DYNAMIC BALANCE AMONG LONG-DISTANCE RUNNERS WITH ACHILLES TENDINOPATHY IN HIGH ALTITUDE TRAINING CAMPS IN WESTERN KENYA

HELLEN CHEBET

MASTERS OF SCIENCE

(Sports Physiotherapy)

JOMO KENYATTA UNIVERSITY

OF

AGRICULTURE AND TECHNOLOGY

2023

Dynamic Balance among Long-Distance Runners with Achilles Tendinopathy in High Altitude Training Camps in Western Kenya

Hellen Chebet

A Thesis Submitted in Partial Fulfilment of the Requirements for the degree of Masters of Science in Sports Physiotherapy of the Jomo Kenyatta University of Agriculture And Technology

2023

DECLARATION

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

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

Hellen Chebet

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

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

Dr. Karuguti Wallace, Ph.D

JKUAT, Kenya

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

Dr. Opondo Evaristo, Ph.D

JKUAT, Kenya

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

Prof. Benita Olivier

Witwatersrand University, SA

DEDICATION

This project is dedicated to my children –Mitchelle, Sam, Ben and Chris.

ACKNOWLEDGEMENT

I would like to acknowledge the support of a number of people, without whom this work would not have been possible. First, my supervisors; Professor Benita Olivier, Dr Karunguti and Professor Opondo for their mentorship, support and guidance through the journey. I am grateful to JKUAT for providing me with a conducive working environment during my studies.

I appreciate my classmates and friends for their moral support during the period I have been in school. Lastly, I am forever grateful to my family for their emotional support and for giving me a humble time while I was working on this project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

AT	Achilles Tendinopathy
GTO	Golgi tendon organ
JKUAT	Jomo Kenyatta University of Agriculture and Technology
MRI	Magnetic resonance imaging
PL	Posterolateral
PM	Posteromedial
SEBT	Star Excursion Balance Test
SPSS	Statistical Package for Social Sciences

DEFINITION OF TERMS

Achilles Tendinopathy	An overuse injury caused by repetitive energy storage and release with excessive compression leading to a sudden injury, or a rupture of the Achilles tendon (Alfredson & Cook, 2007).
Dynamic balance	The ability to maintain the body's center of mass whilst performing movement (Butler et al., 2012).
High Altitude	The height of a place/point that exceeds 2400 m above sea level (Johnson & Luks, 2016)

ABSTRACT

Achilles Tendinopathy (AT) is one of the leading causes of disability among athletes and often leads to an early exit from a sporting career. AT has been associated with intense, prolonged and repetitive functional demands exerted on the Achilles tendon. It is also thought to have an effect on the athletes' dynamic balance ability and performance. Running involves movement of the body in a straight line, whereby balance in motion, horizontal component of momentum is very important for performance and injury prevention. While AT has been widely cited to be common among athletes, how and if it affects the dynamic balance ability of the runners has rarely been explored especially in the local setting, hence this study.This study determined the prevalence of AT among long-distance runners in high altitude training camps in Western Kenya. The exercise history and dynamic balance of those who had AT was also established and compared to the findings in the existing literature. A cross-sectional study was carried out in high altitude training camps of Western Kenya, among long-distance runners (N=410). The prevalence of AT was determined and exercise history of runners confirmed to be having AT, using subjective self-reported pain and palpation tests, was established through completion of self-administered questionnaire. Dynamic balance ability among those who had AT, was examined using the Star Excursion Balance Test (SEBT). The collected data was analysed using Statistical Package for Social Sciences (SPSS) Version 25.0. Descriptive and inferential statistics including measures of central tendency, proportions and frequency was used. The difference between dynamic balance in male and female athletes was assessed using independent t-test with a p-value of < 0.05 considered statistically significant. The results were presented in form of tables, figures and prose format. AT prevalence among the 410 long-distance athletes was 13.9% (n=57). The 57 long-distance athletes who had AT were assessed for dynamic balance using SEBT, of which 73.7% (n=42) were male. The median age of the participants was 27 years with 68.4% (n=39) being 30 years and below. On palpation test, 63.2% (n=36) and 40.4% (n=23) tested positive for AT on the right leg and left leg, respectively. Two (3.5%) had bilateral AT. The median number of competitions completed the previous 2 years was 5 with a maximum of 10 and minimum of 1 race. The mean number of kilometers covered per week in training was 170.0 km with an average pace of 3.3 minutes per kilometer. Most, 61.4% (n=35) covered 151-200 km per week, 21.0% (n=12) 101-150km per week, 12.3% (n= 7) 201-250 km per week, 3.5% (n=2) 51-100 km per week and 1 (1.8%) less than 51 km per week. The mean SEBT composite scores for dominant and non-dominant was 81.85%, and 82.42% respectively. Most athletes had composite scores of less than 94%. There were statistically significant mean differences in the dominant posterolateral and dominant posteromedial normalized scores and composite dominant scores between male and female athletes, with the scores being higher in male runners compared to females. Using the available composite score cut-off of 94%, most of the runners included in this study had impaired balance and were at risk of re-injury or getting new injuries. There appears to be differences in SEBT scores with regards to gender hence the need to develop reference scores taking into account the gender differences.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Increased participation in both recreational and competitive sport has seen the number of Achilles Tendinopathy (AT) cases rise remarkably over the last few decades, with incidences in runners being ten times more, than individuals who are not involved in sport as was reported by Ames et al (2008). It has also been shown to occur in people who are not involved in any sport as well, though at lower incidences (Alfredson & Cook, 2007).

Achilles Tendinopathy is common among the running athletes, especially the long and middle distance runners (Knobloch et al., 2008; Lopes et al., 2012). Among the established runners, AT prevalence have been reported to be approximately 7% to 9% (Maffulli et al., 2019). Lopes and colleagues (2012) also reported AT to be the most prevalent running related injury among long-distance runners with a prevalence rate of close to 18.5%, and second most prevalent in the general sport. A review of 455 athletes who had AT showed that 53% were actively engaged in running while 11% were football players, strongly indicating the role of running activity in the etiology of this condition. The rest of the individuals in the study were engaged in other sporting activities, which involved running as part of the training (Kader et al., 2002).

AT is a clinical overuse syndrome characterized by painful and swollen Achilles Tendon with resultant impaired function of the affected limb (Maffulli et al., 1998). It is usually chronic in nature and often very difficult to treat, predisposing affected athletes to likelihood of long term morbidity (Kader et al., 2002). A longitudinal study by Kannus & Natri, (1997) revealed that almost half of the patients who suffered AT developed other lower limb overuse injuries and some of those who had unilateral symptoms, developed symptoms on the opposite tendon during their 8 year follow up. This shows that, if not diagnosed and treated early it can impact the performance of athletes and their quality of life badly.

AT has also been identified as a common disabling injury, which has a potential of lowering performance or even ending an athlete's career prematurely (Ames et al., 2008). Knobloch et al (2008) in their study, also noted that at some point, 44% of the runners were forced to stop training and competing because of AT, thus ruining their career.

The causes and pathogenesis of AT do not have scientific backing currently, although its occurrence has been linked to training errors like overuse (Sharma & Maffulli, 2006; Pankaj Sharma & Maffulli, 2005). The probable causes of AT are multifactorial and are commonly classified as intrinsic and extrinsic (van Sterkenburg & van Dijk, 2011). Intrinsic causes include foot malalignment, leg length discrepancy, muscle weakness, decreased flexibility and over pronation among others (Kannus & Natri, 1997; Ryan et al., 2009).

Extrinsic factors account for higher percentage of AT occurrence among athletes. This has been attributed mainly to overload on the body structures caused by training errors like increased weekly mileage, change in training pattern, and very high intensities during training (Haglund-Åkerlind & Eriksson, 1993; Knobloch et al., 2008). Other extrinsic causes include too much hill work, environmental conditions and poor running footwear (Kannus & Natri, 1997; Macera et al., 2015).

Balance is the ability to maintain or move right under the existing support base, by use of processed sensory and motor information (Ness et al., 2016). Dynamic balance is a state whereby an individual's center of gravity is kept under the support base while in motion (Butler et al., 2012) or while carrying out a task (Bressel, Yonker, Kras, & Heath, 2007). To achieve a state of balance, a combination of processes including sensory organization, muscle coordination and adequate range of motion is required (Gstöttner et al., 2009). Muscle coordination is key in linking muscle contraction among antagonists and agonists of the trunk and limb muscle. Sensory organization is also key in facilitating vestibular, visual and somatosensory systems to keep the body balanced (Paillard et al., 2006).

Yaggie and Campbell (2006) in their study noted that runners whose static and dynamic balance were not compromised, had lower incidences of injury and that their speed and specific movement performance were excellent; poor balance cannot allow athletes to balance on one limb as they transfer body weight to the contra-lateral limb without a fall or injury during running.

Scholes et al (2018), reported that AT could be having an effect on postural control, in their study, which was also the first to asses single leg standing balance in men with AT. A number of sports related injuries like lateral ankle sprains, have been attributed to inability to maintain balance during performance (Herrington et al., 2009; Irrgang, 1994; Sefton et al., 2009). The authors also stated that balance is a motor skill of clinical importance in relation to enhanced performance and prevention of injuries.

Tendinopathy of the Achilles tendon can be diagnosed accurately using a carefully taken history and comprehensive clinical examination, with radiological examination being used to rule out diagnoses with similar presentation like neuromas and tenosynovitis (Maffulli et al., 2019).

Pain on tendon palpation has been shown to be a reliable and valid method to diagnose AT with a specificity of 73% and sensitivity of 84%. Another reliable method is the subjective tendon pain, reported by the patient which normally occurs 2 to 6 cm above its point of attachment into the calcaneal bone, this has demonstrated a sensitivity of 78% and a specificity of 77% (Hutchison et al., 2013).

Although AT has been shown to be predominant especially among long-distance runners, the burden of AT has not been established among the Kenyan runners. As the prevalence of AT remains unknown, appropriate preventive measures cannot be put in place and several runners' careers will be ruined. Literature is also inadequate with regards to the dynamic balance characteristics of Kenyan runners with AT hence the motivation for this study.

1.2 Problem statement

AT is a predominant overuse injury among individuals involved in running events and recreational sports activities (Alfredson & Cook, 2007). Although Knobloch et al (2008) reported AT to be specifically common among middle and long-distance runners, its prevalence among Kenyan runners is however not known. While a lot of studies have been done on lower limb injuries and balance, the focus has been on athletes involved in highly dynamic sport like hockey and soccer. Very little data exist on the dynamic balance ability among the running athletes, specifically long-distance Kenyan runners with AT.

Motor deficits have been found in individuals with AT (Mahieu et al., 2006). One of the most probable motor deficiency that has gotten almost no consideration in lower limb tendinopathy is balance (Scholes et al., 2018). Although the real cause of motor deficits in lower limb tendinopathies is not clearly understood, alteration in the structure of a tendon as seen in tendinopathies like AT may disrupt the function of Golgi tendon organ (GTO) so as to alter proprioception causing balance deficits (Scholes et al., 2018).

Despite that Kenya is home to many world renown long-distance runners, there is a paucity of research on musculoskeletal injuries among this category of athletes in the country (Mbarak *et al*., 2019). While AT has been widely cited as common among endurance athletes, the burden of AT remains unknown among Kenyan runners, and how and if it affects the dynamic balance ability of runners has rarely been explored, especially in the local setting; hence the need for this study

1.3 Justification

Balance is important for carrying out complex technical movements, and for injury prevention among the athletes. More research was suggested to understand issues of balance among people with AT and any existing association and contributing factors (Scholes et al., 2018). The findings of this study will be useful in highlighting the prevalence of AT among the Kenyan long-distance runners, the exercise history of long-distance runners with AT, and their dynamic balance ability as well.

The findings may also inform the rehabilitation strategies necessary for athletes who suffer AT and consequently enable them to reclaim or surpass their pre-injury best performance.

1.4 Objectives

1.4.1 Broad objective

To determine the prevalence, exercise history and dynamic balance among long-distance runners with AT in high altitude training camps in Western part of Kenya.

1.4.2 Specific objectives

1. To determine the prevalence of AT among long-distance runners in high altitude training camps in Western part of Kenya.
2. To establish the exercise history of long-distance runners with AT in high altitude training camps in Western part of Kenya.
3. To describe the dynamic balance of long-distance runners with AT in high altitude training camps in Western part of Kenya.

1.5 Research questions

1. What is the prevalence of AT among long-distance runners in high altitude training camps in Western Kenya?
2. What is the exercise history of long-distance runners with AT in high altitude training camps in Western Kenya?
3. What is the dynamic balance ability of long-distance runners with AT in high altitude training camps in Western Kenya?

1.6 Significance of the study

The findings of this study will be useful in filling the existing knowledge gap, by providing more information on the prevalence and exercise history as well as the dynamic balance ability of long-distance runners with AT. It will also be key in informing the probable rehabilitation strategies for athletes who suffer AT.

