidence and severity of running injuries sustained by professional runners is needed.

Coaches and runners attempt various strategies to prevent running injuries and still maximize performance. A cross-sectional study on Kenyan runners showed that up to 75% of them were overtraining (Mbarak et al., 2019). Neuromuscular conditioning is a strategy that may be incorporated into training and have the potential of preventing injuries. Its use in running is backed only by anecdotal evidence and from evidence from other sports. There is limited data on how runners in North Rift Kenya utilize this strategy and the association with their injury experience. This highlights the need to have a description of the neuromuscular conditioning strategies used by runners in the North Rift region and to determine the incidence, severity and factors associated with the musculoskeletal injuries they sustain.

1.3 JUSTIFICATION OF THE STUDY

Running, as with other sports events that involve endurance, is viewed by many as a low risk sport, and this has led to its neglect when investigating methods in preventing sports injuries (Parkkari et al., 2001). Contrary to this view, studies show that runners have a high burden of sports injuries with incidence rates of up to 76%. The injuries, being mainly of the overuse type and relatively less dramatic, have drawn less attention when it comes to preventative interventions (Bennell & Crossley, 1996; McBain et al., 2012). Athletes and their trainers thus end up relying on anecdotal experience to try prevent sports injuries with little scientific evidence to back them up (Finch, 2006).

Neuromuscular conditioning has the potential to mitigate the incidence and severity of the injuries runners suffer. There is limited literature showing which neuromuscular conditioning exercises runners in the region utilize and how they are incorporated in their training. Knowing which strategies the runners in the region are using and the factors associated with injury will help sports medicine practitioners and coaches to prescribe the suitable, running – specific conditioning exercises for runners.

Studying the injury incidence and severity will provide information to sports medicine practitioners such as physiotherapists and orthopedists and organizations such as Athletics Kenya, that will help them advocate for the safety of runners. Including both time loss and non-time loss injuries to determine incidence will show the true burden of sports injuries, since both are influential in a professional athlete's career.

The purpose of this study is to describe the neuromuscular conditioning strategies used by local professional runners and to determine the injury incidence, severity and factors associated with injuries they sustain. This will grow the body of knowledge available to athletes, their coaches and sports physicians and physiotherapists that care for these and upcoming athletes. Injury prevention in athletes would ultimately be economically and medically beneficial since treating sports injuries when they occur can be complex (Parkkari et al., 2001).

1.4 STUDY QUESTION

What are the types of neuromuscular conditioning strategies used by professional runners in North Rift Kenya, and what is the incidence, severity and factors associated with the musculoskeletal injuries that they sustain?

1.5 OBJECTIVES

1.5.1 Broad objective

To describe the neuromuscular conditioning strategies used by professional runners in North Rift, Kenya, and to determine the incidence, severity, and factors associated with musculoskeletal injuries that they sustain.

1.5.2 Specific objectives

In runners in North Rift Kenya over one year:

1. Describe the neuromuscular conditioning strategies used.
2. Determine the incidence of running related musculoskeletal injuries.
3. Determine the severity of running related musculoskeletal injuries sustained.
4. Identify factors associated with the incidence of running related musculoskeletal injuries sustained.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

Running as a sport has enjoyed a growth in popularity with a steady rise in global participation. Athletic events account for 20% of participants in the Olympic Games, the largest of all sporting disciplines (Engebretsen et al., 2013; Junge et al., 2009). In Kenya, now seen as a world powerhouse in athletics, the sport's popularity has seen tremendous growth ever since she won her first Olympic gold medal at the men's 10,000 m race in Mexico, 1968 (Butler, 2013). The median age in Kenya has been calculated to be 19 years with 80% of the population being below 35 years of age. Kenyan youth see sport as a valid path to wealth, having so many role models to choose from, particularly in running (Awiti & Scott, 2016; Wirz, 2006).

This rise in popularity and participation has inevitably increased the competitiveness in the various disciplines, with athletes training harder to give them an extra advantage and pushing themselves more when in an athletic meeting. Unfortunately there has been little emphasis on safety. The burden of musculoskeletal sports injury in runners is high with athletic populations reporting an annual injury incidence ranging between 65% and 75% (Jacobsson et al., 2013). It would be expected that measures would be taken to reduce this risk as the popularity of the sport grows, and the body of knowledge on preventative strategies grows, but this is not the case. The injury statistics in athletics have long remained the same. Evidence on the efficacy of prevention strategies has grown but unfortunately, the gap between knowledge and implementation has grown with it (Bates, 2010).

In their landmark paper, Van Mechelen et al. (1992) suggested a four step sequence of preventing sports injury. As illustrated in Figure 1, this starts with establishing the extent of the injury problem, establishing the aetiology and mechanisms involved, introducing preventive measures then assessing their effectiveness.

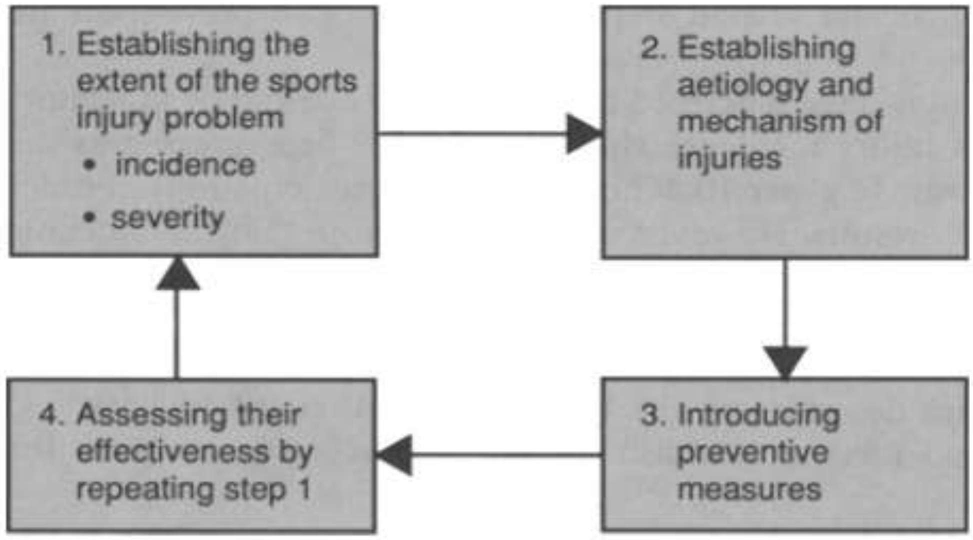

Figure 1: The 'sequence of prevention' of sports injuries.
Adopted from van Mechelen, W., Hlobil, H., & Kemper, H. C. G. (1992). Incidence, Severity, Aetiology and Prevention of Sports Injuries. Sports Medicine, 14(2), 82–99.

Various authors have followed this epidemiological model in sports injury research. This chapter will review the literature on neuromuscular conditioning as a running injury preventive measure as well as literature on the incidence, severity and factors associated with musculoskeletal injuries sustained by runners.

2.1.1 Musculoskeletal injuries in runners

Professional runners go through long hours of training and competition, placing their musculoskeletal system under significant stress. Biomechanical studies have shown that activities such as landing from a jump subjects the lower limbs to impact forces that may exceed 10 – 12 body weights within a duration of 10 ms, and that running may produce impact forces of up to 1.5 to 5 body weights within 10 – 30 ms (Hreljac, 2004). Some authors have equated running to having your foot being pounded by a club several times (Bates, 2010). It is therefore not a surprise that professional athletes are prone to musculoskeletal sport injuries.

2.1.2 Pattern of running related musculoskeletal injuries

Middle and long distance runners are at a high risk of overuse injuries while sprinters, multi-event athletes and hurdlers are at risk of more acute injuries. While a majority of injuries may occur during training, since there is much more exposure during training than during competitions, the risk of injury is about four times higher during competitions. Also during competitions, the risk of injury has been found to be significantly higher in the finals as compared to the qualifying rounds. (Alonso et al., 2012; Bennell & Crossley, 1996; Jacobsson et al., 2013; Zemper, 2005)

2.1.3 Overuse injuries

Applying repeated stresses to biological tissue at levels just below the tensile limit would lead to injury if inadequate time is allowed between stresses. This is illustrated in the stress fatigue curve in Figure 2.

Figure 2: Fatigue curve
A stress-stress cycle combination above the curve would result in injury.

Fortunately, biological tissue is known to adapt to the level of stress applied to it if adequate time is allowed between stresses. Training regimens aim to keep the stress on the musculoskeletal system of athletes below this threshold. If done successfully, the positive remodeling that would occur would shift the curve upwards; if not, as seen in overtraining, then overuse injuries would occur.

Overuse injuries are commonly seen in middle and distance runners with studies estimating that up to 70% of runners sustain such injuries within any one year period. A cross sectional study on Kenyan runners showed that up to 75% of runners were overtraining (Mbarak et al., 2019). The lower extremity is most affected especially at the leg 28%, thigh 22% and knee 16%. Common diagnoses include stress fractures, medial tibial stress (shin splints), chondromalacia patellae, plantar fasciitis, and Achilles tendinitis.

The cause of overuse injuries are multifactorial with training errors being implicated in as many as 60% of injuries. Other variables include anatomical and biomechanical factors which vary from individual to individual, such as differences in longitudinal foot arch height and ankle flexibility among others (Gallo et al., 2012). What is clear is that modifiable factors in training such as distance and intensity must have been exceeded to result in an overuse injury, and that these injuries are preventable.

2.1.4 Acute injuries

These are sudden onset injuries suffered by an athlete from contact or non-contact trauma. The contact may be with another athlete, a moving object such as a discus or an immobile object such as a hurdle. Non-contact injuries result from some form of deceleration, change of direction or landing. They are less common in athletics, seen mainly in the sprinting and field events and according to a Swedish study, account for

4% of the injury burden seen in athletes. Traumatic injuries recorded in athletes include fractures, dislocations and contusions (Jacobsson et al., 2013).

2.2 Neuromuscular conditioning strategies

The uptake of injury prevention strategies are resisted by sports bodies as they may be perceived to be a threat to the appeal of the sport or are seen to change the essential nature of the sport. Athletes and coaches may also resist preventative measures if they adversely affect performance or participation. Injury prevention research thus has to assure these stakeholders that safety measures will actually prevent injuries and will be acceptable to participants (Eime et al., 2004). With this in view, neuromuscular conditioning presents as an attractive running injury prevention strategy since it does not change how the sport is practiced and may even enhance athlete performance.

Neuromuscular performance is determined not only by the quality and quantity of involved muscles but also by the ability of the nervous system to appropriately activate the muscles. There is some evidence of training changes in the somatic nervous system that include alterations towards a more efficient muscle fiber or motor unit recruitment (DeLee et al., 2010, p. 77). The appropriate neural and muscular adaptation to exercise is the goal of sport specific neuromuscular conditioning (Birch et al., 2005).

Proprioception, neuromuscular control, flexibility, jumping and landing skills, strength and balance have been hypothesized to be modifiable factors that influence sports injury (Carolyne Emery, 2005). This premise has been adapted in strategies to prevent injuries to muscles and joints of athletes.

2.2.1 Flexibility training

Stretching exercises for flexibility are regularly included in the warm-up and cool-down routines of athletes as an injury prevention measure. Authors have called this practice into question, with data suggesting that in some instances it may paradoxically decrease athletic performance and increase injury risk (Anderson, 2013, p. 460; Haff, 2006). For sports involving jumping activities with high intensity stretch-shortening cycles (e.g. football, basketball), compliance at the muscle-tendon unit may be beneficial to store and release the high amount of elastic energy. In contrast, running involves low intensity or limited stretch-shortening cycles. There is no need for a very compliant muscle-tendon unit since most of its power generation is a consequence of active muscle work that needs to be directly transferred (by the tendon) to the articular system to generate motion (Witvrouw et al., 2004). However, some phases of running do involve a rapid stretch shortening cycle, for instance when sprinting, stopping and starting (Brooks et al., 2006). Some studies have shown hamstring flexibility to be protective against running injuries (Hreljac et al., 2000).

Studies have failed to show an association of flexibility training and the incidence of running injuries. It has proved to be a difficult area to study due to the ingrained belief that stretching prevents injuries. Runners may even be more likely to stretch if they believe they are more injury prone. A Dutch study on runners showed no difference in running injury rate between one group that had been educated on warm up and stretching and another that had not (Van Mechelen et al., 1993). A systematic review on the impact of stretching on sports injury risk revealed no significant reduction in total injuries with stretching (Thacker et al., 2004). There is still no scientifically based prescription for flexibility training for runners (Anderson, 2013, p. 460).

2.2.2 Strength training

Weakness of the involved muscle has been identified as risk factor for injury during concentric and/or eccentric contractions (Malliaropoulos et al., 2012).

