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Preventative strategies for non-contact lower limb injuries among male football players: a scoping review

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UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

SCHOOL OF THERAPEUTIC SCIENCES

DEPARTMENT OF PHYSIOTHERAPY

RESEARCH REPORT: MSc PHYSIOTHERAPY

Preventative strategies for non-contact lower limb injuries among male football players: a scoping review

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A research report submitted to the Faculty of Health Sciences,

University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirement for a Master of Science in Physiotherapy.

01 August 2024

DECLARATION

I, Molebogeng Bongani Mmitsi, declare that the work contained in this research report is my work, except to the extent indicated in the acknowledgement sections.

This research report is being submitted for a degree of Masters in Physiotherapy, at the University of the Witwatersrand, Johannesburg, South Africa.

This work has not been submitted for any other degree or examination in this or any other university.

Molebogeng Bongani Mmitsi Date: 01/August/2024

Name and Surname

M.B MMITSI

Signature

DEDICATION

As a token of gratitude, I would like to dedicate this project to my wife Nomthandazo Msomi-Mmitsi, for her continuous support throughout the journey of my study. She made me believe when the road was hard that it is possible, she lifted me up when I couldn't persevere and encouraged me to keep working hard on my studies.

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LIST OF ABBREVIATIONS

ACL	**Anterior cruciate ligament**
AKP	**Anterior Knee Pain**
ASP	**Adductor Strengthening Programme**
BEP	**Bounding Exercise Program**
CA	**Copenhagen adduction**
EHAB	**Eccentric hip abduction strength**
EHAD	**Eccentric hip adduction strength gain**
F-MARCH	**FIFA + 11 Injury prevention program**
FIFA	**Federation Internationale de Football Association**
FMS	**Functional movement screening**
GPS	**Global Positioning System**
HSR	**High-speed running**
LCL	**Lateral collateral ligament**
LIST	**Loughborough Intermittent Shuttle Test**
MCL	**Medial collateral ligament**
MLS	**Major League Soccer**
NCAA	**National Collegiate Athletic Association**
NHE	**Nordic hamstring exercises**
NH	**Nordic hamstring**
OSTRC	**Oslo Sports Trauma Research Center**
PCC	**Population Concept Context**
PCL	**Posterior Cruciate Ligament**
RCT	**Randomised controlled trial**
ROM	**Range of motion**
SHS	**Short hamstring syndrome**
SR	**sprint running**
UCL	**UEFA Campions League**
UEFA	**Union of European Football Association**
US	**United States**
USA	**United States of America**

OPERATIONAL DEFINITIONS

Amateur footballers: Any player who is registered to play for a club that is registered with the Football Association as an amateur in accordance with the FIFA Regulations for the status and transfer of players (Law Insider).

Concentric contraction: The type of muscle contraction in which the muscles shorten while generating force and overcoming resistance (Katsura et al., 2019).

Contact injuries: Any injury caused by physical contact with any extrinsic factor (Brukner and Kahn.,2021).

Eccentric contraction: It is characterized by the lengthening of the muscle-tendon complex (Hody et al., 2019).

Flexibility: Flexibility is an intrinsic property of the body tissues that determines the range of motion achievable without injury at a joint or group of joints (Holt et al., 1996).

Modifiable risk factor: It is a determinant that can be modified by intervention thereby reducing the probability of injury (Burt 2009).

Non-contact injuries: A non-contact injury does not occur because of physical contact with an object or person, but it may be due to intrinsic forces built by the movements and actions of the footballer (Brukner and Kahn.,2021).

Risk: The probability that an event will follow. Epidemiology is most often used to express the likelihood that a particular outcome will occur following a specific exposure (Burt 2009).

NB! Operational terms mentioned were referenced as definitions in this study.

ABSTRACT

Background: Football is a team sport that is complex with high tactical, technical, and physical demands. Due to these demands, footballers are exposed to an excessive rate of injury risk, contact and non-contact injuries.

Aim: The aim was to map the range of literature relating to preventative strategies implemented to minimise risk factors associated with non-contact lower limb injuries among male footballers.