CHAPTER TWO

LITERATURE REVIEW

2.1 Prevalence of AT among long-distance runners

AT has been reported to be highly prevalent, often chronic and disabling musculoskeletal overuse injury, commonly seen in middle and long-distance runners (Haglund-Åkerlind & Eriksson, 1993; Janssen et al., 2018; Knobloch et al., 2008; Kujala et al., 2005).

Kujala and colleagues (2005) in their study reported a total incidence of AT in people who were former endurance runners of 52%, while that of individuals who were master orienteering athletes and had finished successful participation in master class was 30%. Kujala et al's study also found out that nearly one in every two professional Finnish runners, is likely to suffer AT before they turn 45 years when compared to the general population, where it is one in every 10 people, and that AT was common among endurance runners as compared to sprinters.

A review by Lopes and colleagues (2012) reported the prevalence of AT to be between 6.2% to 9.5% in the general sport while the prevalence was even higher in individuals involved in ultramarathon running, reaching as high as 18.5%. An AT prevalence of 9.5% was also reported in North America in a retrospective survey study that was investigating risk factors and injury patterns, where AT was also a relatively predominant injury (McKean et al., 2006). In their study, McKean and colleagues (2006) also noted that overuse injuries were more common among masters runners who ran more frequently covering more than 30 miles per week.

Knobloch et al (2008), in their study on 291 German elite long-distance runners, also reported AT as the most prevalent injury related to running, with a prevalence rate of 29%. They linked this high prevalence to too much training loads as most of their participants covered mean weekly distance of 65.2km, which was considered to be above the 64km/week average recommended mileage (Gallo et al., 2012; Knobloch et al., 2008; Macera et al., 2015; Walter, 1989).

In a study by De Jonge et al (2011) in Netherlands, the occurrence of AT was observed to be 1.85 per 1,000 patients. An occurrence rate of 2.35 per 1,000 was reported among those who were aged between 21 and 60 years. In 35% of the cases, there was a positive association with sporting activities. According to a study by Janssen et al (2018), middle-distance runners demonstrated higher AT occurrence rate in Netherlands, as compared to sprinters.

Although AT prevalence might appear to be lower in some cases, Clarsen et al (2013) warned that athletes who suffer AT are often able to train and compete despite the injury hence the accurate prevalence might actually be higher than that which has been reported. The high AT prevalence in runners can be linked to frequent repetitive stress exerted on the lower limb tendons. This is mainly brought about by muscle fatigue caused by increased training intensity and frequencies beyond that which can be physiologically accommodated by the tendons, thereby increasing the chances of overuse changes (Hess, 2010). Other extrinsic causes include training environment like hard and slippery training surfaces and topography of the area of training, Kader et al (2002), however recommended more longitudinal studies in order to establish the real cause-effect relationship**.**

2.2. Exercise history of long-distance runners with Achilles Tendinopathy

Runners mostly target to optimize their performance through training schedules customized to positively influence physiological factors associated with excellent performance, such as running pace at an anaerobic threshold, maximum uptake and utilization of oxygen, and the running economy (Ingham et al., 2008). Researchers, coaches and athletes all agree that training volume which translates to: kilometers covered per unit time, training intensity and training frequency positively influence the runners' performance (Noakes et al., 1990). However, volumes which exceeds the recommended average can predispose runners to lower limb injuries, specifically the overuse injuries (Macera et al., 2015). Most runners have a belief that covering long-distances can translate to better performance, what James et al., (1978) in their study named 'mileage mania'. Several authors have however found this to be detrimental to runners (Fields et al., 2010; Macera et al., 2015; Walter, 1989).

A number of studies have identified distance covered by athletes on weekly basis as a determinant of lower limb overuse injuries like AT. These studies, have reported a correlation between weekly distance covered and risk of general lower limb injuries (Haglund-Åkerlind & Eriksson, 1993; Janssen et al., 2018; Knobloch et al., 2008; Macera et al., 2015; Van Gent et al., 2007).

Knobloch et al (2008) reported high mileage as being responsible for a preponderance of AT cases among long-distance runners who covered a mean weekly distance of 65.2km. This was considered to be above the recommended average, and at some point, 56% of their participants had AT which was also the most predominant injury related to running.

A comparative study in Sweden also found out that among the 83 middle distance runners, 28 participants had suffered AT. Most of the runners with AT in their study, however reported high weekly distance coverage of 102 km, had more years in competitive running, and had been doing more hill works as opposed to those who did not have AT (Haglund-Åkerlind & Eriksson, 1993). Other studies however could not establish a link between mileage and injury (Fields et al., 2010), while other authors reported that increased mileage could actually be protective against lower limb injuries (Bovens et al., 1989).

Training frequencies have also been documented to have an effect on risk of developing lower limb injuries, with those who train for 6 to 7 days a week having an increased risk than those who train for 2 to 5 days (Jacobs & Berson, 1986; Knobloch et al., 2008; Macera et al., 2015; McKean et al., 2006; Walter, 1989; Wen et al., 1998). However, Tauton and colleagues (2003) found increased risk in women who were training once a week.

Although intensity of training has not been identified as a major predisposing factor to injury, McCrory et al (1999) found running pace to be a distiquishing factor between athletes who had AT and those who did not. The subjects who had AT were running at a faster pace of 4.64km per hour, as compared to 4.87km per hour of the ones who did not have AT. Similar association was also found in participants who had Iliotibial band syndrome who were running 3 seconds per mile faster than controls (Messier et al., 1995). Other studies however did not find this association (Nielsen et al., 2012; Walter, 1989).

2.3 Dynamic balance of long-distance runners with Achilles Tendinopathy

Running requires optimal dynamic balance as well as strength and coordination (Anderson & Behm, 2005). An inefficient neuromuscular system may predispose runners to injury as well as lower their performance as was reported by Behm and colleagues (2005).

A link between dynamic balance and increased likelihood of injuries, whereby individuals with impaired balance are more prone to getting injured, has led to the establishment and use of the Star Excursion Balance Test (SEBT) as a reliable tool for measuring stability. SEBT is less instrumented, economical, and less intensive and can inform intervention strategies meant to improve balance and reduce potential injury risks (Plisky *et al.*, 2006; Sabin *et al.*, 2010). Olmsted *et al.* (2002) successfully used SEBT to assess the dynamic balance of patients with and without chronic ankle instability (CAI) and established that patients with CAI exhibited shorter reaches on SEBT as compared to the non-injured group. Likewise, shorter reaches which translate to reduced balance were also found in patients with anterior cruciate ligament deficiency (ACLD) as compared to their matched controls (Herrington *et al.*, 2009). Aminaka and Gribble (2008) also confirmed that patients with Patellofemoral pain syndrome (PFPS) had balance deficits as their anterior reaches were far shorter than those of persons without PFPS.

Hrysomallis et al (2011) reported that basketball and football players who had poor balance were more susceptible to injury. Balance ability was also noted to have the potential of predicting lower limb injury risk (Plisky et al., 2006) and improved balance has been shown to lower injury risk in athletes as was reported by Bressel and colleagues (2007)

Scholes et al (2018), assessed single leg standing balance in men with AT and reported that AT could affect postural control, even though they did not use SEBT for assessment. The study by Scholes and colleagues and other studies conducted on lower limb injuries and balance showed that AT could affect dynamic balance of runners, especially during challenging activities, which needs to be established and quantified further.

Impaired balance associated with tendinopathies could be because of damaged mechanoreceptors. Information related to proprioception is primarily relayed by proprioceptors located in the muscle spindles, intra-tendinous Golgi tendon organ (GTO) and the skin. GTO provides sensory input concerned with tension in tendons and muscles in order to protect them from injury. Alteration in the structure of a tendon as seen in tendinopathies like AT may disrupt the function of GTO so as to alter proprioception causing balance deficits (Scholes et al., 2018).

2.4 Diagnostic tests for Achilles Tendinopathy

There are various tests used to confirm AT diagnosis. These tests can be grouped into two categories; clinical examination and imaging tests.

2.4.1 Clinical examination tests

Tendinopathy of the Achilles tendon can be diagnosed accurately using a carefully taken history and comprehensive clinical examination, with radiological examination being used only to rule out other diagnoses of a similar presentation like neuromas and tenosynovitis of the Achilles tendon (Maffulli et al., 2019)

There are several clinical examinations used for AT diagnosis. One of the tests is subjective self-reported pain; where the patient reports pain on the Achilles tendon, and when asked to show the examiner where they feel pain, he or she locates a spot approximately 2 to 6 cm over the point where the Achilles attaches into the calcaneum, as an area with elevated symptoms. Another subjective test is morning stiffness, where AT is diagnosed by asking the patient how they feel early in the morning. Morning stiffness associated with severe pain in the Achilles tendon with the first steps after getting out of bed is an indicator of positive AT diagnosis (Hutchison et al., 2013).

Palpation test is another commonly used highly reliable diagnostic test. The examiner palpates the patient's Achilles tendon in an ascending manner by delicately squeezing it between the thumb and the fore finger. The presence of AT is confirmed by feeling thickening of the Achilles tendon at a point which is approximately 2 to 6cm from its attachment point onto the calcaneum (Hutchison et al., 2013).

Royal London Test is another tests that has been used and proven to be effective. This is where the clinician examine the Achilles tendon in neutral or slight plantarflexion for pain by palpating it. The ankle is then passively plantarflexed and dorsiflexed and re-examined for pain. In the event that tenderness on palpation diminishes or vanishes totally with most extreme dorsiflexion, tendinopathy istaken to be positive (Maffulli et al., 2003).

Crepitus test where a subjective sentiment of crepitation by the clinician exhibited while pressing the tendon between two fingers is also utilized to demonstrate presence of AT (Hutchison et al., 2013).

2.4.2 Imaging

Computerized Tomography Scanning, MRI, ultrasonography and radiographs have been used for tendon imaging (Mallinson et al., 2013). Among the imaging modalities, MRI and ultrasound are the preferred modalities as documented by Mallinson and associates (2013). This is because MRI results have better tissue differentiation and is able to show details of tissues in various planes. Ultrasound advances on the other hand including transducer innovation has resulted in increased sensitivity especially with the use of doppler imaging, increasing the scope of ultrasound use. However, the challenge is that MRI cannot be accessed by all, as it is expensive. One disadvantage with ultrasound is that, it is more dependent on the user with slight changes of the ultrasound transducer head positioning resulting in sonographic relics resembling those observed in tendon pathology. An advantage with sonography is that while MRI gives results in a general observation of the area under investigation, ultrasound can concentrate on specific symptomatic area (Docking et al., 2015).

MRI and ultrasound are the mainly used imaging modalities for the Achilles tendon although ultrasound is the most commonly used method as identified from literature. Most clinicians opt for Ultrasound imaging over MRI as it is more accessible, has a generally short scanning time, is more affordable, easily tolerated by patients and can demonstrate neovascularization. It is also a dynamic examination which permits cooperation by the patient with regards to the site of manifestations of the symptoms (Docking et al., 2015).

Ultrasonography has also indicated great precision when contrasted with highest quality standards such as pathological finding (Sell et al., 1997).

2.4.3 Accuracy and reliability of the different Achilles Tendinopathy tests

Various studies have researched on the level of accuracy of imaging modalities when used to diagnose tendinopathy. These studies have reliably reported that ultrasound and MRI have good consistency (ultrasound, 0.63–0.83; MRI, 0.68–0.70) however, they have fluctuating sensitivity (ultrasound, 0.68–0.87; MRI, 0.50–0.57) in identifying clinical tendinopathy (Adams et al., 2010). Docking and associates (2015) were of the view that there is need for caution during interpretation of the results reported in these studies, as individuals without symptoms are occasionally included which might lead to an overestimation of the sensitivity and accuracy of the use of imaging modalities in the clinical diagnosis of tendinopathy.

Hutchison et al (2013) studied the consistency and accuracy of the different tests used in the diagnosis of AT. Self-reported (subjective) pain test was found to be highly accurate in testing the absence of AT (sensitivity 78%, negative predictive value (NPV) of 0.77), followed by morning stiffness test which had a sensitivity of 88%, and NPV of 0.83 and pain on palpation which was found to have 84% sensitivity and NPV of 0.82. The tests that affirmed the AT presence in an individual were; Achilles tendon pain reported by the patient, which was shown to be highly accurate with 76% specificity and positive predictive value (PPV) of 0.77, followed by thickening of the tendon which had a specificity of 90% and a PPV of 0.86. Other tests which have proved to be accurate in the diagnosis of AT include crepitus test with a specificity of 100% and PPV of 1.0 and the Royal London Test which was reported to have a specificity of 93% and 0.88 PPV. Using a combination of morning stiffness test and palpation test was reported to result in a specificity of 89% and sensitivity of 83% (Hutchison et al., 2013).