In runners, the most commonly strained muscles are the hamstrings, presenting the highest index of prevalence and re-injury rates (Alonso et al., 2009). The hamstrings have been hypothesized to be at particular risk to injury due to the fact that they span both hip and knee joints, acting as hip extensors and knee flexors during both stance and swing phase of sprinting. In their review, Malliaropoulos et al. (2012) showed that eccentric training has the properties to increase the size, strength and flexibility of hamstring muscles, change hamstring muscle optimum length and stiffening of the muscle spring that can occur independent of, or in addition to, increases in size and isometric strength of the muscle.

Plyometric exercises such as jump training or skipping involve eccentric loading followed immediately by concentric contractions. These exercises have been shown to induce neuromuscular adaptations to the stretch reflex, elasticity of muscle and Golgi tendon organs. With plyometric training, the stretch reflex that is induced in the eccentric phase recruits greater motor-units and the Golgi tendon organs that would prevent muscles from undergoing greater stretch are desensitized. This results in a greater concentric force. It has been demonstrated that these neuromuscular adaptations may prevent knee injuries by increasing dynamic stability (Chimera et al., 2004; Hewett, 2000). Dynamic stability allows athletes to anticipate and react to joint moments or loads.

A study in the USA showed that there was a decreased incidence of knee injuries in female athletes following a specific plyometric training program (Hewett et al., 1999).

A randomized controlled trial on male soccer players in Saudi Arabia showed that strength training did not significantly reduce the rate of ankle sprains (Mohammadi, 2007). The use of strength training by Kenyan athletes has not been documented. A study in Nairobi, Kenya demonstrated that inadequate facilities and equipment was perceived as a barrier to the success of locally trained runners (Kanyiba et al., 2015).

2.2.3 Endurance training

Apart from its positive cardiovascular effects, endurance training has been shown to play a role in neuromuscular conditioning. Yan et al. (2011) in their review, demonstrated that endurance training promotes phenotypic adaptations in skeletal muscle toward a more oxidative phenotype. The conditioning will likely lead to improved performance in endurance sports. Whether these changes lead to less injuries in runners is yet to be explored. It was demonstrated in a study that Kenyan distance runners dedicate a large portion of their training to low speed endurance training (Billat et al., 2003).

2.2.4 Cross training

Running a whole year through without a break from training has been reported to be a significant risk factor for incurring a lower extremity running injury (Van Gent et al., 2007). Cross training for injury prevention is thought to work by reducing load by intentionally practicing non-sport specific training.

2.2.5 Balance training

Running relies on a sense of joint position and muscular control for joint stability. Balance training aims at improving proprioception, which is a kinesthetic awareness of body posture including movement. Hübscher et al. (2010) in a systematic review, demonstrated balance training to be protective against sports injuries particularly in sports that involve pivoting (ball sports such as basketball and football). The protective effect was greater in players with a previous injury.

Two studies on Canadian adolescent athletes demonstrated a reduction of sports injuries following balance training using a wobble board compared to the control groups (Carolyn Emery et al., 2007; Carolyne Emery, 2005). An Iranian study on soccer players showed a reduced rate of ankle sprains following proprioceptive ankle disk training (Mohammadi, 2007). Rasool and George (2007) demonstrated that single leg balance training on male athletes in Saudi Arabia improved their dynamic stability. Considering the role of proprioception in running, balance training may be a protective factor in running injuries.

2.3 INCIDENCE OF RUNNING RELATED MUSCULOSKELETAL INJURIES

The very nature of competitive sports places professional athletes at a high risk of musculoskeletal injuries. Sports injuries from running are common. Heterogeneity in the definitions of injury, definition of the type of runner and incidence measures used across different studies can make drawing comparisons and assessing interventions difficult. Several authors have called for standardization of the reporting of running injuries (Lopes et al., 2012; van Mechelen, 1992).

Some incidence measures that have been used in literature include number of injuries per 1000 km; proportion of injuries in a population; number of injured runners per 100 runners; and number of injured runners per 1000 h of running. Authors have stated the importance of relating risk of injury to the amount of time spent running making ‘injuries per 1000h of training’ an accepted measure (Videbæk et al., 2015).

The definition of running injury varies across different studies and largely explains the wide variation in reported incidences. Some authors put a threshold to the time lost following an injury as a component of their injury definition. For instance, two studies from Luxembourg considered running injuries as those that impeded planned running activity for at least one day. Their reported incidence was 7.64 per 1000h of running and 12.1 per 1000h of running (Malisoux et al., 2015; Theisen et al., 2014). A USA study on experienced runners defined an injury as one that necessitated a medical encounter during competition. Their calculated incidence was 7.2 per 1000h (Krabak et al., 2011).

The different definitions used to define injury made it difficult to compare or combine results from different studies. This necessitated the publishing of a consensus on definitions and methods for reporting epidemiological data in different athlete populations (Timpka et al., 2014). The agreed-on injury definition was one that included any injury sustained regardless of the time lost in training or competition. The argument for this would be that despite an injury not causing time loss, the injury would still be significant since an injured athlete would fail to perform as well as a non-injured athlete. This is particularly significant in professional running where small margins determine the results of a race (Soligard et al., 2017). Authors who have included the recommended non-time loss definition of injury to calculate incidence have inevitably recorded higher values of up to 59 injuries per 1000h (Lun et al., 2004).

2.4 SEVERITY OF RUNNING RELATED MUSCULOSKELETAL INJURIES

The severity of running injuries exist in a continuum. The extreme of death is rare in sport and often, the deterioration would stop at a time loss injury where the athlete is forced to cease further loading. Nevertheless, injury may be as extreme as to compromise an athlete's entire career (Jacobsson et al., 2013; Schwellnus et al., 2016). On the other end of the spectrum are injuries that are below clinical threshold as illustrated in Figure 3 (Fry et al., 1991).

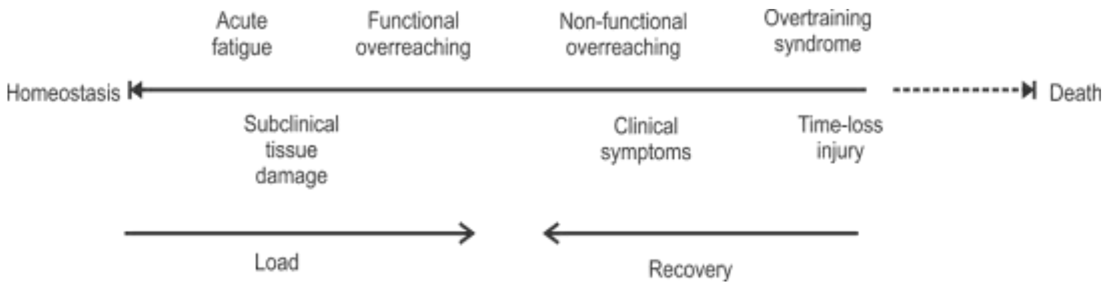

Figure 3: Well-being continuum.
Adopted from: Fry, R. W., Morton, A. R., & Keast, D. (1991). Overtraining in Athletes. Sports Medicine, 12(1), 32–65.

Sports injury severity is defined as "The number of days that have elapsed from the day after the onset of the incident to the day of the athlete's return to full participation in athletics training and become fully available for competition" (Timpka et al., 2014).

A logical argument would be that an athlete suffering from an injury, particularly a time-loss injury, would lose valuable training and competition time and this would reflect negatively in their performance. In elite level competition, where there is very little separating athletes, this disadvantage would be expected to influence outcomes on the scoreboard and leaderboards. This has indeed been hypothesized by authors before, although the focus has been on team sports such as football and basketball.

An 11 year study on 24 European football clubs to study the association between injury rates and team performance showed that injuries had a significant influence on their performances in both their domestic leagues and international cups. Teams that recorded lower injury burdens and higher match availability were more likely to have a higher ranking in their league, score more points per match and have a higher season's rating (Hägglund et al., 2013). A similar result was seen in a study done in USA on basketball players, where it was found that a significant inverse association existed between games missed due to injury/illness and percent games won (Podlog et al., 2015). Investigators in both studies recommended that injury prevention initiatives need be improved to enhance the teams' performance.

Running, being a largely individual sport, brings unique challenges in this aspect. Unlike team competition, a substitute player cannot take the place of an injured athlete to mitigate their absence. A 2016 study by Raysmith and Drew (2016) on Australian track and field athletes found that athletes who out of injury, were forced to modify or miss a larger percentage of training sessions were less likely to meet their performance goals. The investigators deduced that at least 80% availability for training should be met by athletes participating in individual sports so as not to negatively affect their chances of success. To increase athletic success, they suggested that attention should be paid to injury prevention.

Studies that have assessed the severity of running injuries have revealed that these injuries range from mild to moderate. A study on male marathon runners in the Netherlands showed that they had recovered from injuries they sustained in a race within a week (Van Middelkoop et al., 2007). Similarly, a study on cross country runners in the USA reported that half of the runners with injuries lost less than 4 days in training (mild), 18% lost 5 – 14 days (moderate), 7% lost more than 15 days (severe) and 3% were out for the season (Rauh et al., 2006). Jacobsson et al. (2013) reported that most injuries (51%) sustained by the top Swedish track and field athletes were severe, causing a time loss of over 3 weeks. Notably, different athlete populations sustain varying severities of injury. No published study on the severity of injuries sustained by professional runners in Kenya was found.

2.5 FACTORS ASSOCIATED WITH RUNNING INJURIES

Identifying risk factors is seen as the first step in developing preventative strategies when following an epidemiological control model for general injury control (Lett et al., 2002; van Mechelen, 1992). They are especially useful if modifiable factors can be identified as the information may be used to optimize the training environment of runners (Van der Worp et al., 2015). A number of risk factors that predispose runners to musculoskeletal injuries have been identified, paving the way for the establishment of the aetiology and mechanisms of injury and developing preventative measures.

Risk factors may be intrinsic or extrinsic. Some intrinsic risk factors that have been explored in literature include personal factors such as age and gender, anthropometric factors such as weight, height and joint flexibility imbalances, health and lifestyle factors such as history of comorbidities or previous injuries. Extrinsic factors include training variables such as training load and type, equipment and training surfaces. Recent systematic reviews seem to agree that running injuries are multifactorial and that there exists conflicting results on the factors associated with running injuries. The different results seem to be due to the different methodologies, definitions, outcome measures and study populations used in different studies (Saragiotto et al., 2014; Van der Worp et al., 2015; Van Gent et al., 2007).

2.5.1 Age and gender

Most authors agree that age and gender have no significant association with the overall incidence of musculoskeletal running injuries (Jacobsson et al., 2013; Macera et al., 1989; Saragiotto et al., 2014; Wen, 2007). However some gender differences have been noted in the pattern of injuries sustained. Female runners have been shown to be at a higher risk of stress fractures (Milner et al., 2006; Shaffer et al., 2006). Mbarak et al. (2019) in their cross sectional study in Kenya determined that females runners sustained more hip injuries while male runners sustained more groin injuries. A Canadian study demonstrated that recreational runners over 50 years of age had a higher overall injury incidence although this has not been replicated in other studies (Taunton, 2003).

2.5.2 BMI and flexibility

In studies whose populations included professional runners, Body Mass Index (BMI) has not been found to be a significant factor influencing the incidence of running injuries (Saragiotto et al., 2014; Van Gent et al., 2007; van Mechelen et al., 1992). Taunton et al. (2003) whose population included recreational runners showed that in men, a BMI over 26kg/m^2 was protective over running injuries. This has not been replicated in studies on professional runners and is likely due to the small variability in the BMI of these runners. Their BMIs nonetheless, are more likely to be below 25kg/mg^2.

Static flexibility may be measured using the end range of motion at a joint using goniometry. Ankle, knee and hip joint flexibility range of motion measurements are considered to be ‘running specific’ (Anderson, 2013). The sit and reach test (Canadian forward flexion bending test) has also been used to measure hip and back flexibility (Hreljac et al., 2000; Trehearn & Buresh, 2009). Contrary to popular belief, increased flexibility has not been consistently shown to protect from running injury. A review of US army data showed that soldiers in the extremes of flexibility sustained more training injuries (Knapik et al., 1991). On the contrary, retrospective study of runners in the USA revealed that those who had been injury free were more flexible according to the sit and reach tests scores (Hreljac et al., 2000). Poor flexibility may influence running mechanics by placing more stress on adjacent joints. It may also be indicative of muscle imbalance which could facilitate early fatigue. Both these factors may lead to injury. A study on US female collegiate athletes revealed that imbalances between the right and left hip extensors by 15% was a risk factor for lower extremity injury (Knapik et al., 1991).