Method: This was a scoping review type of research. The title of this review was registered on the Open Science Framework before the researcher commenced the study to ensure that there were no duplicates. The review was guided in five stages: (1) defining the research, (2) identifying relevant studies, (3) selecting a topic, (4) charting and collecting data and (5) summarising and reporting the results. The research has utilised the PCC (population, concept, and context) framework. It has considered professional and amateur soccer players of different age groups. The review considered various preventative strategies for non-contact lower limb injuries as they play an integral role in football to minimise the exclusion of footballers from the squad due to injuries. Studies done on preventative measures for injuries that were not specific to non-contact injuries, studies that included female footballers, those studies that included other sporting codes and other injuries that are not of the lower limbs were excluded from the study. The following eight electronic databases were explored: PUBMED, CINAHL, PEDRO, EBSCOhost, COCHRANE, SPORTDISCUS, SCOPUS AND SCIENCE DIRECT.

Results: A total of 617 studies were recognised initially, but only 25 studies met the inclusion criteria, and their outcomes have been presented. Outcomes revealed various injury inhibition programmes implemented for non-contact lower limb injuries among male footballers which were: Nordic hamstring exercises, Copenhagen adduction exercise, muscle strengthening, stretching exercises, ankle taping, FIFA 11, FIFA 11+ warm-up programme, preseason preparation, running mechanics, high chronic training loads, bounding exercises, and multicomponent exercises program.

Conclusion: The study provided a range of preventative strategies found to be utilised to minimise the possibility of non-contact lower limb injuries among male football players. Considering different dynamics within different teams at different levels, these strategies may be used as a guide in implementing injury prevention programmes among male footballers.

Keywords*:* non-contact injuries; lower limbs; soccer; football; injury prevention

CHAPTER 1: INTRODUCTION

1.1 Background

A football game is a worldwide team activity that is complex with high tactical, technical, and physical demands (van Beijsterveldt et al., 2012). These physical demands may include but are not limited to running, jumping, sprinting, quick and sudden changes in direction, kicking the ball, and contact with another person or object. Due to intense physical and physiological demands, football is coupled with a high injury rate, which is higher than the injury rate in industrial occupations (Hawkins et al., 2001). It has been found that having a reduced number of injuries relates to improved chances of team success, therefore it is important to reduce and minimise lost playing time (Perez-Gomez et al., 2020). Perez-Gomez et al focused their study on preventative strategies for non-contact lower limb injuries among male amateur and professional footballers across the globe. Studies selected across different databases have been utilised to determine the scope of available literature on these preventative strategies.

Professional football game players are unprotected from high injury risk, contact, and non-contact injuries, throughout their careers. These injuries may have negative impacts on their careers. Brukner and Kahn (2021) described contact injury as any injury that is caused by physical contact with any extrinsic factor. A non-contact injury does not occur because of physical contact with an object or person, but it may be due to intrinsic forces built by the movements and actions of the footballer. Various risk factors have been identified to be associated with injury incidences and injury rate and these risks are classified into external or internal risk factors. Some protocols have been identified as being effective in minimising injury incidence and injury rate and therefore reducing the health cost accrued by footballers among football teams (Perez-Gomez et al., 2020).

Hall et al (2020) guided a study to detect the usual injury types and body location in high-level male youth soccer players. Participants were under nine years to under 23 groups from different football academies in England, Spain, Uruguay, and Brazil. The main outcome measures of the study were injury type, location, and severity of the injury. The total number of injuries recorded was 443 both for training and matches. These injuries were classified and recorded as follows:
"Non-contact" injuries were found to be the most common acquired injuries (58.5%), with most of the injuries (44.2%) resolving between eight and 28 days. Most injuries (75.4%) occurred in the lower limbs, with muscle recording 29.6%, the most injured tissue. Thirty-one percent to 41% of all non-contact injuries in soccer involve the muscles, with most occurring on the upper leg. Hamstring muscles have been recorded to account for up to 37% of all muscle injuries in soccer players, and this is a number on the increase. The second and third most prevalent injuries are the

injuries of the adductor muscles of the hip and the quadriceps femoris muscle which are 23% and 19% respectively.