When looking at the inter and intra tester-reliability and the clinician's lowest score, palpation, morning stiffness and self-reported pain were found to be reliable tests while crepitus and passive ankle dorsi-flexion were found to be least in reliability. Other clinical tests were found to be moderately reliable. The study results showed that self-reported pain and palpation were the most valid clinical tests in terms of their accuracy and reproducibility (Hutchison et al., 2013).

From this review, it is evident that the prevalence of AT among people involved in sporting activities especially middle and long-distance runners is high. However, there is scarcity of studies on AT among runners in Sub-Saharan Africa. There is also limited studies that have attempted to look at the dynamic balance ability of long-distance runners with AT globally.

CHAPTER THREE

METHODOLOGY

3.1 Study setting

The study was carried out in 15 training camps located in high altitude areas of Western Kenya. These included those situated at Elgeyo-Marakwet, Nandi, Uasin Gishu, Nakuru and Kericho countiesAll the five counties are home to many long-distance runners in Kenya and have training facilities used by many athletes, both local and foreign.

3.2 Study design

A cross-sectional study design was used to carry out this study as guided by the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) (Vandenbroucke et al., 2007). A cross-sectional study is an observational study where the researcher looks at both the exposure and outcomes at the same instance in time among the same individuals (Setia., 2016).

3.3 Study population

The study population for this study consisted of long-distance runners who train at the high altitude training camps in Western Kenya. Long distance runners in the Camps in Western Kenya are estimated to range between 300 and 500 at any given time.

3.4 Eligibility criteria

3.4.1 Inclusion criteria

The following criteria was used to select participan**ts;**

- Long-distance runners, who were based in training camps in Western Kenya during the data collection period.
- All the runners who tested positive to self-reported pain and palpation tests.

Palpation and self-reported pain test

Self-reported pain and palpation tests were carried out as suggested by Hutchinson et al, (2013); The runners were asked if they were feeling any pain at the Achilles tendon. Runners who reported pain were then asked to point out to the researcher the specific area with elevated symptoms along the Achilles tendon. Pain location anywhere between 2cm to 6cm from the Achilles' point of attachment into the calcaneum, confirmed the presence of AT.

The researcher proceeded to palpated the athletes's Achilles tendon from its point of attachment upwards by squeezing it between the thumb and the fore finger gently while feeling the tendon for thickness. The presence of AT was confirmed by abstract feeling of the Achilles tendon thickening (Hutchison et al., 2013).

3.4.2 Exclusion criteria

Long-distance runners with the following conditions were excluded from the study;

- Other lower limb injuries apart from AT during the last six months.
- Vestibular disorders.
- Visual disorders.

3.5 Sample size

Long-distance runners who train at high altitude training camps are roughly 500 in number. The prevalence of AT among long-distance runners documented in literature is approximately 18.5% (Lopes et al., 2012). Hence, it was expected that among the 500 athletes, 93 would have AT. Since the study population was expected to be small, all the athletes were included in the study. The total number of long-distance runners found in the training camps at the time of data collection was 410 (male: n=300; female:n=110).

3.6 Sampling technique

Census approach was used to select participants with AT, whereby participants were consecutively recruited into the study as they were assessed and found to have AT.

3.7 Data collection instruments

Data in this study was collected using a self-administered structured questionnaire and clinical tests used to screen for AT (Appendix III). The entire instrument consisted of 5 sections. Section A, C and D (questions 1-9, 10-24 and 25-39 respectively) of the instrument are questions which enquired on the athlete's demographic characteristics, their exercise and injury history respectively. Section B and E of the instruments were used to screen for AT presence and the runners' dynamic balance respectively. The questions for the determination of exercise and injury history (sections C and D) were adapted from the running baseline questionnaire (Obeid et al., 2013). Dynamic balance test was carried out on the runners with AT using the Star Excursion Balance Test (SEBT) tool (section E) adopted from Olivier et al (2015).

Before carrying out the SEBT, its procedure was first explained to the study participants verbally and demonstrations were done, there after questions and concerns of the participants were addressed. SEBT protocol was then applied as recommended by Gribble et al. (2012). Based on this protocol, an assessment was carried out by having a runner balance on one lower limb while at the same time reaching three different directions; the posterolateral (PL), anterior, and posteromedial (PM) with the other limb (Three tape measures were strapped on the floor along the three directions to guide visibility). The aim was to reach the furthest distance possible of the three directions (Gribble et al., 2012; Hertel et al., 2006; Plisky et al., 2006). The participant was expected to touch the furthest point using the big toe in a light manner possible, without: using the leg used to reach out for support, getting hands off the waist or bearing weight on the contra-lateral limb. The individual was expected to come back to the center using both feet while at the same time keeping the balance (Hertel et al., 2006; Mckeon et al., 2008; Plisky et al., 2006). The procedure was repeated three times with each of the process involving 3 reaches in the 3 directions. A five second rest between each reach was provided to each participant. The furthest reach distance from the three attempts in each direction was used to calculate the normalised reach distance.

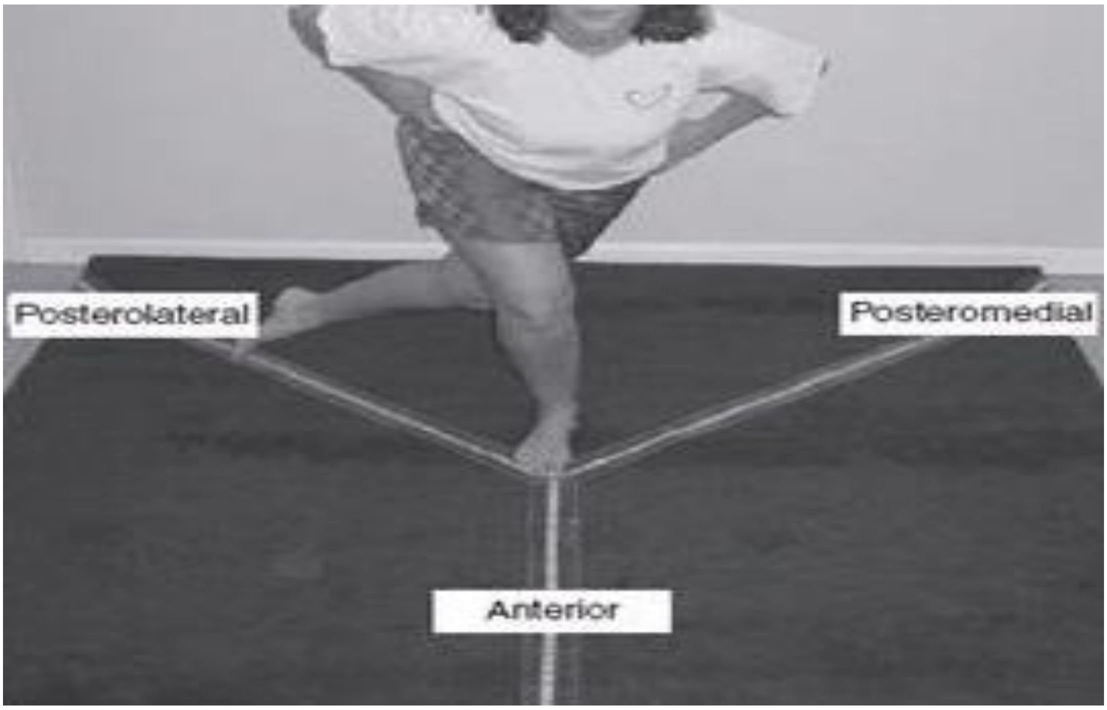

Figure 3.1: Star excursion Balance Test

To compute the composite scores, lower limb length measurements in centimeters were first obtained by measuring the lower limb from the anterior superior iliac spine to the most prominent bone on the medial side of the ankle joint while the participant was lying supine.

The normalized reach distance was then calculated by dividing the reach distance by the leg length then multiplied by 100 to get the normalized reach distance in percentage (Olivier et al., 2015). Normalising reach distance to the length of the limb was done to allow more accurate comparison between tall and short runners as well as dominant and non-dominant limbs since reach distances were expected to be greater for tall runners with equally longer limbs. The normalised reach values collected from the SEBT were then analysed and presented in terms of limb dominance as opposed to left versus the right limbs.

3.8 Reliability and validity of star excursion balance test (SEBT)

SEBT is a highly reliable tool used to measure dynamic balance among individuals. Hyong et al (2014) assessed SEBT test intra-tester reliability in evaluating dynamic balance. The study results showed good reliability of the test with an intra-class correlation (ICC) of 0.82 in the right posterior medial direction, 0.87 on the left anterior medial/posterior medial reaches and 0.67 for the right anterior medial reach.

In another study that assessed SEBT reliability, the inter-tester and intra-tester reliability of the different reach directions were determined. The inter-tester reliability of the SEBT was found to be between 0.35 to 0.93 while the intra-tester reliability was between 0.78 to 0.96 (Gribble et al., 2012).

Another study by Hyong and Kim also assessed the intra and inter-rater reliability of the SEBT test in their study involving 67 healthy individuals. The test results found a high intra and inter-rater reliability of between 0.88-0.93, and 0.83-0.93, respectively (Hyong, Hyouk; Kim, 2014).

3.9 Procedures

3.9.1 Pilot study

A pretest was done among long-distance runners based in Western Kenya representing 10% of the study sample to check the reliability and validity of the study tools and methods before the final study was conducted. Data of individuals included in the pilot study were included in the main study since no changes were made to the study tools after the pilot study.

3.9.2 Main study

The researcher carried out a pre-visit to each of the fifteen camps and sought consent to conduct the study at the facilities after explaining the nature, purpose and procedure of the study. Permission was granted and appointments were made with the long-distance runners at each of the facilities with the help of the camp management.

During the date of appointment, the researcher with the help of a trained research assistant visited each of the training camps. Before participation, each participant was given a detailed explanation on the study protocol, including the order of the tests to be done and a written, informed consent was obtained.

All the long-distance runners were first screened for AT; using the subjective self-reported pain and palpation test as per Hutchison et al (2013). All the runners who were found to be positive for AT had their demographic information, anthropometrics, exercise and training history assessed using a self-administered structured questionnaire. Dynamic balance of the runners who tested positive for AT was further assessed using the SEBT after verbal explanation and demonstrations. Recruitment and examination process was done as illustrated in the flow chart below. **(Figure 3.3)**

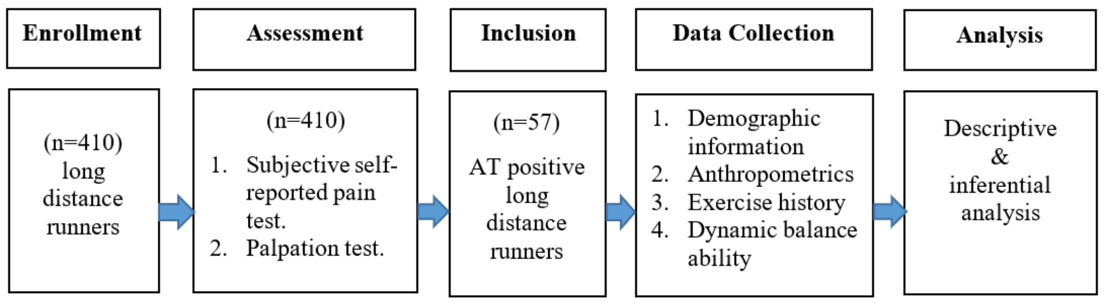

Figure 3.2: Recruitment of Participants and Examination process (N=410)

3.10 Data management and Data analysis

The collected data was entered into Microsoft Excel where it was cleaned and coded. The data was then imported into IBM Statistical Package for Social Sciences (SPSS) version 25.0 for analysis. Data are presented in terms of dominance as opposed to left versus right. Both descriptive and inferential statistics were used for analysis. Continuous variables such as SEBT scores were analyzed using measures of central tendency (mean, median and mode) and measures of dispersion (interquartile range and standard deviation). For categorical variables, frequency tables and proportions were utilized. Independent sample t-test was used to assess the differences in the mean gender-based SEBT scores and the social demographics and anthropometric data. A p-value of < 0.05 was considered statistically significant.

3.11 Data presentation

The analysis output was presented in the form of tables, figures and prose paragraphs.

3.12 Ethical consideration

Ethical review and approval for the study protocol was sought from Jomo Kenyatta University of Agriculture and Technology Ethics Review Committee (Appendix 1V) and National Commission of Science, Technology and Innovation (NACOSTI) (Appendix V) before the study was conducted. Permission was also sought from the management of respective training camps.

Written consent (Appendix II) was sought from the participants after explaining through a written information sheet (Appendix III) the nature and purpose of the study to them. The collected information was kept confidential and the identity of the individual participants was protected by use of codes instead of names. The collected data was stored in a lockable cabinet.