2.5.3 Experience and previous injury

Experience could be an obvious risk for overuse injuries since experienced runners have accumulated more mileage. It could also be protective since more experienced runners may have better technique and conditioning. Studies that have shown experience to be a protective factor have been taken skeptically because they may represent the ‘survival phenomenon’ bias. This is a where the more experienced runners are still running because they have “survived” the injuries that cause many runners to leave the sport. Most literature agrees that experience is not associated with the incidence of running injury although a review by van Mechelen et al. identified it as protective (Van Gent et al., 2007; van Mechelen, 1992; Wen, 2007).

Previous injury, described as having sustained a similar injury in the past 12 months has been identified in numerous systematic reviews as being a risk factor for running injury (Jacobsson et al., 2013; Rauh et al., 2006; Saragiotto et al., 2014; Van Gent et al., 2007). This may be due to the runner resuming activity before the injured tissues have full recovered. Meeuwisse et al. (2007) reported that athletes would continue participating in athletics despite reporting injury and thus remain exposed to the injury risk.

CONCEPTUAL FRAMEWORK

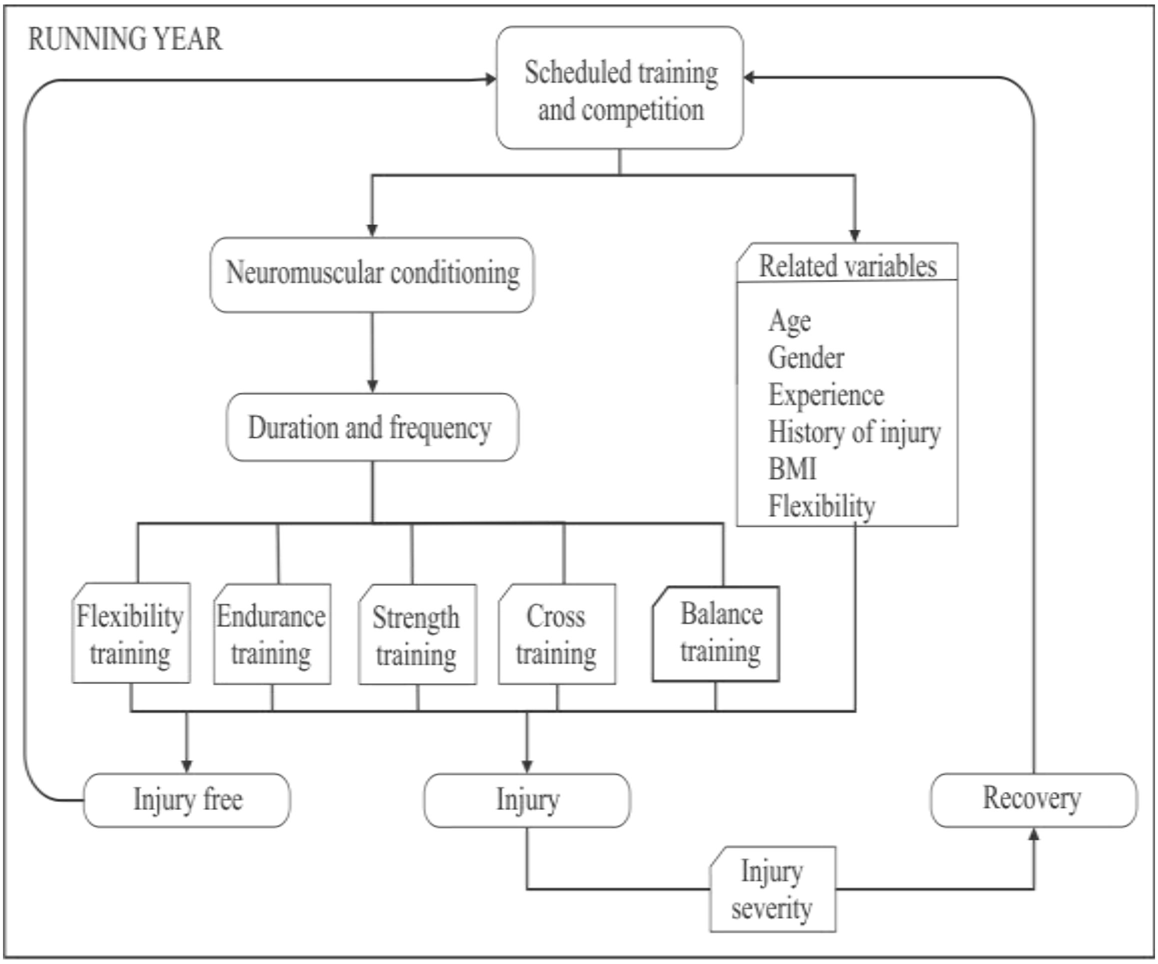

Figure 4: Conceptual framework

CHAPTER THREE

3.0 METHODOLOGY

3.1 INTRODUCTION

Evaluating sports injury prevention strategies as being used in the real world is seen as an important research area in sport injury (Finch, 2006). Studies on sports injuries have been criticized for not using epidemiological analytic models, with many of them being of the case series type and also for focusing on injury and treatment rather than prevention. Injury surveillance has been commendable during competition, but more surveillance needs to be done during the training period. Considering the health outcome, i.e. sport injuries, is fairly common, the prospective study design is the ideal methodology that has been recommended by various authors (Jacobsson et al., 2010, 2013; Waller et al., 1994).

This study was an observational, longitudinal study using the prospective descriptive design. Athletes were followed up both in training and competition. Standardized definitions of injury were used and proven models of sport injury research applied.

3.2 STUDY AREA

Kenya is known to be a leader in the athletics world, particularly in the mid to long distance running events (Pitsiladis et al., 2004). A large percentage of Kenyan athletes hail from the Rift Valley region which is also home to a good number of athletic training camps (Onywera et al., 2006).

This study was carried out in athlete training camps in the North Rift region of Kenya. These included Adidas camp - Kapsabet, Nike camp – Kapsabet, in Nandi county; Annex club in Uasin Gishu county; Adidas camp - Iten, Rosa camp - Kaptagat, Global

Sports – Kaptagat, Pace camp – Kaptagat, Complete Sport camp – Kaptagat, in Elgeyo Marakwet county.

3.3 RESEARCH DESIGN

Researcher carried out a prospective descriptive study.

3.4 POPULATION

Professional runners in the North Rift region.

3.5 Eligibility Criteria

3.5.1 Inclusion criteria

- All runners planning to participate in an official competitive event within a year of the study period.
- Accessible by telephone at least once a month.

3.5.2 Exclusion criteria

- Runners currently nursing an injury.
- Para athletes.

3.6 SAMPLING FRAME

Professional runners that train in selected camps in North Rift Kenya.

3.7 SAMPLING DESIGN

Stratified simple random sampling was used to recruit the runners into the study. The strata were the training camps where professional athletes train. The training camps were chosen purposively. Simple random sampling done by ballot method was then employed to select the runners in each camp to participate in the study as illustrated in Figure 5: Study flow.

3.7 SAMPLE SIZE DETERMINATION

An aim of the study was to assess the incidence and severity of running related musculoskeletal sports injuries among the runners in North-Rift, Kenya. Literature shows that the incidence rate of these injuries range from 6.8 to 59.0 per 1000 hours of training (Lopes et al., 2012). In order to calculate the sample size required to study the incidence of injuries, the researcher assumed an average incidence rate of 46.2 per 1000 hours of training derived from the upper quartile of the uniform distribution. The incidence rate follows a Poisson distribution hence in order to be 95% confident that the researcher determined the incidence rate of running related musculoskeletal injuries among the runners to within plus or minus 5% of 46.2 per 1000 hours of training, the sample size was calculated using the following formula (Cochran, 1963).

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

$$= \left(\frac{1.96}{0.05}\right) \times {}^{46.2}/_{1000}$$

$$= 84$$

Where

$Z_c = 1.96$ is the quantile of the standard normal distribution,

$c = (1 - {}^{\alpha}/_{2})$

$\alpha = 0.5$ (Type 1 error rate equal to 5%)

μ is the incidence rate per unit time (unit is one hour), which is equal to the variance for Poisson distribution.

In anticipation of a nonresponse rate of 5% in this population, the sample size was adjusted to account for this by increasing it by 5%. This resulted in, $\frac{n}{1-r} = \frac{84}{1-0.05} = \frac{84}{0.95} \cong 89$ where r is the nonresponse rate.

The researcher assumed sampling from infinite population hence required a total of 89 runners.

3.8 DATA TYPES AND SOURCES

It has been shown in previous injury research in individual sports, that data collected from players directly, rather than by mail, and continuously, rather than in a single interview, would provide more accurate data (Hreljac, 2004; Waller et al., 1994).

Data from this study was of the quantitative type. Discrete data was recorded when documenting player profiles, injuries or neuromuscular conditioning strategies and continuous when recording some aspects of the player profiles such as height, weight and joint range of motion.

3.9 MATERIALS AND METHODS

Following approval by IREC, data was collected in two phases. The first phase was done from November 2018 to January 2019. It involved direct contact with the participants where an interviewer-administered questionnaire was used to record runner profiles and data on their health, training regimen, preventative strategies used and competition calendar data and to record anthropometric measurements. Joint range of motion was measured using calibrated digital and analogue goniometers, hamstring and back flexibility was measured using a calibrated sit and reach test box. A calibrated stadiometer and digital weighing scale were used to measure height and weight respectively. Digital instruments were zeroed before each measurement. The instruments that were used are shown in Appendix 3: Measuring instruments. At this point, the contact details of the subjects was recorded and stored securely. Participants were provided with training diaries to aid them in keeping track of their training and injuries (Appendix 9: Training diary).

Phase two of data collection was done during the sports year, from January 2019 to December 2019. Two-monthly interviewer administered questionnaires were administered by phone to collect training and injury data which included both on and off-season periods. Injuries sustained and their severity was recorded over the study period using standard definitions and collection procedures. The two data collection questionnaires are included as appendices in this thesis (Appendix 5: Preliminary questionnaire, Appendix 6: Mid-year questionnaire).

3.10 DATA MANAGEMENT

The filled questionnaires were kept in a safe cabinet under a lock and the key kept by the investigator.

Data entry was done into a standard database created using Microsoft access. The participant data was de-identified of any identifying information and the database was encrypted with password to ensure that confidentiality is maintained. The password was accessible to the researcher alone. The entered data was checked for consistency, missing data among other integrity issues, and cleaned appropriately. After data entry and data cleaning was finalized, encrypted backups of the database were created and stored in separate password protected cloud accounts. The cleaned copy of the database was available for analysis.

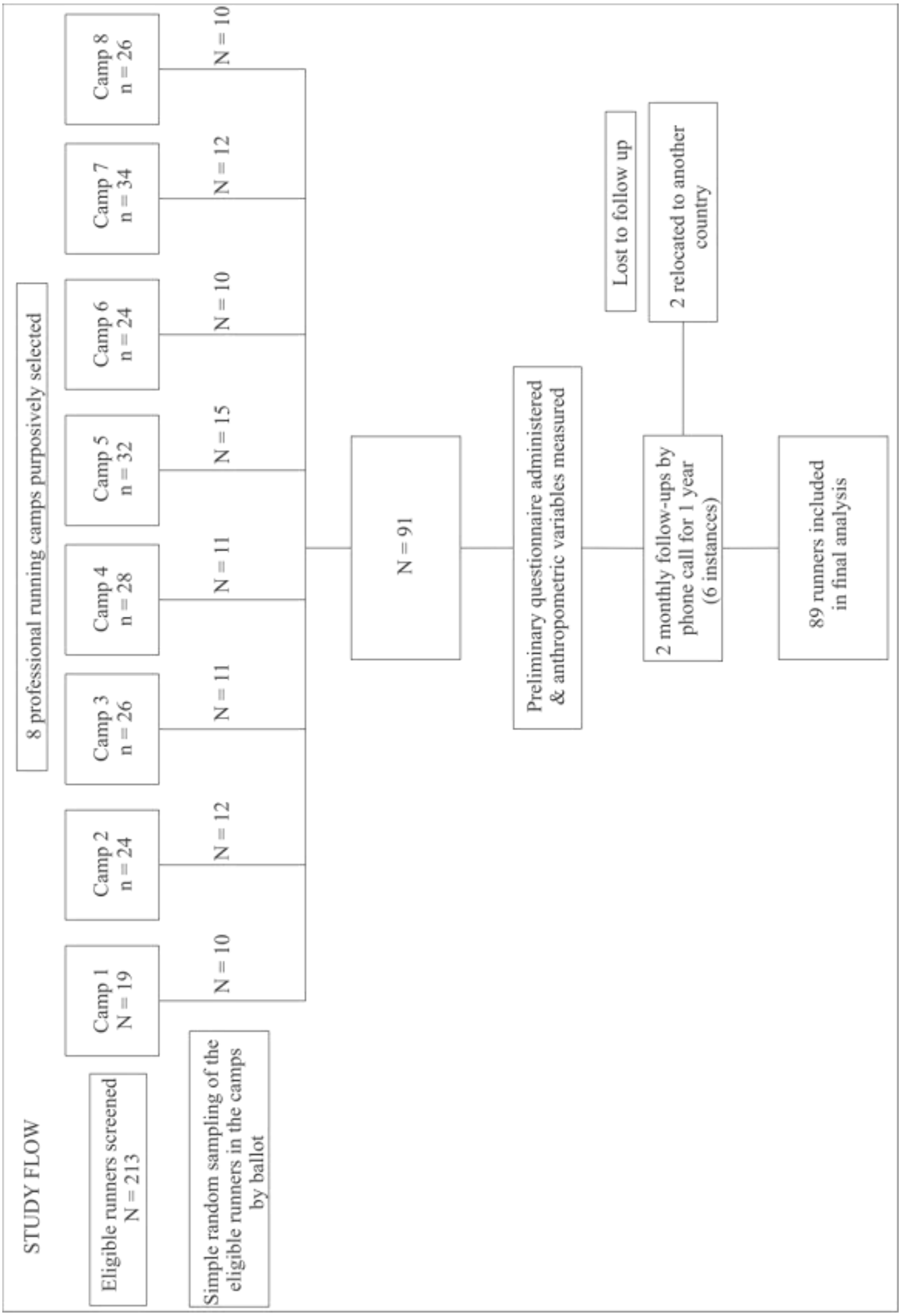

Figure 5: Study flow

3.11 STATISTICAL DATA ANALYSIS

Descriptive statistics for the measures of central tendency such as the mean and the median, as well as the measures of dispersion (standard deviation, and inter quartile range) were used to summarize continuous variables such as age, duration of training, and the duration off the training as a result of the injuries (severity of the injuries) among others.