Pfirrmann et al (2016) did a review to summarise and compare the injury incidences and injury characteristics of male professional adult and amateur youth soccer players. The study had 18 articles that met the inclusion criteria, six for youth soccer players and 12 for adult soccer players. It was found that the rate of injuries was higher for matches than for training for both youth and adult players. However, youth players had a higher incidence of training injuries than professional adult soccer players. One of the reasons could be due to the fitness level of amateur youth soccer players versus adult professional players. Naidoo (2007) did an epidemiological study of soccer injuries sustained in a season of a professional soccer team in South Africa. The study was a questionnaire-based study that collected quantitative data on various components. In their study, it was reported that most of the injuries sustained by players happened among players who were between the ages of 20 and 24 years. Lower limbs were the most affected parts (67.1%) with the knee being the most affected joint (21.4%).

Larruskain et al (2017) compared the epidemiology of injuries between elite male and female football players. Injuries acquired and individual exposure time in a male team and female team, both teams playing in the Spanish first division, were recorded by the club's medical staff for five seasons from 2010 to 2015. The study found that the hours that men were exposed to were 20% higher compared to women. It also discovered that training and match injury incidence was 30%-40% higher for men than for women. Various factors between males and females were identified in addition to biological differences which are training load and content, fixture congestion, staffing, and dedication level.

To design injury prevention programmes, it is important to identify risk factors associated with the occurrence of injury. Risk factors may be classified into intrinsic or extrinsic risk factors. Numerous factors have been identified in football as intrinsic risk factors and may include previous injury, age, poor flexibility, decreased muscle strength, and muscle strength imbalances (Hagglund et al., 2013). Some of the extrinsic risk factors include but are not limited to fatigue, type of the match (friendly or official), match location (home or away) and match results may also have an impact on injury rates among soccer players (Guan et al., 2021).

Bezuglov et al (2020) reported that in football, there are various factors such as age, previous history of injuries, an imbalance between strength and flexibility, and a decrease in both eccentric power and mobility all play an important role in non-contact muscle injury. All these factors form

part of intrinsic risk factors. Other identified factors need more attention which may include training programmes implemented by clubs during different stages of the season, factors contributing to the pattern of injuries during matches concerning time, and rehabilitation protocols implemented by clubs (Bezuglov et al., 2020). It is important to emphasise that understanding the mechanism of injury caused by various factors will assist in improving preventative measures to minimize risks associated with non-contact injuries to the lower limb (Owoeye et al., 2020).

The three most used screening tests to detect injury risks are Functional movement screening (FMS), questionnaires and isokinetic muscle testing (McCall et al., 2015). Preventative exercises classified as the most important to prevent non-contact injuries include eccentric exercises and balance/proprioception (McCall et al., 2015). Eccentric exercise for the hamstring was independently ranked as the third most important exercise to minimise non-contact injuries of the hamstring. Another preventative strategy is a preseason conditioning program. A preseason conditioning program is recommended to include three components which are: aerobic conditioning, muscular flexibility and muscular strengthening (Brooks et al., 2007). Aerobic conditioning increases the capacity and endurance of the cardiorespiratory system, and stretching increases the flexibility of major muscle groups and the range of motion around the joints. Strengthening increases both muscle strength and endurance capacity.

To help and assist professional football players in minimising the risk of injury, it is important to identify and understand the risk factors associated with injury exposure and thereafter implement effective preventative strategies. According to Hawkins et al (2001), the process of injury prevention can be outlined in four stages. The first stage is to describe and identify the extent of the injury. In the second stage, one identifies the factors and mechanisms that contributed to the occurrence of the identified injury. After completing stage one and stage two, the next stage is to introduce preventative strategies and then you return to the first stage. Many studies have been done on the first two stages described by Hawkins et al (2001), but few studies have been identified by the researcher on the preventative strategies for these injuries.

1.2 Problem Statement

Grimm et al (2014) did a study on anterior cruciate ligament (ACL) and knee injury prevention programs for soccer players. Grimm et al (2016) investigated if ankle injury prevention programs for soccer athletes are protective. There are other various injury prevention studies done on specific muscle groups, peripheral joints with the knee having more studies done on ACL injury prevention programs than other joints, and few studies done on comprehensive non-contact lower limb injury

prevention. Previous injuries are known to be risks of re-injury and as causative factors of other injuries, therefore, minimising risk factors with a holistic approach will be more meaningful and beneficial to both the athlete and their respective teams.