3.13 Dissemination of the results

The findings of the study will be presented to JKUAT. The study will also be published in a reputable international journal of physiotherapy. The outcome will be presented in both local and international conferences, seminars and meetings on physiotherapy. The results will also be summarized in leaflets and made available to the training camps.

CHAPTER FOUR

RESULTS

4.1 Participants and prevalence of Achilles Tendinopathy among long-distance runners.

A total of (N=410) long-distance runners from 15 training camps were screened for AT after consenting. Comprehensive medical history and clinical examination was carried out to determine the presence of AT; whereby self-reported pain and palpation tests were administered (Hutchison et al., 2013).

Out of the 410 athletes, 57 were found to have AT on assessment, translating to an AT prevalence of 13.9%. **(Figure 4.1)**

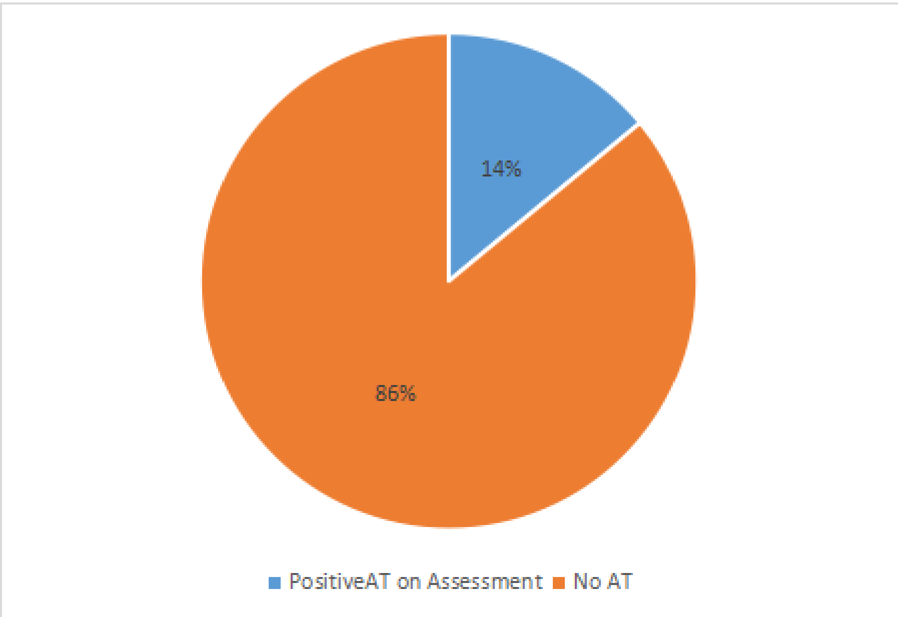

Figure 4.1: The prevalence of AT among the study population (N=410)

Long-distance runners with Achilles Tendinopathy

Most of the long-distance runners diagnosed with AT exhibited symptoms on the dominant foot more than the non-dominant and only 3.5% (n=2) respondents had bilateral AT. **(Table 4.1).**

Table 4.1: Clinical tests results (n=57)

AT test	Positive	Negative
Palpation test on dominant foot	36 (63.2%)	21 (36.8%)
Palpation test on non-dominant foot	23 (40.4%)	34 (59.6%)
Subjective pain test on dominant foot	35 (61.4%)	22 (38.6%)
Subjective pain test on non-dominant foot	22 (38.6%)	35 (61.4%)

4.2 Demographics, anthropometrics and limb dominance (n=57)

Among the 57 respondents with AT, majority (n=42; 73.7%) were male. The mean age of the respondents was 28.1 years (SD=4.6) and 43.8% (n=25) were aged 26-30 years. (**Table 4.2).**

Table 4.2: Demographic information (n=57)

Demographic information	Frequency (n= 57)	Percent (%)
Gender		
Male	42	73.7
Female	15	26.3
Age ranges		
20- 25	14	24.6
26- 30	25	43.8
31- 35	15	26.3
36- 40	3	5.3

The mean weight of the respondent was 55.4 kg (SD= 5.0) while the mean height was 1.7 meters (SD= 0.1) **(Table 4.3).**

Table 4.3: Athletes' height and weight (n=57)

Variable	Mean	SD	95% Cl
Height	1.7	.07	1.69 - 1.72
Weight	55.4	5.03	54.06 - 56.73

SD= Standard deviation

The right limb was the dominant leg for 93.0% (n=53) of the runners while only 7.0%, (n=4) used the left leg **(Figure 4.2).**

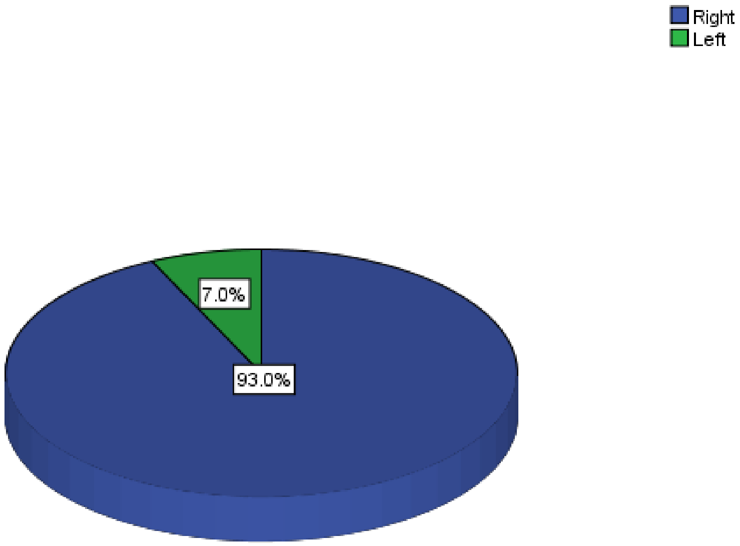

Figure 4.2: Leg used for kicking the ball by the athletes (n=57)

4.5 Exercise history

Exercise history captured information such as; period one had been a long-distance runner, participation in competitive running while in high school, type of race run competitively, number of competitions participated the previous two years and weekly training mileage.

Among the athletes with AT, majority (n= 24; 42.1%) had been long-distance runners for 5 to 10 years while only 5.3% (n= 3) had been long-distance runners for less than one year. Most (n= 53; 93.0%) participated in competitive sports while in high school and 38.6% (n= 22) competed in 42km races. **(Figure 4.3).**

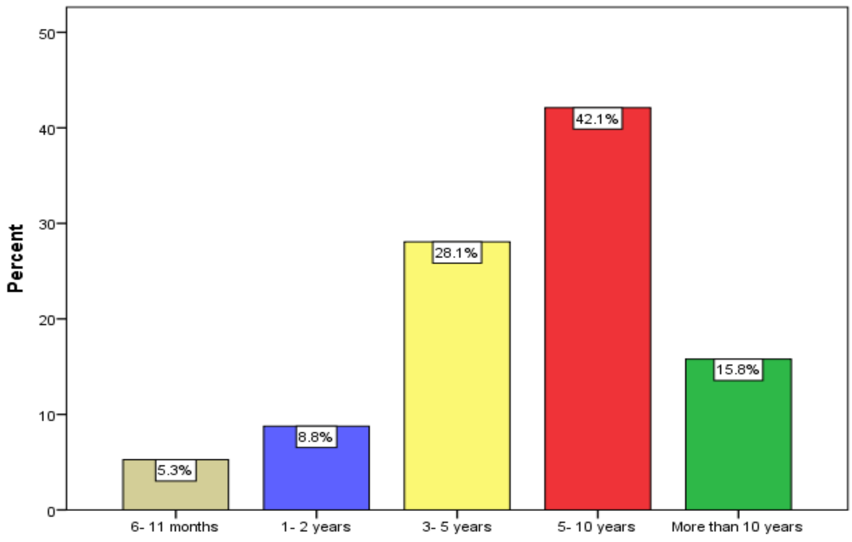

Figure 4.3: Period as a long-distance runner (n=57)

Most of the participants 93.0% (n=53) had participated in competitive sports while in high school **(Figure 4.4).**

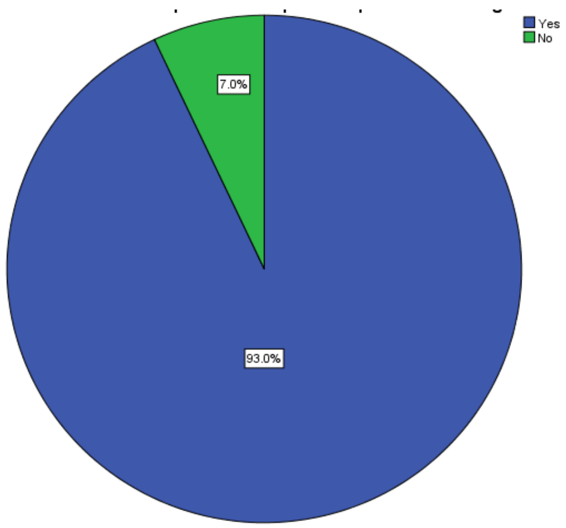

Figure 4.4: Sports participation in school (n=57)

Majority of the runners (n= 22; 38.6%) competed in 42km races as shown in (**Figure 4.5).**

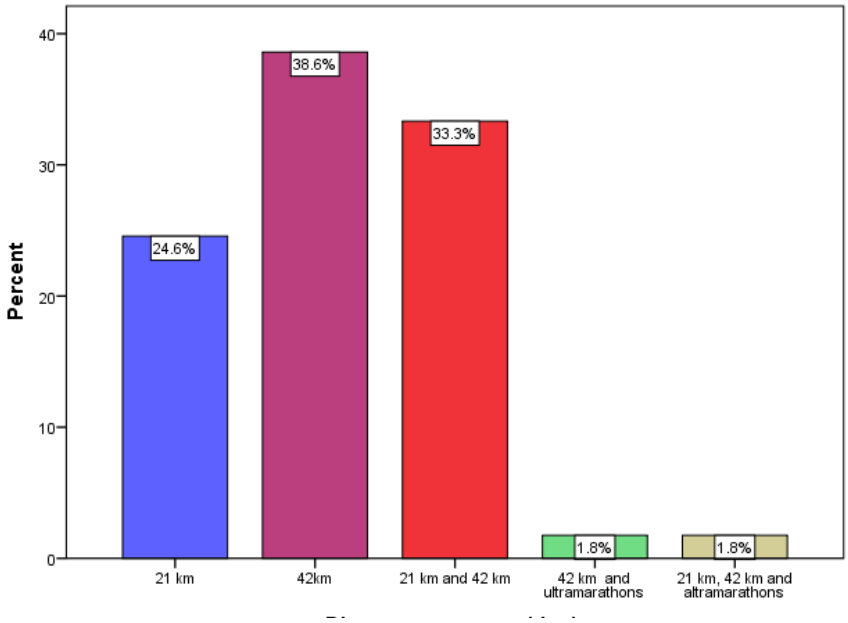

Figure 4.5: Type of race the respondents participate in (n=57)

The median number of major competitions completed in the previous 2 years was 5 IQR (6-4), with the person who had participated in the most competitions having participated in 10 and the one who had participated in least number of races had participated in 1 race. The distribution of number of races and individuals who participated in them is shown in **Table 4.4** below.

Table 4.4: Number of competitions participated in the last 2 years (n=57)

Number of competitions completed in the last 2 years	Frequency (n)	Percent (%)
1	2	3.5
2	7	12.3
3	3	5.3
4	16	28.1
5	13	22.8
6	5	8.8
7	2	3.5
8	4	7.0
9	2	3.5
10	3	5.3
Total	**57**	**100.0**

The mean number of kilometers covered per week was 170.0 km (SD=35.4) with a mean pace of 3.3 minutes per kilometer (SD=0.3). The personal best time to complete a 21 km race that was shortest was 59 minutes and 12 seconds while that of 42 km was 2 hours 4 minutes. A majority, (n=35; 61.4%) covered 151- 200 km per week.