Categorical variables such as gender, neuromuscular conditioning strategies, and musculoskeletal injuries among others were summarized using frequencies and the corresponding percentages.

Incidence rate of musculoskeletal injuries was computed as the total number of musculoskeletal injuries divided by the total training time during the period of the study.

Associations between athlete variables and the injury incidence were tested. Chi square test and Fisher's exact test were used for categorical variables such as neuromuscular conditioning strategies used, BMI and flexibility test categories. Wilcoxon rank-sum test was used for continuous variables such as age and years of experience.

Data analysis was done using R: A language and environment for statistical computing (Team, 2019).

3.12 VARIABLES AND MEASUREMENTS

Independent variables:

- Age, gender.
- Neuromuscular conditioning strategies used, running experience, injury history.
- BMI, lower limb flexibility.

Dependent variables:

- Incidence of running injuries sustained.
- Severity of running injuries sustained.

3.13 ETHICAL ISSUES

The study proposal was submitted to Institutional Research Ethics Committee (IREC) of Moi Teaching and Referral Hospital/Moi University for approval. A formal approval number, FAN: IREC 2071, was granted (Appendix 4: IREC approval). The study procedures were explained to each participant prior to obtaining an informed consent document in either English or Kiswahili (Appendix 7: Consent form (English), Appendix 8: Consent form (Kiswahili)). Confidentiality and privacy was maintained throughout the study period. Injured runners were referred for appropriate care.

3.14 LIMITATIONS OF THE STUDY

Being a prospective design, there was a risk of loss of participants to follow up. This was been mitigated by prophylactically increasing the sample size by a factor to correct for any losses. Also the researcher maintained a good rapport with the participants.

Injury diagnosis was made on history alone. This was mitigated by ensuring a comprehensive injury history was taken and corroborating the findings with the physiotherapy staff in the training camps.

CHAPTER FOUR

4.0 RESULTS

4.1 Demographic characteristics

A total of 89 professional runners participated in the study of whom 66 were male and 23 were female. Ages of the participants ranged from 17 years to 43 years, with a mean age of 26.12 (SD 5.05). Sixteen were educated to primary level, 60 to secondary level and 13 had received tertiary level education.

4.2 Athletic profile

Participants being athletically coached in groups were 73 (82%), 5 (6%) had personal coaches whereas 11 (12%) had no coach. Most of the participants, 79 (89%), were members of either a sports club or a sports camp; 17 (19%) of the participants were members of a gym.

The mean number of years in the field was 5.98 years (SD = 4.69). The majority of study participants had competed in the international level (64%); 19% had competed in national events while 17% had competed in regional events as shown in Figure 6.

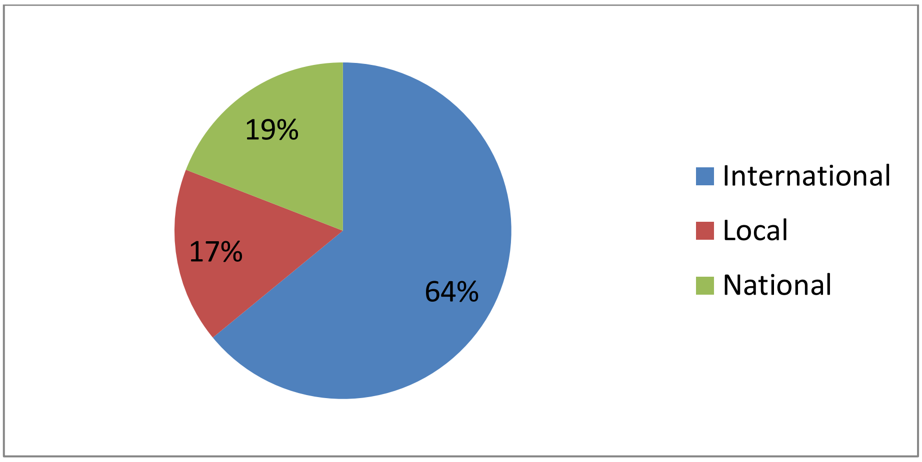

Figure 6: Level of competition

Very few reported to have participated in sprints with only 3 (3.37%) having participated in 400m. Figure 7 shows the distribution by various distances.

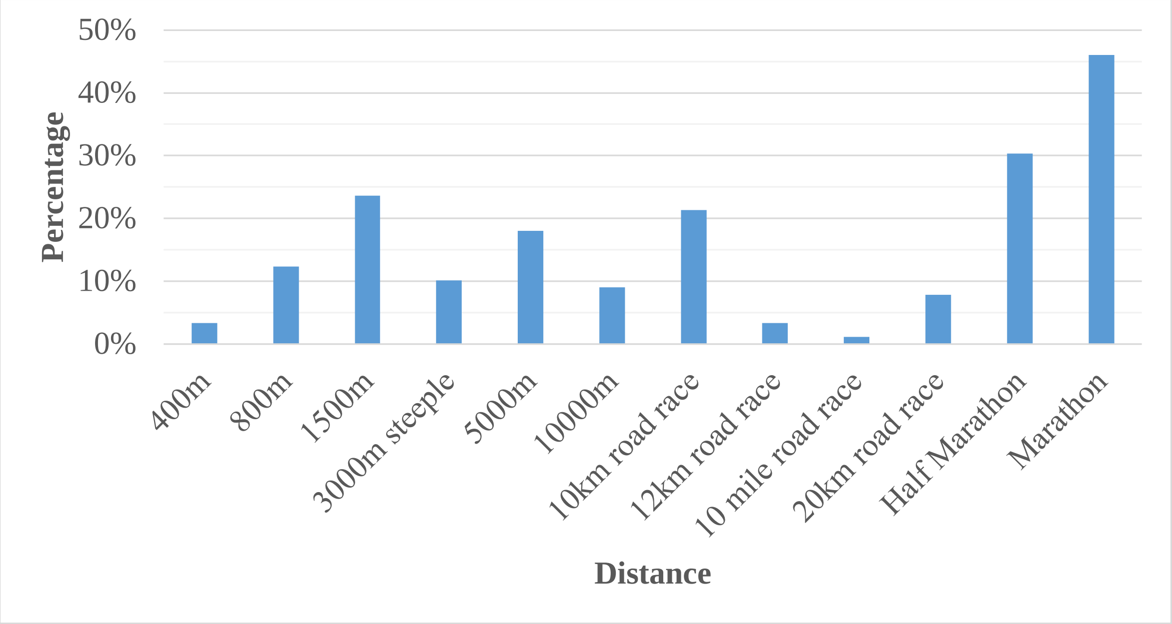

Figure 7: Participation in events

4.3 ANTHROPOMETRIC CHARACTERISTICS

The height of the male participants ranged from 161 cm to 209 cm with a mean of 173.37 cm (SD = 7.33). The height of the female athletes range from 153 cm to 178 cm with a mean of 161.71 cm (SD = 5.8). The weight of the male athletes ranged from 46.5 kg to 71.5 kg with a mean of 57.3 kg (SD = 5.56). The weight of the female participants ranged from 42.8 kg to 60.4 kg with a mean of 48.55 kg (SD = 4.66). The average BMI of the male athletes was 19.09 (SD = 1.59) while that of the female athletes was 18.56 (SD = 1.49). Most (71.2%) of the male athletes fell within the normal range of BMI, while some, (28.8%) fell in the underweight category. More than half (56.5%) of the female athletes were underweight, 10 (43.5%) were of normal BMI. None of the participants were overweight nor obese. Table 1 shows the distribution according to BMI.

Table 1: BMI of participants

BMI	Total (n = 89)	Male (n = 66)	Female (n = 23)
	No. (%)	No. (%)	No. (%)
Underweight	32 (36.0)	19 (28.8)	13 (56.5)

Normal	57 (64.0)	47 (71.2)	10 (43.5)

The average range of motion of various joints of the lower limbs of the athletes are shown in Table 2.

Table 2: Joint range of motion

Joint	**Range of Motion (degrees)**			
	Female		Male	
	Right	Left	Right	Left
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Ankle				
Dorsiflexion	29.76 (8.91)	30.76 (9.9)	33.33 (11.76)	34.73 (12.7)
Plantarflexion	27.1 (9.23)	28 (9.89)	27.5 (7.55)	28.03 (7.89)
Intertarsal				
Inversion	26.67 (7.96)	25 (6.2)	25.77 (8.32)	25.67 (7.8)
Eversion	18.55 (5.82)	19.57 (6.33)	20.3 (8.55)	20.2 (7.45)
Metatarsophalangeal				
Flexion	32.81 (9.43)	34.29 (9.07)	34.44 (9.13)	34.33 (9.32)
Extension	32.14 (8.33)	31.38 (8.56)	35.81 (9.72)	36.73 (10.2)
Abduction	16 (3.51)	17 (3.97)	19.6 (9.12)	18.62 (7.21)
Adduction	16.71 (7.15)	16.48 (7.47)	18.29 (15.14)	17.67 (15.65)
Knee				
Flexion	125.68 (8.23)	125.95 (7.15)	115.16 (30.34)	139 (138.95)
Hip ROM				
Flexion	119.36 (8.03)	119.55 (7.4)	111.89 (20.23)	112.23 (19.22)
Extension	14.05 (2.89)	13.41 (4.01)	22.52 (27.9)	15.52 (13.07)
Internal Rotation	38.55 (7.78)	36.55 (7.03)	32.69 (9.48)	34.63 (9.47)
External Rotation	31.32 (8.57)	31.09 (9.22)	32.3 (7.79)	32.45 (9.8)
Abduction	34.32 (7.47)	34.45 (7.04)	31.31 (8.25)	31.55 (9.43)
Adduction	26.05 (6.06)	26.5 (5.86)	24.81 (8.01)	24.7 (8.55)

Half (45) of the participants were in the ‘need improvement’ category of the sit and reach test, 16 (18%) scored ‘fair’, 12 (13.5%) scored ‘good’, 10 (11.2%) scored ‘very good’ and 6 (6.7%) scored ‘excellent’ as shown in Table 3 below.

Table 3: Sit and reach test scores

Category:	Excellent	Very good	Good	Fair	Needs improvement
Frequency	6	10	12	16	45
Percentage	6.74	11.24	13.48	18	50.56

4.4 INJURY AND LIFESTYLE PROFILE

Most of the athletes, 66 (75%) had suffered a sports injury before. Only 5 (5.6%) of the participants took alcohol. None of them smoked cigarettes and none were suffering from chronic lifestyle illnesses.

4.5 NEUROMUSCULAR CONDITIONING STRATEGIES

Table 4 shows the different neuromuscular conditioning strategies that the participants were involved in during the study period and the mean time in minutes that they spent on each strategy.

Most of the participants spent a majority of their training time on endurance training; 88 participants spent an average of 174 minutes per week on slow distance training, 15 participants spent an average of 63 minutes on repetition training, 83 participants spent 38 minutes per week on interval training and 73 participants spent an average of 29 minutes per week on fartlek runs.

Almost all the participants (83) incorporated stretches in their training routine, spending an average of 87 minutes per week on stretches. The 79 participants who would warm up before training spent an average of 112 minutes per week doing so.