In a study done by Hall et al (2020), the study reported 58% of "non-contact" injuries. Most injuries were reported to occur on the lower limbs, with the muscle being the most frequently injured tissue. This study by Hall et al (2020) correlates with the day-to-day challenges I come across in our football setting. Numerous players that come for treatment have lower limb injuries more than upper limbs, with the muscle being the most affected tissue and we treat injuries of the upper leg more often.

There is no current scoping review done (as far as the researcher's knowledge is concerned) to map the range of preventative strategies for lower limb non-contact football injuries. Football is a sport associated with regular physical contact during participation, however, the occurrence of non-contact musculoskeletal injuries such as hamstring strain and ACL sprain or ruptures are commonly reported to be 90% of all muscle injuries and 51%-64% of joint or ligament injuries (Lemes et al., 2020). This study reviewed published and unpublished literature and identified and summarized these preventative strategies.

1.3 Review Question

What were the preventative strategies implemented to minimise risk factors associated with non-contact lower limb injuries among male footballers?

1.4 Review Aim

The aim was to map the range of literature relating to preventative strategies implemented to minimise risk factors associated with non-contact lower limb injuries among male footballers.

1.5 Review Objectives

The objectives of this review were to:

- Identify and collate data from existing quantitative and qualitative studies on preventative strategies for non-contact injury risk factors among male footballers.
- Describe all the collected data on preventative strategies descriptively and logically.

1.6 Significance of the Study

Football is a global sport with millions of players participating in the sport. These players are prone to be injured at some point in their careers. These injuries have negative effects not only on the

player but also on their respective teams are negatively impacted. Identifying and analysing these preventative measures can help to minimise lost playing time and improve the chances of a team succeeding and may be achieved in various ways such as record keeping, identifying risk factors and continuous research. Football coaches, team doctors, physiotherapists, biokineticists, fitness and conditioning coaches and other members involved within a football team structure will benefit from useful and relevant information to support their decision-making around their localised injury prevention practice. The study will empower their knowledge of implementing preventative strategies for non-contact lower limb injuries. Isolated preventative strategies on specific muscle groups and peripheral joints of the lower limbs will be identified and collated to merge the scope of literature available, and therefore it will be more meaningful and easier to implement these strategies within clinical practice.

The following statement has been put as the limitation of the study:
"The study included studies implemented on preventative strategies to minimise lower limb injuries irrespective of whether the study yielded significant or not significant results statistically".

1.7 Organisation of the Research Report

Figure below gives an outline of this research report organisation.