The median number of training days for the athletes included in the study was 6 days IQR (7-6). Most, (n=35; 61.4%) trained for six days a week and 36.8% (n=21) trained daily **(Table 4.5).**

Table 4.5: Exercise history (n=57)

Exercise history	Frequency (n)	Percent (%)
Km covered per week		
0- 50 km	1	1.8
51- 100 km	2	3.5
101-150 km	12	21.0
151- 200 km	35	61.4
201- 250km	7	12.3
Average pace per week (min/km)		
Less than 3 min	2	3.5
3- 3.4 min	38	66.7
3.5- 3.9 min	12	21.0
4.0- 4.4 min	5	8.8
Training days per week		
4 days	1	1.8
6 days	35	61.4
7 days	21	36.8
Current running habits		
I am running regularly and still perform regularly	57	100

History of hospitalization

Most of the runners, (n= 55; 96.5%) had never required hospitalization after a competitive event and of the 3.5% (n= 2) who required hospitalization, one was hospitalized in 2012 for dizziness **(Figure 4.6).**

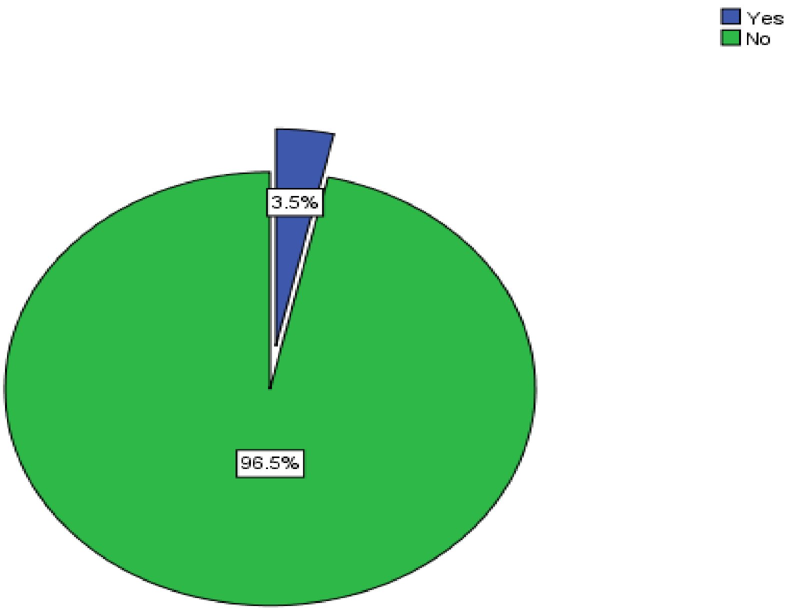

Figure 4.6: Hospitalization history (n=57).

4.6 Dynamic balance test (SEBT scores)

The mean normalized reach distance values were lowest generally for dominant anterior (69.7%) and the highest mean score was dominant posteromedial (86.8%) as presented in **Table 4.6.** Average normalized reach distance with regard to direction on SEBT was 72.9%, 84.3%, and 89.2% for anterior, PL and PM, respectively.

Table 4.6: Dominant and non-dominant normalized scores

Foot	Variable	Mean (%)	SD	95% Cl
Dominant	Anterior normalized score	69.7	9.80	67.11 - 72.31
	Posteromedial normalized	86.8	11.67	83.72 - 89.91
	Posterolateral normalized	80.6	14.06	76.91 - 84.38
Non-dominant	Anterior normalized score	71.1	11.70	67.99 - 74.20
	Posteromedial normalized	85.6	11.41	82.57 - 88.63
	Posterolateral normalized	82.2	14.48	78.40 - 86.08

There was no significant difference between the mean composite scores for the non-dominant and the dominant sides. **(Table 4.7).**

Table 4.7: Mean composite scores

Variable	Mean	SD	95% Cl
Composite dominant score	81.9	10.3	79.12 - 84.57
Composite Non-dominant score	82.4	11.6	79.34 - 85.49

Association between SEBT score and selected demographic characteristics.

There were statistically significant differences between gender in the dominant posterior lateral normalized scores *(*p=0.014). Similarly, a significant difference in mean score for gender was found for dominant posterior medial normalized scores, *(*P=0.002) and composite dominant scores, (P-value = 0.044), with the scores being higher in men compared to females **(Table 4.8).**

Table 4.8: Gender distribution of mean score differences (n=57)

Variable (Normalized scores)	Gender	Mean	df	t-statistic	p-value
Dominant posterior lateral	Male	83.4±14.4	55	2.547	0.014
	Female	73.1±10.2			
Non-dominant posterior lateral	Male	84.4±14.3	55	1.950	0.056
	Female	76.1±13.6			
Dominant posterior medial	Male	89.6±10.8	55	3.309	0.002
	Female	78.9±10.5			
Dominant anterior	Male	70.1±8.9	55	.508	0.614
	Female	68.6±12.3			
Differences in dominant and non- dominant posteromedial	Male	2.5+ 5.3	55	1.56	0.126
	Female	-.2 ±6.9			
Differences in dominant and non- dominant posterolateral	Male	-1.8+ 4.8	55	0.902	0.371
	Female	-3.3 ± 7.8			
Composite dominant score	Male	83.5 ±9.5	55	2.06	0.044
	Female	77.3 ±11.4			
Composite non-dominant score	Male	83.8 ±10.4	19.66	1.36	0.188
	Female	78.4 ±14.1			

Only 8.77% (n=5) of the 57 athletes had composite score of greater than 94.0% on dominant and 17.54% (n=10) on non-dominant side (**Table 4.9).**

Table 4.9: Distribution of composite scores

Score	Frequency	Percent (%)
Composite score dominant		
>94	52	91.23
<94	5	8.77
Composite score non-dominant		
>94	47	82.46
<94	10	17.54

There was statistically significant correlation between age and composite dominant scores (P= < 0.01) and kilometers covered and composite dominant scores (p=0.05) (**Table 4.10).**

Table 4.10: Correlation between age and composite scores

Variable	Composite dominant	Composite non-dominant
Age	.404**	.256
Km covered	.283*	.202

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMANDATIONS

5.1 Discussion

This study explored the prevalence of AT among Kenyan long-distance runners, established the exercise history of runners with AT and their dynamic balance as measured using SEBT.

5.1.1 Prevalence of Achilles Tendinopathy

This study reports an AT prevalence of 13.9%, which is much lower than the 52% AT prevalence reported among athletes participating in long and middle distance races in Finland by Kujala et al (2005). Kujala et al’s study was however different from the current study, as it was a historical cohort design, which relied mainly on historical information and self-reported previous AT diagnosis. The higher prevalence of AT reported by Kujala and colleagues (2005), was perhaps because the study had a large sample size of 785 former elite athletes who participated in their study. Moreover, the reported prevalence was a lifetime cumulative as opposed to the present study that determined point prevalence among Kenyan long-distance runners. Another distinction is the fact that Kujala et al’s participants were all male, former elite runners with more experience in competitive running compared to participants in the current study. Being male, elite and having run for a longer time have all been documented in literature to be major risk factors to overuse injuries like AT (Zwerver et al., 2011). It is also likely that their results may have been affected by recall bias, considering that their data was based on the mental recall of previous AT injuries by the runners. Thus, it is possible that cases with a similar presentation as AT, may have been misreported as AT by athletes.

The prevalence reported in this study is also much lower compared to that reported by Knobloch et al (2008), in which 29% prevalence was found among elite middle and long-distance runners. They also reported that, at some point 56% of the runners were found to have AT. It is important to note however, that the study by Knobloch and colleagues was a retrospective design. It is plausible that the results might have been affected by recall bias or inaccurate diagnosis of cases presenting like AT, given that it was self-reported by the athletes other than from a clinical examination by a clinician. AT diagnosis in the current study was confirmed through subjective self-reported Achilles pain by the runner and palpation test by a qualified physiotherapist (Hutchison et al., 2013). The participants in Knobloch et al's study (2008) were also older than those who took part in the present study, possibly with more years in competitive running. This also, may have been the reason for higher incidences of AT in their study (Haglund-Åkerlind & Eriksson, 1993).

The prevalence reported in this study is within the range reported in a review by Lopes and colleagues (2012), where the prevalence of AT among athletes involved in ultramarathon running ranged from 6.2% to 18.5%. The variation in the prevalence reported in the review could be attributed to the differences in the methodologies in the individual articles and the disparate approaches of diagnosing AT by different authors. Besides, the review combined prevalence rates from different studies which had varying study populations.

5.1.2 Exercise history

Researchers, coaches and runners are all in agreement with the fact that training volume which translates to kilometers covered per unit time, training intensity and training frequency positively influence the athletes' performance (Noakes et al., 1990). Long-distance runners mostly have training schedules which target to optimize their performance. The training is meant to influence the physiological factors correlated with their performance such as velocity at the anaerobic threshold, maximum oxygen uptake and its utilization, and the running economy (Ingham et al., 2008). This study sought to find out the training/exercise history of those athletes with AT.

Participants in the present study took part in long-distance running, with majority having 21km or 42 km as their preferred races. The mean kilometers covered during training per week among the study participants was 170km with an average pace of 3.3 minutes per kilometer. Most runners trained for six days a week on average.

The weekly mileage of 170 km reported in this study is much higher than 65km weekly mileage reported by Knobloch et al (2008). Among the 291 elite long-distance runners in Knobloch et al's study, 56% at some point developed AT as the main predominant overuse injury and all of them reported a mean weekly mileage of above 65 km. This was considered to be above the recommended average. They speculated that possibly high weekly mileage was associated with increased prevalence of AT. Since their study was retrospective in nature, and mileage was also self-reported by the runners, then perhaps, recall bias could not be ruled out and reported weekly distance might have been underestimated. Yet again, weekly mileage was just an estimate and mileage variation between sessions were most likely not put into consideration.

Weekly distance coverage by participants in this study, is also much higher than what was found by Haglund and colleagues, (1993), which was a comparative study on training habits of runners with and without Achilles tendon problems. They reported, that high weekly distance covered was correlated with AT prevalence. The participants with AT in their study were covering an average of 102.2km weekly which is way below what was found in this study, (170km per week). The difference can be attributed to variation in study population, as Haglund and colleagues' participants were all middle distance runners and probably this was a higher training load for them, as compared to long-distance runners in this study. Their study also had a small sample size of 10 runners with AT and so this again may not be giving a true reflection.

The mean weekly mileage in this study is close to what was found by Mbarak et al (2019) in Kenya where 75% of the runners had a weekly coverage of above 150km. In their study of 108 runners, 27.8% had AT which was also third highest reported running related injury in a study where majority were long-distance runners. The researcher thought that the similarity in mileage could possibly be because both studies had a similar population of Kenyan runners, majority having preference for long-distance running with a considerable proportion of elite runners, who train in similar environment. Mostly, these runners train at the high altitude training camps, where they have probably become well adapted to endurance running and high mileage.

It is worth noting, that the findings of this study with regards to weekly mileage (170km) and pace and that of Mbarak et al (2019) and Haglund-Åkerlind & Eriksson (1993) are way above the proposed average weekly coverage of 64km per week beyond which, can predispose runners to injury as stated by several authors (Gallo et al., 2012; Knobloch et al., 2008; Macera et al., 2015; Walter, 1989). However, the study by Van Middelkoop et al, (2008), did not find high mileage to be a risk factor for overuse injuries. Variation in mileage between this study and earlier investigations can raise a concern as to whether, the recommended training volume as reported documented in literature, is applicable everywhere and to all types of races given that some of the best long-distance runners come from Kenya. The researcher speculated that perhaps the cause of overuse running related injuries like AT among Kenyan runners could be majorly because of other risk factors other than mileage like hilly terrains since most of them come from North Rift region of Western Kenya which is quite hilly. Future research is therefore recommended on the applicable evidence informed weekly mileage to establish the exact training volumes that puts into consideration the training environment and the type of race a runner is specialized in.

Most of the participants in this study had an average of 5 to 10 years of experience and majority had been runners since high school, meaning they probably had been running for more than 10 years. This is comparable to the Swedish runners who took part in a study by Haglund-Åkerlind & Eriksson, (1993) who had AT and all of them had a running experience of approximately 9 years on average. Kujala et al (2005) and Knobloch et al (2008) in their studies also found high AT prevalence among former elite and elite runners who had been professional runners for many years possibly than the subjects in this study although they did not specify the years of experience.

The similarities between earlier studies (Haglund-Åkerlind & Eriksson, 1993; Knobloch et al., 2008; Kujala et al., 2005) and the present study is that all the participants were distance runners. It has been suggested by many authors that endurance running and years spent in the field of running has a correlation with AT and this seems to agree with the findings of this study (Haglund-Åkerlind & Eriksson, 1993; Knobloch et al., 2008; Kujala et al., 2005; Macera et al., 2015).

5.1.3 Dynamic balance

Balance is key to athletes as poor balance has been associated with increased likelihood of lower limb injuries (McGuine et al., 2000; Plisky et al., 2006). Information related to proprioception is primarily relayed by proprioceptors located in the muscle spindles, intra- tendinous Golgi tendon organ (GTO) and the skin. It is therefore logical to think that tendinopathic changes including alteration in the structure of a tendon as seen in lower limb tendinopathies like AT may alter proprioception causing balance deficits (Scholes et al., 2018).

Compromised balance cannot allow athletes to keep their weight and body mass on one limb, as they transfer it to the opposite limb without a fall or injury during running (Knight et al., 2016). SEBT tool is accepted widely as a tool for assessing dynamic balance. Its utilization in identifying individuals who are at risk of injury, and tracking rehabilitation process cannot be over emphasized. Another primary objective of this study was therefore to determine the dynamic balance abilities of runners with AT as measured using the SEBT.