The most popular strength training strategy was calisthenics training, where 77 athletes spent an average of 35 minutes per week training. Less than half of the participants incorporated either resistance training (31) or plyometric training (40) in their routine. These participants spent an average of 26 minutes and 42 minutes per week on these strategies respectively.

Just over half of the participants (45) did single leg exercises for balance training, spending an average of 14 minutes per week on these. The 5 that incorporated balance board exercises in their training spent an average of 23 minutes per week on balance board training.

Very few participants did a form of cross training with only 2 participants being involved in swimming and 1 participant in cycling.

Table 4: Neuromuscular conditioning strategies used

Training strategy	Number of athletes that utilized strategy	Ave minutes per week (SD)
Flexibility training		
Warm up	79	111.76 (48.52)
Stretches	83	86.79 (51.12)
Strength training		
Resistance	31	26.35 (18.12)
Calisthenics	77	34.66 (33.66)
Plyometrics	40	41.90 (49.94)
Endurance training		
Slow distance training	88	173.60 (99.89)
Interval training	83	38.28 (19.96)
Repetition training	15	63.00 (52.86)
Fartlek	73	28.93 (8.74)
Cross training		
Swimming	2	32.50 (3.54)
Cycling	1	43.75
Balance training		
Balance board	5	23 (41.66)
Single leg exercises	45	13.84 (8.82)

4.6 INJURY INCIDENCE

During the follow up period, 57 (64.4%) athletes reported an injury.

The incidence rate of injuries was 42.40 injuries per 1000 hours of training (95% CI: 33.33, 51.47).

4.7 INJURY SEVERITY

Of the 57 participants who reported an injury during follow up, 14 (24.56%) suffered non – time loss (slight) injuries while 43 (75.44%) suffered time loss injuries.

The mean time lost was 12.86 days (SD =24.08) and median was 5 (1, 14). As illustrated in Table 5, 14 (32.56%) of these athletes lost between 1 and 4 days of training and competition due to their injury (mild), 17 (39.53%) lost between 5 and 14 days (moderate) while 12 (27.91%) lost more than 15 days (severe). None of the injuries sustained were so severe as to take the participant out of participation in training and competition for the entire season.

Table 5: Distribution of time loss injuries

Time loss in Days	n (%)
1 – 4	14 (32.56)
5 – 14	17 (39.53)
> 15	12 (27.91)
Out for the season	-

4.8 FACTORS ASSOCIATED WITH RUNNING INJURIES

There was no significant association found between the age nor gender of the participants and injury incidence as shown in Table 6 below.

Table 6: Association between participant demographics and injury

	Injury free	Injured	P-values
Age	**Median (IQR)**		
Age in years	28 (23, 30)	26 (22,29)	0.168[1]
Gender	**Frequency (%)**		
Female	8 (34.8)	15 (65.2)	
Male	24 (36.4)	42 (63.6)	0.892[2]

[1]Wilcoxon rank sum test, [2]Chi square test.

The running experience and history of having suffered an injury in the season before were also not significantly associated with injury incidence as illustrated in

Table 7.

Table 7: Association between participant athletic profile and injury

	Injury free	Injured	P-values
Experience	**Median (IQR)**		
Years of experience	5.5(3, 9.5)	5 (2,8)	0.147[1]
Injuries before	**Frequency (%)**		
No	7 (31.82)	15 (68.18)	
Yes	25 (37.31)	42 (62.69)	0.8[2]

[1]Wilcoxon rank sum test, [2]Fisher's exact test.

Anthropometric measurements such as BMI and preseason hamstring and back flexibility as measured by the sit and reach test were not significantly associated with injury incidence. These tests of associations are shown in Table 8 below. Flexibility imbalances between right and left sides were also not significantly associated with injury incidence. This is illustrated in Table 12, Appendix 1: Flexibility imbalance and injury (Page 57).

Table 8: Association between anthropometric variables and injury

	Injury free	Injured	P-values
BMI	**Frequency (%)**		
Underweight	13 (40.6)	19 (59.4)	
Normal	19 (33.3)	38 (66.7)	0.5[1]
Sit and Reach			
Excellent	3 (50.0)	3 (50.0)	
Very good	4 (40.0)	6 (60.0)	
Good	3 (25.0)	9 (75.0)	
Fair	5 (31.25)	11 (68.75)	
Need Improvement	16 (35.56)	29 (65.44)	0.853[1]

[1]Fisher's exact test

As shown in Table 9, there was no significant difference in injury incidence between participants who participated in a particular neuromuscular conditioning strategy and those who did not.

Table 9: Association between neuromuscular conditioning strategies used and injury incidence

Neuromuscular conditioning strategy	Injury free	Injured	P-values
	Frequency (%)		
Warm up			
No	2 (20)	8 (80)	
Yes	30 (38)	49 (62)	0.32[1]
Stretching			
No	2 (33.3)	4 (66.7)	
Yes	30 (36.1)	53 (63.9)	1[1]
Resistance			
No	18 (31)	40 (69)	
Yes	14 (45.2)	17 (54.8)	0.186[2]
Calisthenics			
No	6 (50)	6 (50)	
Yes	26 (33.8)	51 (66.2)	0.337[1]
Plyometrics			
No	17 (34.7)	32 (65.3)	
Yes	15 (37.5)	25 (62.5)	0.784[2]
Slow distance training			
No	0 (0)	1 (100)	
Yes	32 (36.4)	56 (63.6)	1[1]
Interval training			
No	1 (16.7)	5 (83.3)	
Yes	31 (37.3)	52 (62.7)	0.413[1]
Repetition training			
No	28 (37.8)	46 (62.2)	
Yes	4 (26.7)	11 (73.3)	0.559[1]
Fartlek			
No	4 (25)	12 (75)	
Yes	28 (38.4)	45 (61.6)	0.396[1]
Single leg exercises			
No	16 (36.4)	28 (63.6)	
Yes	16 (35.6)	29 (64.4)	0.937[2]

[1]Fisher's exact test, [2]Chi square test.

As shown in Table 10, there was a statistically significance difference in injury severity among injured runners who participated in single leg balance exercises and those that did not. Those runners that did tended to sustain more non-time loss injuries (slight) or injuries that would lose the runner only 1 to 4 days (mild) of participation in running.

Table 10: Association between neuromuscular conditioning strategy used and four categories of injury severity

Neuromuscular conditioning strategy	Injury severity (Time lost in days) None	1 to 4	5 to 14	>14	P-values[1]
	Frequency (%)				
Warm up					
No	3 (37.5)	1 (12.5)	2 (25)	2 (25)	
Yes	11 (22.5)	13 (26.6)	15 (30.6)	10 (20.4)	0.723
Stretching					
No	1 (25)	1 (25)	1 (25)	1 (25)	
Yes	13 (24.5)	13 (24.5)	16 (30.2)	11 (20.6)	0.996
Resistance					
No	8 (20)	10 (25)	12 (30)	10 (25)	
Yes	6 (35.3)	4 (23.5)	5 (29.4)	2 (11.8)	0.544
Calisthenics					
No	2 (33.3)	1 (16.7)	2 (33.3)	1 (16.7)	
Yes	12 (23.5)	12 (23.5)	16 (31.4)	11 (21.6)	0.943
Plyometrics					
No	5 (15.6)	6 (18.8)	12 (37.5)	9 (28.1)	
Yes	9 (36)	7 (28)	6 (24)	3 (12)	0.142
Slow distance training					
No	0 (0)	0 (0)	1 (100)	0 (0)	
Yes	14 (25)	14 (25)	16 (28.6)	12 (21.4)	0.377
Interval training					
No	2 (40)	2 (40)	1 (20)	0 (0)	
Yes	12 (23.1)	12 (23.1)	16 (30.8)	12 (23.1)	0.328
Repetition training					
No	13 (28.3)	9 (19.6)	14 (30.4)	10 (21.8)	
Yes	1 (9.1)	5 (45.5)	4 (36.4)	1 (9.1)	0.205
Fartlek					
No	4 (33.3)	3 (25)	4 (33.3)	1 (8.3)	
Yes	10 (22.2)	11 (24.4)	13 (28.9)	11 (24.4)	0.635
Single leg exercises					
No	4 (14.3)	4 (14.3)	11 (39.3)	9 (32.1)	
Yes	10 (34.5)	9 (31.0)	7 (24.1)	3 (10.3)	0.039

[1]Fisher's exact test.

When further analyzed, runners participating in single leg exercises and runners participating in plyometric strength training both suffered less severe injuries. Those who participated in these neuromuscular conditioning strategies tended to suffer slight to mild injuries. This was statistically significant (p = 0.005, p = 0.026 respectively) as illustrated in Table 11.

Table 11: Association between neuromuscular conditioning strategy used and two categories of injury severity

Neuromuscular conditioning strategy	**Injury severity (Time lost in days)**		
	None and 1 to 4	**5 – 14 and >14**	
	Frequency (%)		**P-values[1]**
Warm up			
No	4 (50)	4 (50)	
Yes	24 (49)	25 (51)	0.957
Stretching			
No	2 (50)	2 (50)	
Yes	26 (49.1)	27 (50.9)	0.971
Resistance			
No	18 (45)	22 (55)	
Yes	10 (58.8)	7 (41.2)	0.340
Calisthenics			
No	3 (50)	3 (50)	
Yes	24 (47.1)	27 (52.9)	0.891
Plyometrics			
No	11 (34.4)	21 (65.6)	
Yes	16 (64)	9 (36)	0.026
Slow distance training			
No	0 (0)	1 (100)	
Yes	28 (50)	28 (50)	0.225
Interval training			
No	4 (80.0)	1 (20.0)	
Yes	24 (46.2)	28 (53.9)	0.148
Repetition training			
No	22 (47.8)	24 (52.2)	
Yes	6 (54.6)	5 (45.5)	0.689
Fartlek			
No	7 (58.3)	5 (41.7)	
Yes	21 (46.7)	24 (53.3)	0.473
Single leg exercises			
No	8 (28.6)	20 (71.4)	
Yes	19 (65.5)	10 (34.5)	0.005

[1]Fishers exact test

CHAPTER FIVE

5.0 DISCUSSION

5.1 NEUROMUSCULAR CONDITIONING STRATEGIES

Majority of the training time of the participants was spent on endurance training. The main type of endurance training was slow distance training. This agrees with a study by Billat et al. (2003) who observed that most Kenyan athletes were involved in low speed training. This may be attributed to the type of events the participants were training for, being long and middle distance events. In a review by Yan et al. (2011) it was shown that endurance training leads to a variety of physiological and biochemical adaptations in skeletal muscle toward a more oxidative phenotype. These changes would lead to better performance in long distance running events.

The second most popular training strategy was flexibility training consisting of warm up (mean of 112 minutes per week) and stretches (87 minutes per week). Its popularity may be due to the perception that stretching reduces injury by improving flexibility. This is despite conflicting reports on the efficacy of stretching in reducing injury. Many authors still encourage athletes to incorporate stretches and warm up in their routine as it may improve carbohydrate uptake and glycogen synthesis in muscles (Anderson, 2013, p. 461).

A majority of athletes incorporated strength training in their routine. The time allocated to this training was less compared to endurance and flexibility. This may be due to the perception that strength training could be detrimental to performance in endurance competitions.

Calisthenics and plyometrics were the main forms of strength training performed by the participants while single leg exercises was the main form of balance training performed by the participants. This may be due to the unavailability of equipment such as weight machines and balance boards for strength and balance training respectively. In their study, Kanyiba et al. (2015) demonstrated that Kenyan running facilities were not adequately equipped.

5.2 INJURY INCIDENCE

In this study, the researcher found an incidence of 42.4 injuries per 1000 hours of training. This contrasts with a study on elite marathon runners by Krabak et al. (2011) who found a rate of 7.2 per 1000 hours of running. The difference could be explained by the different definition of running injuries. In their study, they defined a running injury as disability sustained by a study participant during the race, resulting in a medical encounter by the medical staff. This reduces the incidence since a majority of injuries occur during training and may not be witnessed by medical staff.

Malisoux et al. (2015) and Theisen et al. (2014) carried out studies on recreational runners and found injury rates of 7.6 and 12.1 injuries per 1000 hours of running respectively. The lower rates are also explained by the different definitions of injury used. The authors used a time loss definition, where an injury would have to restrict running for at least one day for it to be considered in the study. Such a high threshold of recording injury would miss a large number of overuse injuries and underestimate the true incidence of running injuries

In this study, injuries were considered regardless of whether they received medical attention or their consequences with respect to impairments in connection with competition or training. This is consistent with the 2014 consensus by Timpka et al. (2014) and explains the higher injury rates reported compared to other studies. A study on recreational runners by Lun et al. (2004) that used a similar definition found a comparably high incidence rate of 59 per 1000 hours.

5.3 INJURY SEVERITY

A majority of the 43 participants who suffered time loss injuries had mild (32.6%) to moderate injuries (39.5%). This concurs with findings in a prospective study done by Rauh et al. (2006) on high school cross country runners where up to 89% of the runners' injuries were either mild or moderate. This may be attributed to the fact that the main type of injuries suffered by middle to long distance runners are of the overuse type. These injuries are caused by repeated non-functional overreaching causing progressive damage to tissues involved in running and usually just need some time to recover. This was also demonstrated in a study by Van Middelkoop et al. (2007) where runners injured in preparation for and during a marathon were followed up and the majority were shown to have remarkably recovered one week after the marathon.

These finding contrasts a study by Jacobsson et al. (2013) where they looked at injury severity among the top 10 track and field athletes in Sweden and found that the majority of time loss injuries suffered were severe (over 3 weeks absence from normal training). The inclusion of other athletic events such as sprints and field events may explain this difference, since these athletes are prone to acute injuries that may require a prolonged recovery time. It should also be noted that decisions regarding need for treatment and return to sport may be biased depending on the overestimation or underestimation of an injury by the coaching team and athlete. This leads to a wide variability of recovery times among running teams and individual runners for seemingly similar injuries. Elite runners especially are eager to resume their training activities and may return to the field before they fully recover from their injuries.

5.4 FACTORS ASSOCIATED WITH RUNNING INJURIES

5.4.1 Demographic variables

Demographic characteristics such as age and gender were found to be not significantly associated with injury. This concurs with the findings in several studies including a prospective study by Macera et al. (1989) in USA and systematic reviews by Saragiotto et al. (2014) and Wen et al. (2007).

Contrastingly, studies by Milner et al. (2006) and Shaffer et al. (2006) showed that women runners are at a higher risk of lower limb stress fractures. A Kenyan study by Mbarak et al. (2019) also showed that female runners sustained more hip injuries while male runners sustained more groin injuries. This may be due to the fact that despite there being biomechanical differences between men and women that would lead to different patterns of injury, the overall incidence of injury between the two genders are similar.

When a wider age bracket is considered, as shown in a study on recreational runners preparing for a marathon by Taunton et al. (2003) where over 50 year olds had a higher risk of injury, greater age may emerge as a risk factor. However, since elite athletes are usually not in the extremes of age, this would not be a concern as shown in this study and in systematic reviews by both Saragiotto et al. (2014) and Wen et al. (2007).

5.4.2 Athletic profile

Running experience was found to have no association with injury incidence. This is similar to findings in reviews by Wen et al. (2007) and Gent et al. (2007);

contrastingly, studies such as one review by van Mechelen (1992) found that experience is a protective factor. The retrospective studies reviewed that showed experience as protective may have been influenced by the ‘healthy runner’ bias since more injury prone runners would stop running and not be included in the study population. Being a prospective study, this selection bias was avoided in this current study and may explain the difference in this finding.

History of previous injury was found not to be associated with injury incidence in the subsequent season. This contrasts with study findings such as that of Jacobsson et al. (2013) that looked at top Swedish athletes and Rauh et al. (2006) that looked at high school cross country runners in USA. Systematic reviews by Gent et al. (2007) and Saragiotto et al. (2014) also contrast this study as they identify previous injury as a risk factor for running injuries. The reason for the difference may be that most of the injuries suffered by the participants in this study were largely mild to moderate in severity and this may likely have been the case in the previous season. If these injuries had completely healed then they are not likely to predispose the athlete to a similar injury when the injured tissues are stressed again.

5.4.3 Anthropometric variables

Neither BMI nor sit and reach test scores were found to be associated with injury. This agrees with studies by van Mechelen et al. (1992), van Gent et al. (2007) and Saragiotto et al. (2014) who reviewed risk factors of running injuries also found no association between these anthropometric measures and running injuries.

In contrast, a study by Taunton et al. (2003) who looked at recreational runners training for a 10 km marathon showed that in males, a BMI of >26 kg/m^2 was protective of injuries. In this study, most runners were highly conditioned professional runners and were all within similar BMI categories thus no significant association was found.

Most studies agree that greater flexibility in runners is not significantly associated with injury. In contrast, a study by Hreljac et al. (2000) found that a group of runners that had been injury free in their careers had better sit and reach scores compared to a group that had suffered injuries. Greater flexibility may allow tissues to operate within larger ranges of motion before reaching limits which would cause injury, thus being protective but may also lead to undesirable laxity that leads to injury from error. In this study, no significant difference in flexibility was found between injured and non-injured participants.

5.4.4 Neuromuscular conditioning strategies

There was no difference in injury incidence and severity between runners who practices flexibility training such as stretching and warm up compared to those who did not. This agrees with a systematic review by Thacker et al. (2004) that showed no significant reduction in sports injuries with stretching and a study by van Mechelen et al. (1993) that showed no change in running injury incidence with warm up and stretching. Running largely does not involve a high intensity of stretch-shortening cycles thus the muscle-tendon unit compliance that flexibility training aims to improve may not be needed. Furthermore, many muscle injuries occur within a normal range of motion rather than the extremes.

Strength training by resistance and calisthenics exercises did not have a significant effect on injury incidence and severity. However, runners who trained in plyometric strengthening sustained significantly more slight to mild injuries than moderate to severe injuries compared to the runners that did not. This may be explained by the neuromuscular adaptations that are induced by plyometric training that improve the dynamic stability at the joints. The findings agrees with a USA study on female athletes that showed a reduction in knee injuries following plyometric training. An experimental study in the USA on hockey and soccer players also showed beneficial muscle preparatory activation following plyometric training (Chimera et al., 2004; Hewett et al., 1999).

Balance training by single leg exercises did not have a significant effect on injury incidence but was noted to have an effect on injury severity. Injured runners who did single leg exercises tended to have slight to mild injuries while those who did not tended to have moderate to severe injuries. This agrees with the systematic review by Hübscher et al. (2010) that demonstrated the protective effect of balance training on sports injuries. Single leg exercises improve proprioception. This may be beneficial to runners by triggering the appropriate neuromuscular responses to avert severe injury.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The neuromuscular conditioning strategy runners spent most time on was endurance training followed by flexibility training then strength training. The most popular types of these strategies was slow distance training, warm ups and calisthenics respectively.

The incidence rate of injuries was high at 42.40 injuries per 1000 hours of training with most of the injuries being mild to moderate in severity.

Age, gender, running experience, injury history, BMI, lower limb flexibility, neuromuscular conditioning strategies used were not significantly associated with the incidence of running injury in professional runners. However, balance training by use of single leg exercises and strength training by plyometrics was associated with less severe musculoskeletal injuries sustained by runners ($p = 0.005$, $p = 0.026$ respectively).

6.2 RECOMMENDATIONS

Professional runners should perform single leg balance training and plyometric strength training to mitigate the severity of running injuries they may suffer. Sporting bodies such as Athletics Kenya may support this by partnering with coaches and sports medicine practitioners to develop training manuals that incorporate these neuromuscular conditioning exercises.

Since this was a descriptive study, prospective cohort studies are necessary to quantify the protective factor conferred by training in plyometric strength and single leg balance exercises.

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APPENDICES

APPENDIX 1: FLEXIBILITY IMBALANCE AND INJURY

Table 12: Association between joint flexibility imbalance and injury

	Injury free	Injured	
	Frequency (%)		**P-values (Fisher's exact test)**
Ankle Dorsiflexion			
Q1	8 (36.4)	14 (63.6)	
Q2	10 (30.3)	23 (69.7)	
Q3	4 (40)	6 (60)	
Q4	9 (42.9)	12 (57.1)	0.81
Ankle Plantarflexion			
Q1	7 (31.8)	15 (68.2)	
Q2	11 (32.4)	23 (67.6)	
Q3	6 (60)	4 (40)	
Q4	7 (35)	13 (65)	0.412
Intertarsal Inversion			
Q1	9 (40.9)	13 (59.1)	
Q2	10 (45.5)	12 (54.5)	
Q3	7 (33.3)	14 (66.7)	
Q4	5 (23.8)	16 (76.2)	0.475
Intertarsal Eversion			
Q1	9 (40.9)	13 (59.1)	
Q2	12 (37.5)	20 (62.5)	
Q3	4 (36.4)	7 (63.6)	
Q4	6 (28.6)	15 (71.4)	0.858
Metatarsophalangeal Flexion			
Q1	9 (39.1)	14 (60.9)	
Q2	10 (38.5)	16 (61.5)	
Q3	4 (26.7)	11 (73.3)	
Q4	7 (33.3)	14 (66.7)	0.853
Metatarsophalangeal Extension			
Q1	13 (59.1)	9 (40.9)	
Q2	7 (29.2)	17 (70.8)	
Q3	5 (27.8)	13 (72.2)	
Q4	5 (23.8)	16 (76.2)	0.057
Metatarsophalangeal Abduction			
Q1	8 (32)	17 (68)	
Q2	13 (41.9)	18 (58.1)	
Q3	3 (30)	7 (70)	
Q4	6 (31.6)	13 (68.4)	0.812

Metatarsophalangeal Adduction			
Q1	9 (40.9)	13 (59.1)	
Q2	8 (30.8)	18 (69.2)	
Q3	9 (42.9)	12 (57.1)	
Q4	4 (25)	12 (75)	0.614
Knee Flexion			
Q1	10 (45.5)	12 (54.5)	
Q2	10 (31.3)	22 (68.8)	
Q3	6 (50)	6 (50)	
Q4	5 (23.8)	16 (76.2)	0.314
Hip ROM Flexion			
Q1	9 (40.9)	13 (59.1)	
Q2	10 (38.5)	16 (61.5)	
Q3	5 (27.8)	13 (72.2)	
Q4	7 (33.3)	14 (66.7)	0.828
Hip ROM Extension			
Q1	7 (31.8)	15 (68.2)	
Q2	11 (31.4)	24 (68.6)	
Q3	6 (60)	4 (40)	
Q4	7 (35)	13 (65)	0.391
Hip ROM Intern_Rotation			
Q1	9 (40.9)	13 (59.1)	
Q2	13 (43.3)	17 (56.7)	
Q3	5 (33.3)	10 (66.7)	
Q4	4 (20)	16 (80)	0.361
Hip ROM Extern_Rotation			
Q1	8 (36.4)	14 (63.6)	
Q2	10 (29.4)	24 (70.6)	
Q3	6 (60)	4 (40)	
Q4	7 (33.3)	14 (66.7)	0.359
Hip ROM Adduction			
Q1	9 (39.1)	14 (60.9)	
Q2	10 (28.6)	25 (71.4)	
Q3	3 (37.5)	5 (62.5)	
Q4	9 (42.9)	12 (57.1)	0.712

APPENDIX 2: SIT AND REACH, BMI, INJURY SEVERITY CATEGORIES

Table 13: Sit and reach test categories

TABLE 4.16. Fitness Categories for Trunk Forward Flexion Using a Sit-and-Reach Box (cm)[a] by Age and Sex

	Age (year)									
Category	**20–29**		**30–39**		**40–49**		**50–59**		**60–69**	
Sex	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**
Excellent	40	41	38	41	35	38	35	39	33	35
Very good	39	40	37	40	34	37	34	38	32	34
	34	37	33	36	29	34	28	33	25	31
Good	33	36	32	35	28	33	27	32	24	30
	30	33	28	32	24	30	24	30	20	27
Fair	29	32	27	31	23	29	23	29	19	26
	25	28	23	27	18	25	16	25	15	23
Needs improvement	24	27	22	26	17	24	15	24	14	22

[a]These norms are based on a sit-and-reach box in which the "zero" point is set at 26 cm. When using a box in which the zero point is set at 23 cm, subtract 3 cm from each value in this table.

M, men; W, women.

Adopted from Pescatello, L. S., Medicine, A. C. of S., Riebe, D., & Thompson, P. D. (2014). *ACSM's Guidelines for Exercise Testing and Prescription*. Wolters Kluwer Health.

Table 14: BMI categories

BMI* (kg/m^2)	**Category**
>18.5	Underweight
18.5 – 24.99	Normal
25.0 – 29.99	Overweight
≥30.00	Obese

$$*BMI = \frac{(weight\ in\ kilograms)}{(height\ in\ metres)^2}$$

Adopted from *Physical Status: The Use and Interpretation of Anthropometry : Report of a WHO Expert Committee*. World Health Organization.

Table 15: Injury severity categories

Time lost in days	**Category**
< 1	Slight
1 – 4	Mild
5 – 14	Moderate
> 15	Severe
Out for the season	Very severe

Adopted from Rauh, M. J., Koepsell, T. D., Rivara, F. P., Margherita, A. J., & Rice, S. G. (2006). Epidemiology of musculoskeletal injuries among high school cross-country runners. *American Journal of Epidemiology*, *163*(2), 151–159.