A major finding in this study is that most participants had composite scores of less than 94%. Plisky et al (2009) proposed a cut off score of 94%, below which an athlete’s balance is taken to be impaired. The same score was used in this study; considering SEBT’s high reliability, although sports and gender-specific cut-off scores are not available currently. The reported score, according to Plisky and colleagues (2009), meant that most of the runners with AT had a higher likelihood of developing other lower limb injuries. Plisky et al’s study also pointed out that, the chances of female athletes with lower scores was higher at 6.5 times than the male athletes. The runners with AT were therefore at an increased risk of re-injury and more likely to develop other lower limb injuries or rupturing the affected tendons with time.

The findings of this study are consistent with those of Herrington et al (2009), Aminaka et al (2008) and Olmsted et al (2002), who also found scores less than 94% on patients with Anterior cruciate ligament deficiency (ACLD), patellofemoral pain syndrome (PFPS) and chronic ankle instability (CAI) respectively. A comparison of the present findings with those of the above mentioned studies is presented in **Table 5.1.** The researcher thought that although the diagnoses, anatomical sites, structures and even the causes were varied, the physiology behind the impaired balance is the same. As much as there was damage to the integrity of structures like tendons, muscles, joint capsule and ligaments, there was also damage to the mechanoreceptors located in these structures. Interruption of feedback from the damaged mechanoreceptors is likely to cause judgement errors leading to impaired balance regardless of the cause or anatomical location, perhaps with varying severity (Knight et al., 2016).

The normalized PM and PL scores found in this study is slightly higher, though comparable than the reach distances found by Olmsted and colleagues (2002) in their study on CAI. Although balance deficits are evident in both studies, the differences between them could be explained in light of variation in study populations in terms of diagnosis, mechanism of injury and structures affected. The lower scores reported in the present study and in patients diagnosed with CAI by Olmsted et al. (2000) can be attributed to marked limitation of ankle movements, specifically dorsiflexion (Rabin et al., 2014). Limited ankle dorsiflexion associated with both CAI and AT is thought to contribute to reduced balance (Curtis et al., 2013). Olmsted and colleagues further associated lower scores in patients with CAI to apprehension, whereby any activity that causes stress to the joint like during SEBT is likely to elicit fear. This was not the case with runners with AT, since almost all of them continued training and competing despite the condition as was observed in this study and that of Ardern et al (2016). Consequently, it would be necessary in future research to clarify the real cause of balance impairments in AT.

Although Herrington et al (2009) in their study on ACLD indicated slightly higher scores than in this study in the PM and PL directions, their anterior scores(41%) were much lower than what was found in this study (72.9%). One possible reason that can be attributed to exceptionally low anterior scores in the ACLD patients could be weakness of quadriceps muscle commonly associated with ACLD and often not seen in patients with AT (Konishi et al., 2003). Studies that have been done on muscle activation during SEBT have indicated maximum quadriceps muscle activation during anterior reaches (Earl & Hertel, 2001). Likewise, quadriceps muscle strength has also been shown to correlate with balance, whereby weak quadriceps muscle was associated with reduced balance (Hunt et al., 2010). This is the same concept that possibly could apply to patients with PFPS where the anterior reaches were also much lower (62.8%) than what was found in the current investigation (72.9%); although Aminaka and colleagues (2008) only tested their PFPS subjects in the anterior direction. Even though other lower limb characteristics like flexibility and power of different groups of muscles were not tested in the present study, the researcher hypothesized that perhaps the effects of AT on quadriceps muscle is minimal compared to ACLD and PFPS, hence future research should investigate this further.

The scores reported in the previous studies (Aminaka et al., 2008; Herrington et al., 2009; Olmsted et al., 2002) and the findings of the present study agree that anterior scores are the least scored direction on SEBT. The variation was minimal except for the study by Herrington et al (2009) where the anterior score was much lower (41%) for patients with ACLD. This is also agreeing with studies done earlier on healthy subjects (Gorman et al., 2012; Stiffler et al., 2015). Although Butler and colleagues (2012) found greater anterior scores, it is important to note that the high scores were exhibited by novice high school athletes who at the same time scored poorly on both PM and PL directions as compared to professional athletes.

Lower anterior scores are explained to be caused by a limitation in reach distance during the anterior reach since the visual sub-system of balance comes into play as the participant can read their scores as they perform, as opposed to the posterior reaches where only the vestibular and somatosensory subsystems are utilised. Thus lower anterior scores compared to PM and PL in our view, is not unusual when pathology is not considered (Coughlan et al., 2012). Published literature is however sparse on this phenomenon, which needs further investigation. Based on the present findings, the researcher speculated that shorter anterior scores across the lower limb injuries could be perhaps because of similar strategies used to attain equilibrium after pathology; where an individual adopts a hip strategy of forward and downward rotation of upper body instead of the ankle approach of rotating the body about the ankle joint, commonly used by healthy persons (Leavey et al., 2010). The hip strategy may decrease both the available range of motion in the joints and the efficiency of muscle groups required to move the lower limb along the sagittal plane during SEBT as indicated by Leavy and colleagues (2010).

Table 5.1: Comparison of Average SEBT Scores among Different Studies

Author	**This study**	**Herrington et al,.(2009)**	**Aminaka et al., (2008)**	**Olmsted et al., (2002)**
Diagnosis	AT	ACLD	PFPS	CAI
Anterior	72.9	41.4	62.8	79.2
PM	89.2	90.4	NM	85.6
PL	84.3	90.0	NM	79.4

ACLD-Anterior cruciate ligament deficiency; AT-Achilles Tendinopathy; PFPS-patellofemoral pain syndrome; NM-Not measured by author; CAI-chronic ankle insufficiency

Another key finding in this study is that male distance runners scored higher than their female counterparts, in almost all directions of SEBT despite normalization of reach distances, with the differences being statistically significant (<0.05). This result was supported by findings of other studies done earlier (Bhat & Moiz, 2013; Ral et al., 2006). Although these studies were done on healthy participants, generally lower scores exhibited by females seems to cut across. The observed finding could be attributed to neuromuscular differences between male and female runners, decreased dynamic stabilization of joints and muscle asymmetry by females owing to the anatomical and hormonal differences (Henry & Kaeding, 2001). There is need for further research on the influence of gender on dynamic balance as has been proposed by other authors (Sabin et al., 2010). Other studies found no significant differences between gender and SEBT scores (Gribble et al., 2004), although another study found females to have greater reach distances than males on SEBT (Gribble et al., 2004). The fact that female runners were few compared to males in this study may not give a true reflection on gender disparity with regards to SEBT scores, all in all there seems to be an influence of gender on dynamic balance.

5.2 Conclusion

This study found an AT prevalence of 13.9% among Kenyan long-distance runners. This was considered significant since one runner is considered a team by himself/herself. For this reason the probable causes of AT needs to be looked into perhaps through longitudinal designs so as to establish measures of preventing this disabling injury which is often very difficult to treat.

Most Kenyan long-distance runners record high mileage per week during training and also exercise quite frequently, as was evident in this study. AT can compromised dynamic balance of runners and increase their risk of suffering future running-related musculoskeletal injuries. Most of the participants in this study had low composite scores below the proposed cut-off of 94%, indicating that majority were at risk of re-injury and required intervention. Therefore, as SEBT is a very reliable and sensitive test, it should be adopted by physical therapists, coaches, and physicians to identify individuals who are at risk of injury and give prompt intervention to prevent runners from experiencing deleterious performances or prematurely exiting their sporting career.

There appears to be statistically significant differences in SEBT scores with regards to gender hence the need to develop reference scores taking into account the gender differences. This suggests the need for researchers and clinicians to assess and interpret an athlete's performance on dynamic balance with reference to their gender.

5.3 Recommendations

5.3.1 Study recommendations

5.3.2 Recommendation for Clinical practice & Training

1. Dynamic balance testing is an essential examination for all athletes with or at risk of developing AT. This is likely to mitigate the risk of developing other overuse injuries particularly in the lower limbs.
2. Since AT was identified among a significant number of athletes and is known to compromise proprioception hence balance, it is recommended that sports health and training teams in-cooperate neuromuscular and proprioceptive training into their training schedules as an injury prevention strategy. Neuromuscular training should therefore be adopted as part of training routines for Kenyan distance runners as a preventive measure and as part of the intervention to rehabilitate athletes with Achilles tendinopathy.
3. Kenyan runners and their coaches should be educated on the suggested evidence-informed training mileages to reduce training volumes which can predispose athletes to over-use injuries like AT

5.3.3 Recommendation for further research

1. Future research should identify gender and sport-specific SEBT cut-offs scores associated with increased injury risk.
2. Experimental studies should be conducted in order to determine the differences in SEBT scores among long-distance runners with and those without AT.
3. More sports-related health research, especially in the Kenyan setting is also advised in order to establish the factors that predispose distance runners to AT

5.4 Limitations

There were a number of limitations to the study.

1. SEBT test was only carried out among athletes with AT leaving out those without AT. It would have been ethically sound to assess all long-distance runners regardless of their AT status. However, this was not possible due to the limited time and resources available. This gap was bridged through comparing the balance-related findings to that of other studies in the discussion.
2. There was a disproportionate number of female and male participants which is likely to interfere with the interpretation of the study outcomes.

REFERENCES

Adams, C. R., Schoolfield, J. D., & Burkhart, S. S. (2010). Accuracy of preoperative magnetic resonance imaging in predicting a subscapularis tendon tear based on arthroscopy. *Arthroscopy - Journal of Arthroscopic and Related Surgery*, *26*(11), 1427–1433.

Alfredson, H., & Cook, J. (2007). A treatment algorithm for managing Achilles tendinopathy: New treatment options. *British Journal of Sports Medicine*, *41*(4), 211–216.

Ames, P. R. J., Longo, U. G., Denaro, V., & Maffulli, N. (2008). Achilles tendon problems: Not just an orthopaedic issue. *Disability and Rehabilitation*, *30*(20–22), 1646–1650.

Aminaka, N., & Gribble, P. A. (2008). Patellar taping, patellofemoral pain syndrome, lower extremity kinematics, and dynamic postural control. *Journal of athletic training*, *43*(1), 21-28.

Anderson, K., & Behm, D. G. (2005). The impact of instability resistance training on balance and stability. *Sports Medicine*, *35*(1), 43–53.

Ardern, C. L., Glasgow, P., Schneiders, A., Witvrouw, E., Clarsen, B., Cools, A., Gojanovic, B., Griffin, S., Khan, K. M., & Moksnes, H. (2016). 2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern. *British Journal of Sports Medicine*, *50*(14), 853–864.

Basnett, C. R., Hanish, M. J., Wheeler, T. J., Miriovsky, D. J., Danielson, E. L., Barr, J. B., & Grindstaff, T. L. (2013). Ankle dorsiflexion range of motion influences dynamic balance in individuals with chronic ankle instability. *International journal of sports physical therapy*, *8*(2), 121.

Bhat, R., & Moiz, J. A. (2013). Comparison of dynamic balance in collegiate field hockey and football players using star excursion balance test. *Asian Journal of Sports Medicine*, *4*(3), 221–229.

Bovens, A. M. P., Janssen, G. M. E., Vermeer, H. G. W., Hoeberigs, J. H., Janssen, M. P. E., & Verstappen, F. T. J. (1989). Occurrence of running injuries in adults following a supervised training program. *International Journal of Sports Medicine*, *10*(S 3), S186-S190.

Bressel, E., Yonker, J. C., Kras, J., & Heath, E. M. (2007). Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. *Journal of Athletic Training (National Athletic Trainers' Association)*, *42*(1).

Butler, R. J., Southers, C., Gorman, P. P., Kiesel, K. B., & Plisky, P. J. (2012). Differences in soccer players' dynamic balance across levels of competition. *Journal of Athletic Training*, *47*(6), 616–620.

Clarsen, B., Myklebust, G., & Bahr, R. (2013). Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology: the Oslo Sports Trauma Research Centre (OSTRC) overuse injury questionnaire. *British journal of sports medicine*, *47*(8), 495-502.

Coughlan, G. F., Fullam, K., Delahunt, E., Gissane, C., & Caulfield, B. M. (2012). A comparison between performance on selected directions of the star excursion balance test and the Y balance test. *Journal of athletic training*, *47*(4), 366-371.

De Jonge, S., Van Den Berg, C., De Vos, R. J., Van Der Heide, H. J. L., Weir, A., Verhaar, J. A. N., Bierma-Zeinstra, S. M. A., & Tol, J. L. (2011). Incidence of midportion Achilles tendinopathy in the general population. *British Journal of Sports Medicine*, *45*(13), 1026–1028.

Docking, S. I., Ooi, C. C., & Connell, D. (2015). Tendinopathy: Is imaging telling us the entire story? *Journal of Orthopaedic and Sports Physical Therapy*, *45*(11), 842–852.

Earl, J. E., & Hertel, J. (2001). Lower-extremity muscle activation during the star excursion balance tests. *Journal of sport rehabilitation*, *10*(2), 93-104.