APPENDIX 3: MEASURING INSTRUMENTS

1

2

3

4

1. Goniometers
2. Sit and reach box
3. Stadiometer
4. Weighing scale

Figure 8: Measuring instruments

APPENDIX 4: IREC APPROVAL

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

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

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET

Reference: IREC/2017/217
Approval Number: 0002071

1st March, 2018

Dr. Mbaka Steve Nyaundi,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
01 MAR 2018
APPROVED
P. O. Box 4606 - 30100 ELDORET

Dear Dr. Mbaka,

RE: FORMAL APPROVAL

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

"Neuromuscular Conditioning Strategies used, Incidence, Severity, and Predictors of Musculoskeletal Injuries Sustained by Professional Runners in North Rift, Kenya".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 2071*** on 1st March, 2018. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 28th February, 2019. 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,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

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

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

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

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2017/217
Approval Number: 0002071

1st March, 2019

Dr. Mbaka Steve Nyaundi,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
01 MAR 2019
APPROVED
P. O. Box 4606-30100 ELDORET

Dear Dr. Mbaka,

RE: CONTINUING APPROVAL

The Institutional Research and Ethics Committee has reviewed your request for continuing approval to your study titled:-

"Neuromuscular Conditioning Strategies used, Incidence, Severity and Predictors of Musculoskeletal Injuries Sustained by Professional Runners in North Rift, Kenya".

Your proposal has been granted a Continuing Approval with effect from 1st March, 2019. You are therefore permitted to continue with your study.

Note that this approval is for 1 year; it will thus expire on 28th February, 2020. 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,

DR. S. NYABERA
DEPUTY-CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc:	CEO	-	MTRH	Dean	-	SOD
	Principal	-	CHS	Dean	-	SPH
	Dean	-	SOM	Dean	-	SON

APPENDIX 5: PRELIMINARY QUESTIONNAIRE

DEMOGRAPHICS

Gender:

☐ Male ☐ Female

Marital status:

☐ Married ☐ Single

Age (years):...

Alternative sources of income other than athletics: ....

....

....

....

Level of total monthly income (KES):

☐ 0 – 10,000 ☐ 10,001-50,000 ☐ 50,001 – 100,000

☐ 100,001 – 250,000 ☐ 250,001 – 500,000 ☐ >500,000

Education level:

☐ Primary ☐ Secondary ☐ Tertiary

Athletic Coaching:

☐ Personal trainer ☐ Group coach ☐ No coach

Are you attached to a sports club or camp?

☐ Yes ☐ No

Initials ....

Are you a member of a gym?

☐ Yes ☐ No

Have you suffered any sport injuries before?

☐ Yes ☐ No

If yes, explain (diagnosis/symptoms and date of injury) ....

....

....

....

ATHLETICS EXPOSURE

Number of years in the field: ....

Athletic event specialized in:

Track:

☐ **Sprints**

☐ 100m ☐ 200m ☐ 400m
☐ 110m hurdles ☐ 400m hurdles

☐ **Distance**

☐ 800m ☐ 1500m ☐ 3000m Steeplechase
☐ 5000m ☐ 10000m ☐ Marathon
☐ Half Marathon ☐ 20km Road Race ☐ 10mile Road Race
☐ 12km Road Race ☐ 10km Road Race ☐ 5km Road Race

Initials ....

Level of competition

☐ Local ☐ National ☐ International

Competitions participated in over the past 1 year:

DNF = did not finish; DQ = disqualified; DNS = did not start

Placement (ranking)	**Competition**	**Event**

Performance

Initials ....

Event	**Personal best**	**Season's target**

INJURY PREVENTION STRATEGIES

Which of the following injury prevention strategies do you practice? (Tick applicable column and fill in details)

Shoes ☐ Yes ☐ No

Which type of training shoe do you use?

☐ Shod (flat/spikes) ☐ Soled (trainers) ☐ Aftermarket insole

Name of brand ....

How many pairs of training shoes do you own? ....

How long have you had your current pair of training shoes? ....

How often do you replace your shoes? ....

Joint support ☐ Yes ☐ No

Which type of joint support do you use?

☐ Joint tape ☐ Joint brace

Initials ....

Kinesio/Sport taping ☐ Yes ☐ No

Neuromuscular Conditioning programs

Which of the following strategies are incorporated in your training schedule? (Tick where applicable)

☐ **Flexibility Training**	☐ Warm up/ warm down ☐ Stretches
☐ **Strength Training**	☐ Resistance training (weights, resistance bands, machines) ☐ Calisthenics (push-ups, squats, sit-ups, lunges, chin ups) ☐ Plyometrics (jumping exercises)
☐ **Endurance training**	☐ Slow distance training ☐ Pace tempo ☐ Interval training ☐ Repetition training ☐ Fartlek
☐ **Cross training**	☐ Swimming ☐ Cycling ☐ Football ☐ Zumba

Initials ....

	☐ Yoga ☐ Other: …………………………
☐ **Balance training**	☐ Balance board ☐ Single leg exercises ☐ Yoga ☐ Bosu ball

What other injury prevention strategies apart from the ones listed above do you utilize? (List and Describe) ....

....

....

....

....

....

Initials ....

Lifestyle and well-being

Do you suffer from any chronic illnesses?

☐ Yes ☐ No

If yes, which ones and which medication are you on? ....

....

Do you take alcohol?

☐ Yes ☐ No

If yes, quantify (average units per week) ....

Do you smoke cigarettes?

☐ Yes ☐ No

If yes, quantify (pack years) ....

Menstrual history (female athletes)

Age at menarche.................................Ave. length of cycle (days) ....

Date of LNMP...................................Ave. length of menstruation (days)...................

Do you suffer from any of the following conditions? (Tick where applicable)

☐ Painful periods ☐ Irregular periods ☐ Heavy periods

Which contraceptive method do you use? ....

Initials ....

ANTHROPOMETRY

Height (cm):..

Weight (kg):..

Ankle ROM	Right	Left
Dorsiflexion		
Plantarflexion		

Intertarsal ROM	Right	Left
Inversion		
Eversion		

Metatarsophalangeal ROM	Right	Left
Flexion		
Extension		
Abduction		
Adduction		

Knee ROM	Right	Left
Flexion		

Initials ....

Hip ROM	Right	Left
Flexion		
Extension		
Internal Rotation		
External Rotation		
Abduction		
Adduction		

Sit and Reach test (cm): ....

Initials ....

APPENDIX 6: MID-YEAR QUESTIONNAIRE

TRAINING

How many training sessions have you had this past month? ....

How long did each last on average? ....

How many running sessions were done on a:

Track.................................... Trail...................................... Treadmill................................

(Encourage/reinforce use of training diary)

Neuromuscular conditioning done over the past one month

Type of workout		No. of sessions	Average duration
Flexibility Training	☐ Warm up/ warm down ☐ Stretches		
Strength Training	☐ Resistance training (weights, resistance bands, machines) ☐ Calisthenics (push-ups, squats, sit-ups, lunges, chin ups) ☐ Plyometrics (jumping exercises)		
Type of workout		**No. of sessions**	**Average duration**
Endurance training	☐ Slow distance training ☐ Pace tempo ☐ Interval training ☐ Repetition training ☐ Fartlek ☐ Hill sprints		
Cross training	☐ Swimming ☐ Cycling ☐ Football ☐ Zumba		

Initials ....

	☐ Yoga ☐ Other: …………………………		
Balance training	☐ Balance board ☐ Single leg exercises ☐ Yoga ☐ Bosu ball		

Training injuries

Have you suffered any injuries in the past month?

☐ Yes ☐ No

If yes, which ones?

Anatomical site	**Diagnosis/ symptoms (illustrate as much as you can)**	**Conditions during injury: Wet (W), Dry (D) & Terrain**	**Time lost (Time off training due to injury)**

Injury prevention in training

Which of the following injury prevention strategies did you use?

☐ **Shoes**

Which type of shoe(s) did you use?

☐ Shod (flat/spikes) ☐ Soled (trainers) ☐ Aftermarket insole

Have many times have you replaced your shoe this month? (0-x) ....

COMPETITION

Have you participated in an official competition (s) this past month?

☐ Yes ☐ No

If no, end interview. If yes, which ones?

Level of competition:

☐ Local ☐ National ☐ International

Performance:

Competition	Event	Performance	
		Ranking	Time

Injuries in competition

Did you suffer any injuries during competition?

Initials ....

☐ Yes ☐ No

If yes, which ones?

Anatomical site	**Diagnosis/ symptoms (illustrate as much as you can)**	**Conditions during injury: Wet (W), Dry (D) & Terrain**	**Time lost (Time off training due to injury)**

During competition, which of the following injury prevention strategies did you use?

☐ **Shoes**

Which type of shoe(s) did you use?

☐ Shod (flat/spikes) ☐ Soled (trainers) ☐ Aftermarket insole

Have many times have you used your competition shoes?

☐ I have separate competition shoes which I have had for (years/months) ....

☐ These are the same shoes I use for training

☐ I got new shoes for the competition

Initials ....

APPENDIX 7: CONSENT FORM (ENGLISH)

MOI UNIVERSITY COLLEGE OF HEALTH SCIENCES / MOI TEACHING AND REFERRAL HOSPITAL INSTITUTIONAL RESEARCH AND ETHICS

Title of study: Neuromuscular conditioning strategies used, Incidence, Severity, and Predictors of musculoskeletal injuries sustained by professional runners in North Rift, Kenya.

Investigators: Dr. Steve Mbaka (Principal investigator)

Dr. L. K. Lelei

Dr. V. Bargoria

Dr. P. Makokha

Institution: Moi University, School of Medicine

Department of Orthopaedics

Moi Teaching and Referral Hospital

053 43231

Informed consent for: Athletes

This informed consent has two parts:

- Information sheet (to share information about the study with you)
- Certificate of Consent (for signatures if you choose to participate)

You will be given a copy of the signed Informed Consent Form

Initials ....

Part I: Information sheet

You are being asked to take part in a research study. This information is provided to tell you about the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to be in the study, you will be given a copy of this consent form for your records.

Taking part in this research study is voluntary. You may choose not to take part in the study. Saying no will not affect your rights to health care or services. You are also free to withdraw from this study at any time. If after data collection you choose to quit, you can request that the information provided by you be destroyed under supervision- and thus not used in the research study. You will be notified if new information becomes available about the risks or benefits of this research. Then you can decide if you want to stay in the study

<u>Purpose of this study</u>

The purpose of this study is to find out how professional runners protect themselves from injury, and whether these methods influence the number and severity of injuries they sustain during the study period.

Ultimately, the study may be published in the academic repository of Moi University, School of Medicine, and other journals concerned with sports medicine.

<u>Type of research</u>

This is an observational study, where we shall only collect data about your usual practices but shall not influence them with any intervention.

Initials ....

Why have I been identified to participate in this study?

You were selected as a participant because you are a professional runner based in the North Rift region.

How long will the study last?

You will be in this study for one year

What will happen to me during the study?

The study involves you sparing some time to answer questions about your injury status and athletics participation by way of face-to-face and phone interviews conducted by qualified personnel.

There are no reasonable foreseeable physical risks in participating in the study.

Are there benefits to taking part in the study?

You may benefit personally from this study by having access to advice from sports medicine practitioners about sport injuries.

The athletics community will benefit by having more information about sport injury prevention practices.

Who do I call if I have questions about the study?

Dr. Steve Mbaka Tel. 0720 719717

Questions about your rights as a research subject: You may contact Institutional Review Ethics Committee (IREC) 053 33471 Ext.3008. IREC is a group of people that reviews studies for safety and to protect the rights of study subjects

Initials ....

Will the information I provide be kept private?

All reasonable efforts will be made to keep your protected information private and confidential. Protected Information is information that is, or has been, collected or maintained and can be linked back to you. Using or sharing (“disclosure”) of such information must follow National privacy guidelines. By signing the consent document for this study, you are giving permission (“authorization”) for the uses and disclosures of your personal information. A decision to take part in this research means that you agree to let the research team use and share your Protected Information as described below.

As part of the study, Dr. Steve Mbaka and his study team may share the details of your athletics competition and training regimen. These may be study or non-study related. They may also share portions of your medical record, with the groups named below:

- The National Bioethics Committee
- The Institutional Review and Ethics Committee
- Moi University, School of Medicine
- Moi Teaching and Referral Hospital, Orthopaedics department

National privacy regulations may not apply to these groups; however, they have their own policies and guidelines to assure that all reasonable efforts will be made to keep your personal information private and confidential.

The study results will be retained in your research record for at least six years after the study is completed. At that time, the research information not already in your medical record will be stored securely in the principal investigator's cloud account. Any research information entered into your medical record will be kept indefinitely.

Unless otherwise indicated, this permission to use or share your Personal Information does not have an expiration date. If you decide to withdraw your permission, we ask that you contact Dr. Steve Mbaka in writing and let him know that you are withdrawing your permission. The mailing address is P.O. Box 10753 - 00100. At that time, we will stop further collection of any information about you. However, the health information collected before this withdrawal may continue to be used for the purposes of reporting and research quality.

You have the right to see and copy your personal information related to the research study for as long as the study doctor or research institution holds this information. However, to ensure the scientific quality of the research study, you will not be able to review some of your research information until after the research study has been completed.

You will receive a copy of this form after it is signed.

Part II: Consent (Over 18 years of age)

I have read or have had read to me the description of the research study. The investigator or his representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks as well as the possible benefits of the study. I freely volunteer to take part in this study.

....	....	....
Name of participant (Witness to print if the subject is unable to write)	Signature of the subject/ thumbprint	Date and time

....	....
Name of representative/ witness	Relationship to subject

....	....	....
Name of person obtaining consent	Signature of person obtaining consent	Date

Dr. Steve Mbaka..........	....	....
Name of investigator	Signature of investigator	Date

Initials ....

Part II: Consent and Assent (Under 18 years of age)

I have read or have had read to me the description of the research study. The investigator or his representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks as well as the possible benefits of the study. I freely volunteer myself/ my child to take part in this study.

....	....	....
Name of participant (Witness to print if the subject is unable to write)	Signature of the subject/ thumbprint	Date and time
....	....	....
Name of parent/guardian	Signature/ thumbprint	Date and time
....	....	....
Name of person obtaining consent	Signature of person obtaining consent	Date
Dr. Steve Mbaka............	....	....
Name of investigator	Signature of investigator	Date

Initials ....

APPENDIX 8: CONSENT FORM (KISWAHILI)

MOI UNIVERSITY COLLEGE OF HEALTH SCIENCES / MOI TEACHING AND REFERRAL HOSPITAL INSTITUTIONAL RESEARCH AND ETHICS

Mada ya utafiti: Uhusiano baina ya mazoezi ya misuli vinavyotumiwa na wanariadha wa Kaskazini wa Bonde la Ufa, Kenya, na viwango vya majeraha ya michezo wanariadha hao hupata.

Watafiti: Dr. Steve Mbaka (Mtafiti mkuu)

Dr. L. K. Lelei

Dr. V. Bargoria

Dr. P. Makokha

Taasisi: Moi University, School of Medicine

Department of Orthopaedics

Moi Teaching and Referral Hospital

053 43231

Ruhusa idhini ya: Wanariadha

Idhini hii ya habari ina sehemu mbili:

- Karatasi ya habari (habari kuhusu utafiti)
- Hati ya Ruhusa (kwa ishara ikiwa unachagua kushiriki)

Utapewa nakala ya Fomu iliyoidhinishwa ya Ruhusa

Herufi za kwanza za jina la mshiriki ....

Sehemu ya I: Maelezo ya habari

Taarifa hii hutolewa ili kukuambia kuhusu utafiti. Tafadhali soma fomu hii kwa makini. Utapewa nafasi ya kuuliza maswali. Ikiwa unaamua kuwa katika utafiti, utapewa nakala ya fomu hii ya idhini kwa kumbukumbu zako. Kushiriki katika utafiti huu ni hiari yako. Unaweza kuchagua kutoshiriki katika utafiti. Kusema hapana haitaathiri haki zako kwa huduma za afya. Wewe pia una uhuru kujiondoa kwenye utafiti huu wakati wowote. Ikiwa baada ya ukusanyaji wa data unachagua kuacha, unaweza kuomba kwamba taarifa iliyotolewa na wewe iharibiwe chini ya usimamizi - na hivyo haitumiwi katika utafiti. Utajulishwa kama taarifa mpya itapatikana kuhusu hatari au faida za utafiti huu. Kisha unaweza kuamua kama unataka kukaa katika utafiti

Kusudi la utafiti huu

Kusudi la utafiti huu ni kujua jinsi wanariadha wakimbiaji wanajilinda kutokana na majeraha, na kama mbinu hizi zina uhusiano na viwango vya majeraha ya michezo wanariadha hao hupata.

Hatimaye, utafiti huu unaweza kuchapishwa katika orodha ya kitaaluma ya Chuo Kikuu cha Moi, Shule ya Madawa, na majarida mengine yanayohusiana na dawa za michezo

Aina ya utafiti

Hii ni utafiti wa uchunguzi, ambapo tutakusanya tu data kuhusu mazoea yako ya kawaida lakini hautawaathiri kwa kuingilia kati.

Herufi za kwanza za jina la mshiriki ....

Kwa nini nimechaguliwa kushiriki katika utafiti huu?

Ulichaguliwa kama mshiriki kwa sababu wewe ni mwanariadha wa kitaalamu unayeishi katika eneo la bonde la ufa.

Utafiti utaendelea kwa muda mgani?

Utakuwa katika utafiti huu kwa mwaka mmoja

Nini kitatokea kwangu wakati wa kujifunza?

Utafiti unahusisha wewe kuchukua wakati mwingi wa kujibu maswali kuhusu hali yako ya kuumia na ushirikiano wa riadha kwa njia ya mahojiano ya uso kwa uso, na ya simu itakayofanywa na wafanyakazi watendeti.
Hakuna hatari ya kimwili itakayotokana katika kushiriki kwa utafiti huu

Je, kuna faida ya kushiriki katika utafiti?

Unaweza kujifaidi binafsi kutokana na utafiti huu kwa kupata ushauri kutoka kwa watendaji wa dawa za michezo kuhusu majeraha ya michezo.
Jamii ya wanariadha itafaidika kwa kuwa na maelezo zaidi kuhusu mazoea ya kuzuia majeraha ya michezo.

Nitajulisha nani ikiwa nina maswali kuhusu utafiti?

Dr. Steve Mbaka

Nambari ya simu. 0720 719717

Maswali kuhusu haki zako kama somo la utafiti: Unaweza kuwasiliana na Kamati ya Maadili ya Ukaguzi wa Taasisi (IREC) 053 33471 Ext.3008. IREC ni kikundi cha

Herufi za kwanza za jina la mshiriki ....

watu ambao huelezea masomo kwa ajili ya usalama na kulinda haki za masomo ya kujifunza

Je! Habari nitayayatoa itahifadhiwa binafsi?

Hatutafichua wala kuchapisha mambi yoyote kuhusu yale uliyotueleza ila tu yale yanayohusiana na uchunguzi huu. Jitihada zote za busara zitafanywa ili kuweka maelezo yako ya ulinzi binafsi na ya siri. Taarifa zilizolindwa ni habari ambazo, au imekuwa, imekusanywa au imehifadhiwa na inaweza kuunganishwa kwako. Kutumia au kugawana ("kutoa taarifa") ya taarifa hizo lazima ifuate miongozo ya faragha ya Taifa. Kwa kusaini waraka wa hati kwa ajili ya utafiti huu, unatoa ruhusa ("idhini") kwa matumizi na maelezo ya habari yako binafsi. Uamuzi wa kushiriki katika utafiti huu una maana kwamba unakubali kuruhusu timu ya utafiti kutumia na kushiriki habari yako ya ulinzi kama ilivyoelezwa hapo chini.

Kama sehemu ya utafiti, Dk Steve Mbaka na timu yake ya utafiti wanaweza kushiriki maelezo ya ushindani wako katika mashindano. Wanaweza pia kushiriki katika sehemu za rekodi yako ya matibabu, na makundi yaliyotajwa hapo chini:

- Kamati ya Taifa ya Bioethics.
- Kamati ya Ukaguzi na Maadili ya Taasisi,
- Chuo Kikuu cha Moi, Chuo cha Dawa
- Moi Teaching and Referral Hospital, Idara ya Orthopediki

Kanuni za faragha za kitaifa haziwezi kutumika kwa makundi haya; hata hivyo, wana sera zao na miongozo ili kuhakikishia kwamba jitihada zote za busara zitafanywa ili kuweka maelezo yako ya kibinafsi kwa usiri. Matokeo ya utafiti yatahifadhiwa kwenye rekodi yako ya utafiti kwa angalau

Herufi za kwanza za jina la mshiriki ....

miaka sita baada ya kujifunza. Wakati huo, habari ya utafiti kwenye kumbukumbu yako ya matibabu itahifadhiwa salama katika akaunti ya wingu ya uchunguzi. Taarifa yoyote ya utafiti iliyoingia kwenye rekodi yako ya matibabu itahifadhiwa kwa muda usiojulikana.

Isipoelezwa vinginevyo, ruhusa hii ya kutumia au kushirikisha habari yako ya kibinafsi haina tarehe ya kumalizika muda. Ikiwa unaamua kuondoa ruhusa yako, tunaomba kuwasiliana na Dk. Steve Mbaka kwa kuandika na kumjulisha kuwa unatoa ruhusa yako. Anwani ya barua pepe ni P.O. Sanduku la 10753 - 00100. Wakati huo, tutaacha kukusanya zaidi habari yoyote kuhusu wewe. Hata hivyo, habari za afya zilizokusanywa kabla ya uondoaji huu zinaweza kuendelea kutumika kwa ajili ya taarifa na ubora wa utafiti.

Una haki ya kuona na kunakili maelezo yako ya kibinafsi kuhusiana na utafiti. Hili lawezekana kwa muda mrefu kama daktari wa utafiti au taasisi ya utafiti inashikilia habari hii. Hata hivyo, ili kuhakikisha ubora wa kisayansi wa utafiti, huwezi kutazama maelezo yako ya utafiti hadi baada ya utafiti wa utafiti kukamilika.

Utapokea nakala ya fomu hii baada ya kusainiwa.

Sehemu ya II: Ruhusa (Waliohitimu Umri zaidi ya 18)

Nimesoma au nimesomewa maelezo ya utafiti. Mpelelezi au mwakilishi wake ameelezea utafiti kwangu na amejibu maswali yote niliyo nayo wakati huu. Nimeambiwa kuhusu uwezekano wa hatari pamoja na manufaa ya utafiti. Mimi nimejitolea kwa hiari kushiriki katika utafiti huu.

Herufi za kwanza za jina la mshiriki ....

Nadhibitisha nimeyafahamu aliyonieleza mtafiti na nimekubali kwa hiari yangu mwenyewe kusaidia katika uchunguzi huu.

....	....	....
Jina la mshiriki (Shahidi kuchapisha kama mshiriki haliwezi kuandika)	Saini ya mshiriki / thumbprint	Tarehe na wakati

....	....
Jina la mwakilishi / shahidi	Uhusiano na mshiriki

....	....	....
Jina la mtu anayeomba idhini	Saini ya mtu anayeomba idhini	Tarehe

Dk. Steve Mbaka	....	....
Jina la mchunguzi	Saini ya mchunguzi	Tarehe

Herufi za kwanza za jina la mshiriki ....

Sehemu ya II: Ruhusa (Wasiohitimu umri ya 18)

Nimesoma au nimesomewa maelezo ya utafiti. Mpelelezi au mwakilishi wake ameelezea utafiti kwangu na amejibu maswali yote niliyo nayo wakati huu. Nimeambiwa kuhusu uwezekano wa hatari pamoja na manufaa ya utafiti. Mimi nimejitolea kwa hiari kushiriki katika utafiti huu. Nadhibitisha nimeyafahamu aliyonieleza mtafiti na nimekubali kwa hiari yangu mwenyewe kusaidia katika uchunguzi huu.

....	....	....
Jina la mshiriki (Shahidi kuchapisha kama mshiriki haliwezi kuandika)	Saini ya mshiriki / alama	Tarehe na wakati
....	....	....
Jina la mzazi/mlezi	Saini/ Alama	Tarehe na wakati
....	....	....
Jina la mtu anayeomba idhini	Saini ya mtu anayeomba idhini	Tarehe
Dk. Steve Mbaka.........	....	....
Jina la mchunguzi	Saini ya mchunguzi	Tarehe

Herufi za kwanza za jina la mshiriki ....

APPENDIX 9: TRAINING DIARY

Training Diary

Location .... Date ....

Distance ....

Time ....

Pace .... Heart Rate ....

Weather

Sunny Cloudy

Partly Sunny Rainny

Perceived Exertion

Not Tired Slightly Tired

Moderately Tired Extremely Tired

Comments ....

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Location .... Date ....

Distance ....

Time ....

Pace .... Heart Rate ....

Weather

Sunny Cloudy

Partly Sunny Rainny

Perceived Exertion

Not Tired Slightly Tired

Moderately Tired Extremely Tired

Comments ....

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Appendix 10: Work plan

EVENT	PERIOD
Proposal writing	July 2017
IREC Approval	March 2018
Pilot Study	April 2018
Data Collection	November 2018 – December 2019
Data Analysis	January 2020
Mock Defense	September 2020
Thesis Defense	May 2021

APPENDIX 11: BUDGET

ITEM	ESTIMATE (Ksh)
Approval by IREC	2,000
Stationary	40,000
Communication	42,000
Transport	30,000
Research assistants	100,000
Biostatistician	36,000
Total	**250,000**