Fields, K. B., Sykes, J. C., Walker, K. M., & Jackson, J. C. (2010). Prevention of running injuries. *Current Sports Medicine Reports*, *9*(3), 176–182.

Gallo, R. A., Plakke, M., & Silvis, M. L. (2012). Common Leg Injuries of Long-Distance Runners: Anatomical and Biomechanical Approach. *Sports Health*, *4*(6), 485–495.

Gorman, P. P., Butler, R. J., Rauh, M. J., Kiesel, K., & Plisky, P. J. (2012). Differences in dynamic balance scores in one sport versus multiple sport high school athletes. *International journal of sports physical therapy*, *7*(2), 148.

Gribble, P. A., Hertel, J., & Plisky, P. (2012). Using the star excursion balance test to assess dynamic postural-control deficits and outcomes in lower extremity injury: A literature and systematic review. *Journal of Athletic Training*, *47*(3), 339–357.

Gribble, P., Hertel, J., & Denegar, C. (2004). The Effects of Fatigue and Gender on Dynamic Postural Control. *Medicine & Science in Sports & Exercise*, *36*(Supplement), S188.

Gstöttner, M., Neher, A., Scholtz, A., Millonlg, M., Lembert, S., & Raschner, C. (2009). Balance ability and muscle response of the preferred and nonpreferred leg in soccer players. *Motor Control*, *13*(2), 218–231.

Haglund-Åkerlind, Y., & Eriksson, E. (1993). Range of motion, muscle torque and training habits in runners with and without Achilles tendon problems. *Knee Surgery, Sports Traumatology, Arthroscopy*, *1*(3–4), 195–199.

Henry, J. C., & Kaeding, C. (2001). Neuromuscular differences between male and female athletes. *Current Women's Health Reports*, *1*(3), 241—244.

Herrington, L., Hatcher, J., Hatcher, A., & McNicholas, M. (2009). A comparison of Star Excursion Balance Test reach distances between ACL deficient patients and asymptomatic controls. *Knee*, *16*(2), 149–152.

Hertel, J., Braham, R. A., Hale, S. A., & Olmsted-Kramer, L. C. (2006). Simplifying the star excursion balance test: Analyses of subjects with and without chronic ankle instability. *Journal of Orthopaedic and Sports Physical Therapy*, *36*(3), 131–137.

Hess, G. W. (2010). Achilles Tendon Rupture: A Review of Etiology, Population, Anatomy, Risk Factors, and Injury Prevention. *Foot & Ankle Specialist*, *3*(1), 29–32.

Hrysomallis, C. (2011). Balance ability and athletic performance. *Sports Medicine*, *41*(3), 221–232.

Hunt, M. A., Mcmanus, F. J., Hinman, R. S., & Bennell, K. L. (2010). Predictors of single-leg standing balance in individuals with medial knee osteoarthritis. *Arthritis Care and Research*, *62*(4), 496–500.

Hutchison, A. M., Evans, R., Bodger, O., Pallister, I., Topliss, C., Williams, P., Vannet, N., Morris, V., & Beard, D. (2013). What is the best clinical test for achilles tendinopathy? *Foot and Ankle Surgery*, *19*(2), 112–117.

Hyong, Hyouk; Kim, J. H. (2014). Test of Intrarater and Interrater Reliability for the SEBT. *The Society of Physical Therapy Science*, *26*(8), 1139–1141.

Ingham, S. A., Whyte, G. P., Pedlar, C., Bailey, D. M., Dunman, N., & Nevill, A. M. (2008). Determinants of 800-m and 1500-m running performance using allometric models. *Medicine and Science in Sports and Exercise*, *40*(2), 345–350.

Irrgang, J. J., Whitney, S. L., & Cox, E. D. (1994). Balance and proprioceptive training for rehabilitation of the lower extremity. *Journal of Sport Rehabilitation*, *3*(1), 68-83.

Jacobs, S. J., & Berson, B. L. (1986). Injuries to runners: A study of entrants to a

10,000 meter race. *The American Journal of Sports Medicine*, *14*(2), 151–155.

Janssen, I., van der Worp, H., Hensing, S., & Zwerver, J. (2018). Investigating achilles and patellar tendinopathy prevalence in elite athletics. *Research in Sports Medicine*, *26*(1), 1–12.

Johnson, N. J., & Luks, A. M. (2016). High-altitude medicine. *Medical Clinics*, *100*(2), 357-369.

Kader, D., Saxena, A., Movin, T., & Maffulli, N. (2002). Achilles tendinopathy: Some aspects of basic science and clinical management. *British Journal of Sports Medicine*, *36*(4), 239–249.

Kannus, P., & Natri, A. (1997). Etiology and pathophysiology of tendon ruptures in sports. *Scandinavian Journal of Medicine and Science in Sports*, *7*(2), 107–112.

Knight, A. C., Holmes, M. E., Chander, H., Kimble, A., & Stewart, J. T. (2016). Assessment of balance among adolescent track and field athletes. *Sports Biomechanics*, *15*(2), 169–179.

Knobloch, K., Yoon, U., & Vogt, P. M. (2008). Acute and overuse injuries correlated to hours of training in master running athletes. *Foot & ankle international*, *29*(7), 671-676.

Konishi, Y., Konishi, H., & Fukubayashi, T. (2003). Gamma loop dysfunction in quadriceps on the contralateral side in patients with ruptured ACL. *Medicine and Science in Sports and Exercise*, *35*(6), 897–900.

Kujala, U. M., Sarna, S., & Kaprio, J. (2005). Cumulative incidence of achilles tendon rupture and tendinopathy in male former elite athletes. *Clinical Journal of Sport Medicine*, *15*(3), 133–135.

Leavey, V. J., Sandrey, M. A., & Dahmer, G. (2010). Comparative effects of 6-week balance, gluteus medius strength, and combined programs on dynamic postural control. *Journal of sport rehabilitation*, *19*(3).

Lopes, A. D., Hespanhol, L. C., Yeung, S. S., & Costa, L. O. P. (2012). What are the main running-related musculoskeletal injuries? A systematic review. *Sports medicine*, *42*, 891-905.

Macera, C. A., Pate, R. R., Powell, K. E., Jackson, K. L., Kendrick, J. S., & Craven, T. E. (1989). Predicting lower-extremity injuries among habitual runners. *Archives of internal medicine*, *149*(11), 2565-2568.

Maffulli, N., Kenward, M. G., Testa, V., Capasso, G., Regine, R., & King, J. B. (2003). Clinical diagnosis of Achilles tendinopathy with tendinosis. *Clinical Journal of Sport Medicine*, *13*(1), 11–15.

Maffulli, N. (1998). Overuse tendon conditions: time to change a confusing terminology. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, *14*(8), 840-843.

Maffulli, N., Longo, U. G., Kadakia, A., & Spiezia, F. (2019). Achilles tendinopathy. *Foot and Ankle Surgery*, *17*(2), 19–21.

Mahieu, N. N., Witvrouw, E., Stevens, V., Van Tiggelen, D., & Roget, P. (2006). Intrinsic risk factors for the development of Achilles tendon overuse injury: A prospective study. *American Journal of Sports Medicine*, *34*(2), 226–235.

Mbarak, M. A., Muteti, E. N., Anjila, E., & Bargoria, V. (2019). Running-related musculoskeletal injuries, risk factors and treatment among Kenyan runners. *East African Orthopaedic Journal*, *13*(1), 34-39.

McCrory, J. L., Martin, D. F., Lowery, R. B., Cannon, D. W., Curl, W. W., Read, H. M., Hunter, D. M., Craven, T., & Messier, S. P. (1999). Etiologic factors associated with Achilles tendinitis in runners. *Medicine and Science in Sports and Exercise*, *31*(10), 1374—1381.

McGuine, T. A., Greene, J. J., Best, T., & Leverson, G. (2000). Balance as a predictor of ankle injuries in high school basketball players. *Clinical Journal of Sport Medicine*, *10*(4), 239–244.

McKean, K. A., Manson, N. A., & Stanish, W. D. (2006). Musculoskeletal injury in the masters runners. *Clinical Journal of Sport Medicine*, *16*(2), 149-154.

Mckeon, P. O., Ingersoll, C. D., Kerrigan, D. C., Saliba, E., Bennett, B. C., & Hertel, J. (2008). Balance training improves function and postural control in those with chronic ankle instability. *Medicine and Science in Sports and Exercise*, *40*(10), 1810–1819.

Messier, S. P., Edwards, D. G., Martin, D. F., Lowery, R. B., Cannon, D. W., James, M. K., ... & Hunter, D. M. (1995). Etiology of iliotibial band friction syndrome in distance runners. *Medicine and science in sports and exercise*, *27*(7), 951-960.

Ness, B. M., Comstock, B. A., & Schweinle, W. E. (2016). Changes in dynamic balance and hip strength after an eight-week conditioning program in NCAA Division I female soccer (football) athletes. *International Journal of Sports Physical Therapy*, *11*(7), 1054.

Nielsen, R. O., Buist, I., Sørensen, H., Lind, M., & Rasmussen, S. (2012). Training errors and running related injuries: a systematic review. *International Journal of Sports Physical Therapy*, *7*(1), 58–75.

Noakes, T. D., Myburgh, K. H., & Schall, R. (1990). Peak treadmill running velocity during the vo2 max test predicts running performance. *Journal of Sports Sciences*, *8*(1), 35–45.

Obeid, J. S., McGraw, C. A., Minor, B. L., Conde, J. G., Pawluk, R., Lin, M., Wang, J., Banks, S. R., Hemphill, S. A., Taylor, R., & Harris, P. A. (2013). Procurement of shared data instruments for Research Electronic Data Capture (REDCap). *Journal of Biomedical Informatics*, *46*(2), 259–265.

Olivier, B., Stewart, A. V., Olorunju, S. A. S., & McKinon, W. (2015). Static and dynamic balance ability, lumbo-pelvic movement control and injury incidence in cricket pace bowlers. *Journal of Science and Medicine in Sport*, *18*(1), 19–25.

Olmsted, L. C., Carcia, C. R., Hertel, J., & Shultz, S. J. (2002). Efficacy of the star excursion balance tests in detecting reach deficits in subjects with chronic ankle instability. *Journal of athletic training*, *37*(4), 501.

Paillard, T., Noé, F., Rivière, T., Marion, V., Montoya, R., & Dupui, P. (2006). Postural performance and strategy in the unipedal stance of soccer players at different levels of competition. *Journal of Athletic Training*, *41*(2), 172–176.

Plisky, P. J., Gorman, P. P., Kiesel, K. B., Butler, R. J., & Rauh, M. J. (2009). Comparison of performance on the star excursion balance test by sport, competition level, and gender. *J Orthop Sports Phys Ther*, *39*, A111.

Plisky, P. J., Rauh, M. J., Kaminski, T. W., & Underwood, F. B. (2006). Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *Journal of Orthopaedic and Sports Physical Therapy*, *36*(12), 911–919.

Rabin, A., Kozol, Z., & Finestone, A. S. (2014). Limited ankle dorsiflexion increases the risk for mid-portion Achilles tendinopathy in infantry recruits: A prospective cohort study. *Journal of Foot and Ankle Research*, *7*(1), 1–7.

Rasmussen, C. H., Nielsen, R. O., Juul, M. S., & Rasmussen, S. (2013). Weekly running volume and risk of running-related injuries among marathon runners. *International journal of sports physical therapy*, *8*(2), 111.

Ryan, M., Grau, S., Krauss, I., Maiwald, C., Taunton, J., & Horstmann, T. (2009). Kinematic analysis of runners with Achilles mid-portion tendinopathy. *Foot and* Ankle International, 30(12), 1190–1195.

Sabin, M. J., Ebersole, K. T., Martindale, A. R., Price, J. W., & Broglio, S. P. (2010).

Balance performance in male and female collegiate basketball athletes: influence of testing surface. *The Journal of strength & conditioning research*, *24*(8), 2073-2078.

Scholes, M., Stadler, S., Connell, D., Barton, C., Clarke, R. A., Bryant, A. L., & Malliaras, P. (2018). Men with unilateral Achilles tendinopathy have impaired balance on the symptomatic side. *Journal of Science and Medicine in Sport*, *21*(5), 479–482.

Sefton, J. E. M., Hicks-Little, C. A., Hubbard, T. J., Clemens, M. G., Yengo, C. M., Koceja, D. M., & Cordova, M. L. (2009). Sensorimotor function as a predictor of chronic ankle instability. *Clinical Biomechanics*, *24*(5), 451–458.

Sharma, P., & Maffulli, N. (2006). Biology of tendon injury: Healing, modeling and remodeling. *Journal of Musculoskeletal Neuronal Interactions*, *6*(2), 181–190.

Sharma, Pankaj, & Maffulli, N. (2005). Tendon injury and tendinopathy: Healing and repair. *Journal of Bone and Joint Surgery - Series A*, *87*(1), 187–202.

Stiffler, M. R., Sanfilippo, J. L., Brooks, M. A., & Heiderscheit, B. C. (2015). Star excursion balance test performance varies by sport in healthy division 1 collegiate athletes. *Journal of Orthopaedic and Sports Physical Therapy*, *45*(10), 772–780.

Van Gent, R. N., Siem, D., Van Middelkoop, M., Van Os, A. G., Bierma-Zeinstra, S. M. A., & Koes, B. W. (2007). Incidence and determinants of lower extremity running injuries in long distance runners: A systematic review. *British Journal of Sports Medicine*, *41*(8), 469–480.

Van Middelkoop, M., Kolkman, J., Van Ochten, J., Bierma-Zeinstra, S. M. A., & Koes, B. W. (2008). Risk factors for lower extremity injuries among male marathon runners. *Scandinavian Journal of Medicine and Science in Sports*, *18*(6), 691–697.

van Sterkenburg, M. N., & van Dijk, C. N. (2011). Mid-portion Achilles tendinopathy: why painful? An evidence-based philosophy. *Knee Surgery, Sports Traumatology, Arthroscopy*, *19*, 1367-1375.

Vandenbroucke, J. P., Elm, E. V., Altman, D. G., Gøtzsche, P. C., Mulrow, C. D., Pocock, S. J., ... & Strobe Initiative. (2007). Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. *Annals of internal medicine*, *147*(8), W-163.

Walter, S. D. (1989). The Ontario Cohort Study of Running-Related Injuries. *Archives of Internal Medicine*, *149*(11), 2561.

Wen, D. Y., Puffer, J. C., & Schmalzried, T. P. (1998). Lower extremity alignment and risk of overuse injuries in runners. *Occupational Health and Industrial Medicine*, *38*(1), 42–43.

Yaggie, J. A., & Campbell, B. M. (2006). Effects of balance training on selected skills. *The Journal of Strength & Conditioning Research*, *20*(2), 422-428.

Zwerver, J., Bredeweg, S. W., & Van Den Akker-Scheek, I. (2011). Prevalence of jumper's knee among nonelite athletes from different sports: A cross-sectional survey. *American Journal of Sports Medicine*, *39*(9), 1984–1988.

APPENDICES

Appendix I: Consent Form

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF MEDICINE

INFORMATION SHEET

Introduction: I am a student at JKUAT taking Master of Science in Physiotherapy Degree. I am carrying out a study on the dynamic balance and Achilles tendinopathy among long-distance runners in high altitude training camps in Western part of Kenya.

Title of the study: Dynamic balance and Achilles tendinopathy among long-distance runners in high altitude training camps in Western part of Kenya.

Institution: Jomo Kenyatta University of Agriculture and Technology (JKUAT)

Investigator: Hellen Chebet

Purpose of the study: The purpose of this study will be to assess the prevalence of AT among long-distance runners in high altitude training camps in Western Kenya and to determine their exercise history and dynamic balance.

Permission is requested from you to enroll in this research study. The following general principles will apply:

i. Your agreement to participate in this study is voluntary and you will not get any reward or token for participating in the study.

ii. You may withdraw from the study at any time without necessarily giving a reason for your withdrawal without consequences.

iii. After you have read the explanation please feel free to ask any questions that will enable you to understand clearly the nature of the study.

Procedure to be followed: With your permission, I will ask you some questions about yourself, I will then assess you for AT. If you have the condition, I will take you through a dynamic balance test.

Benefits and rewards: There will be no reward to participate in the study.

Discomfort and Risks: Some of the questions you will be asked will be of a personal nature and may make you uncomfortable. Some of the assessment that will be carried out might also make you uncomfortable. If this happens you may refuse to answer any question or you may choose to take a break from the assessment if you so choose. You may also stop the interview at any time. Participation may take approximately 30-60 minutes of your time.

Assurance of confidentiality: All information obtained from you will be kept in confidence. At no point will you or your name be mentioned or used during data handling or in any resulting publications. Serial numbers will be used instead.

Contacts

If you wish to contact me or my institution, please use the following contacts:

1. **Hellen Chebet**
   +254727703462

2. **Head of Department**
   Rehabilitative sciences-JKUAT

   +254734282692

Appendix II: Consent Form

I, the undersigned, willingly agree to participate in this study, the nature and purpose of which have been fully explained to me by the investigator. I understand that the information gathered will be used for the purposes of this study only and maximum confidentiality will be maintained.

Respondent……………………………… Sign ……………………Date……………

Witness (Investigator) ……………………………… Sign ………………………

Date…………………………………….

Investigators statement

I, the undersigned, have explained to the participant in a language she/he understands the procedures to be followed in the study and the risks and benefits involved.

Investigator………………………………………………………

Sign ……………………………… Date…………………………………………….

Appendix III: Questionnaire and Assessment Tools

Section A: Demographic information

Kindly answer the questions below by ticking or writing on the spaces provided the correct answers that applies to you.

1. What is your age? ……………………..
2. What is your gender?

a) Male
b) Female

3. What is your religion?

a) Christian
b) Muslim
c) Hindu
d) Traditional
e) Others, specify …………………

4. What is your marital status?

a) Single
b) Married
c) Divorced
d) Widowed
e) Others, specify …………………

5. Training camp ……………………………………….
6. County…………………………………………………
7. What is your current weight in kg? ___________________________________
8. Current height (without shoes) in cm ___________________________________
9. With which leg do you kick the ball?

a) Right
b) Left

Section B: Findings

i) Physical examination findings

1. Palpation test

Right

a) Positive
b) Negative

Left

a) Positive
b) Negative

2. Subjective pain test

Right

a) Positive
b) Negative

Left

a) Positive
b) Negative

Section C: Exercise history

10. For how long have you been a long-distance runner?
a) Less than 6 months
b) 6 months – 11 months
c) 1 – 2 years
d) 3- 5 years
e) 5- 10 years
f) Above 10 years

11. Did you participate in competitive sports while in high school?
a) Yes
b) No

12. What year did you start running? ___________________________________
13. What distance(s) do you run competitively?
a) 21km
b) 42km
c) 21km and 42km
d) Ultramarathons
e) 42km and ultramarathons
f) 21km, 42km and ultramarathons
14. How many running competitions have you competed in in the last two years ____________________________________
15. What is your personal best time for the completion of event? ____________________
16. How many days per week do you train? ___________________
17. How many km do you average per week? _________________
18. What is your average pace per week? (in min/km) _________________
19. Select the option that best applies to your current running habits as well as your current participation in regular physical exercise:
a) I am running regularly.
b) I am Running regularly and I still perform regularly
c) I am not running regularly but I still perform regular physical exercise.
d) I am not running regularly and I do not still perform regular physical exercise.
20. Have you ever required hospitalization after a competitive event?
a) Yes
b) No
21. What year(s) were you hospitalized after a competitive event? _____________
22. What were the diagnosis? ____
23. Do you have a history or diagnosis of any of the following vascular conditions such as Angina Pectoris, Coronary Artery Disease, Arrhythmia, Congestive Cardiac Failure, Blood Pressure problems, Clotting Abnormalities, Transient Ischemic Attacks or Stroke, Heart Attack etc.?
a) Yes

b) No

24. Do you have a history or diagnosis of a Respiratory or Lung condition such as Exercise Induced Asthma, Asthma, Emphysema, Chronic Bronchitis / cough etc.?

a) Yes

b) No

Section D: Injury related questions

25. Have you sustained any injuries in the last six months?

a) Yes

b) No

26. In which body area did you sustain these injury (ies)?

a) Lower back

b) Hip

c) Knee

d) Ankle/foot

e) Shoulder

f) Other

27. In which body area(s) is / are the other injury /injuries? ________________________

28. Do you currently experience low back pain?

a) Yes

b) No

29. How often have you experienced lower back pain in the last six months?

a) Always

b) Daily

c) Weekly

d) Monthly

30. Do you currently have hip pain?

a) Yes

b) No

31. How often have you experienced hip pain in the last six months?

a) Always

b) Daily
c) Weekly
d) Monthly

32. Where do you feel the hip pain?
    a) In the front
    b) At the back
    c) On the outside
    d) On the inside / groin area

33. Do you currently have knee pain?
  a) Yes
  b) No

34. How often do you experience knee pain in the last 6 months?
    a) Always
    b) Daily
    c) Weekly
    d) Monthly

35. Do you currently have any other injury?
    a) Yes
    b) No

36. Please describe the "other" pain as best as you can:

____

37. How often have you experienced pain as a result of this other injury in the last 6 months?
    a) Never
    b) Always
    c) Daily
    d) Weekly
    e) Monthly

38. Mark the option that best applies to you:
    a) I have had a joint replacement to the lower extremity
    b) I have had another significant surgical intervention for the lower extremity
    c) I have not had any of the above significant surgical interventions

d) Please specify the other significant surgical intervention to the lower extremity.

39. Which other previous injuries have you had?

Section E

ii) Star excursion balance test recording sheet (adopted from Olivier and Taljaard, 2018).

Name of athlete	**Date of assessment**

Notes

Enter measurements in cm or inches, but use the same unit throughout

Leg length R		Leg length L	
Dominance		NB: To record dominance use "R" or "right" for right and "L" or "left" for left (no other words, letters or symbols will be recognised by the formula)	

Trial	**R anterior**	**L anterior**	**R postero-medial**	**L postero-medial**	**R postero-lateral**	**L postero-lateral**
Trial 1						
Trial 2						
Trial 3						
Greatest reach distance						

Observations (e.g. shaking, losing balance, and any other)	

Normalized reach distance: normalized to leg length according to right or left sides					
R anterior	**L anterior**	**R postero-medial**	**L postero-medial**	**R postero-lateral**	**L postero-lateral**

Normalized reach distance: normalized to leg length according to dominant and non-dominant sides					
Dominant anterior	**Non-dominant anterior**	**Dominant postero-medial**	**Non-dominant postero-medial**	**Dominant postero-lateral**	**Non-dominant postero-lateral**

Difference between right and left or dominant and non-dominant		
Anterior	**Postero-medial**	**Postero-lateral**
0.0		

Composite score R	

Composite score dominant	

Composite score L	

Composite score non-dominant	

Appendix 1V: IREC Approval

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY
P. O. Box 62000-00200 Nairobi, Kenya Tel 0675870225 OR Extn 3209
Institutional Ethics Review Committee

June 17th, 2019 **REF: JKU/2/4/896B**

Hellen Chebet,
School of Medicine.

Dear Ms. Chebet,

RE: DYNAMIC BALANCE AND ACHILLES TENDINOPATHY AMONGST LONG DISTANCE RUNNERS IN HIGH ALTITUDE TRAINING CAMPS IN WESTERN KENYA

The JKUAT Institutional Ethics Review Committee has reviewed your responses to issues raised regarding your application to conduct the above mentioned study with you as the Principal Investigator.

The is to inform you that the IERC has approved your protocol. The approval period is from June 17th 2019 to June 17th 2020 and is subject to compliance with the following requirements:

a) Only approved documents (informed consent, study instruments, study protocol, etc.) will be used.
b) All changes (amendments, deviations, violations, etc.) must be submitted for review and approval by the JKUAT IERC before implementation.
c) Death and life threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the IERC immediately.
d) Any changes, anticipated or otherwise that may increase the risks to or affect the welfare of study participants and others or affect the integrity of the study must be reported immediately.
e) Should you require an extension of the approval period, kindly submit a request for extension 60 days prior to the expiry of the current approval period and attach supporting documentation.
f) Clearance for export of data or specimens must be obtained from the JKUAT IERC as well as the relevant government agencies for each consignment for export.
g) The IERC requires a copy of the final report for record to reduce chances for duplication of similar studies.

Should you require clarification, kindly contact the JKUAT IERC Secretariat.

Yours Sincerely,

Dr. Patrick Mbindyo
SECRETARY, IERC

INSTITUTIONAL ETHICS REVIEW COMMITTEE
18 JUN 2019
APPROVED
P.O. Box 62000-00200
NAIROBI
www.jkuat.ac.ke
J K U A T

Setting Trends in Higher Education, Research, Innovation and Entrepreneurship

Appendix V: NACOSTI Approval

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **934985**

Date of Issue: **15/February/2021**

RESEARCH LICENSE

This is to Certify that Ms.. Hellen Chebet of Jomo Kenyatta University of Agriculture and Technology, has been licensed to conduct research in Elgeyo-Marakwet on the topic: DYNAMIC BALANCE AND ACHILLES TENDINOPATHY AMONGST LONG DISTANCE RUNNERS IN HIGH ALTITUDE TRAINING CAMPS IN WESTERN KENYA for the period ending : 15/February/2022.

License No: **NACOSTI/P/21/8915**

934985

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.