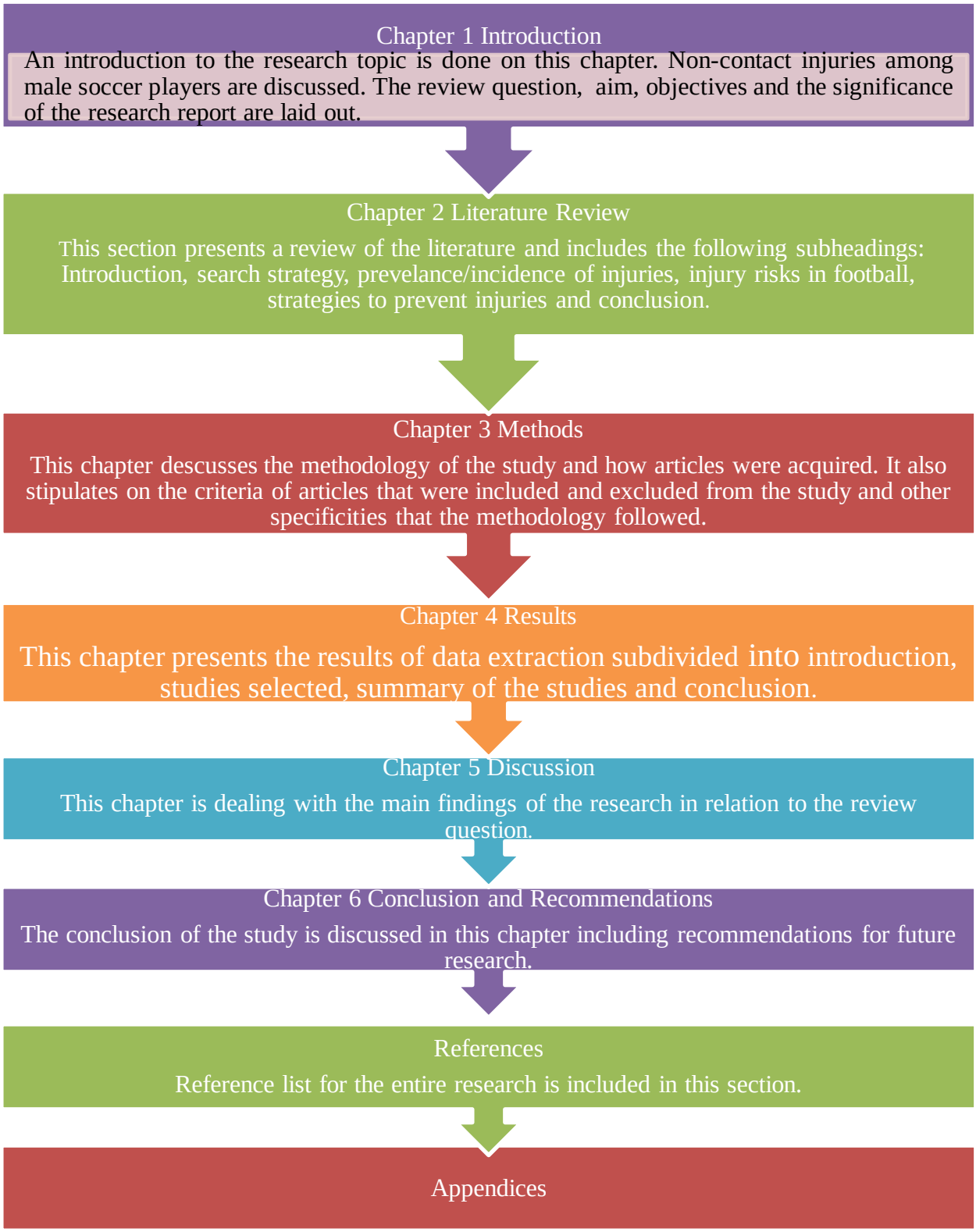

Figure 1. 1 Organisation of the research report

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CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the current literature that documents preventative strategies for non-contact lower limb injuries among male footballers. The discussion will be based on the prevalence of injuries, injury risks and strategies to prevent injury risks in football. Besides the Fédération Internationale de Football Association plus (FIFA+) injury prevention programmes, the literature review discovered that injury prevention exercise programs are isolated and specific to one specific muscle group or joint of the lower limbs. Preventative strategies for non-contact lower limb injuries for different muscle groups and different joints are also discussed. Different studies from different countries that are specific to football have been reviewed in this chapter.

2.2 Search strategy

The literature search was performed using a systematic approach as recommended in the JBI reviewers' manual. The initial step included a search on MEDLINE (PubMed) and CINAHL MEDLINE permits the researcher to see who has conducted the research, who published the results and the location of the research conducted. The step that followed was to analyse text words within the title and abstracts of the articles selected. Primary keywords included "football" OR "Soccer", "injury", "risk factor", "lower limb", "non-contact", "prevention", and "strategy". A second search using all identified keywords and index terms was undertaken across various databases. The databases that were searched include Physiotherapy Evidence Database (PEDro), Science Direct, SPORTDiscus with Full Text, CINAHL Plus with Full Text (EBSCO), Cochrane Library, and SCOPUS. In the third step, references from recognised articles were utilised to look for any extra articles connected with the title of the study.

2.3 Prevalence/incidence of injuries

Football participation carries risks of injury for all players and the rate of injury is dependent on various factors: participation level, skill, age, position on the field, environmental setting, sex, time when the injury occurred and location of the injury (Silvers-Granelli et al., 2015). Various studies reported that most injuries among footballers occur in the lower limbs and suggest that commonly injured areas are the knees, the upper leg, and the ankles (Snodgrass et al., 2021). In a study done by Hall et al (2020), it was reported that 75.4% of injuries occurred in the lower limbs. Whereas a study done by Snodgrass et al (2021), reported that of all injuries related to football, 60-98% were in the lower limbs.

In a review done by Owoeye et al (2020), where injuries for both professional and amateur footballers were reported, they concluded that amateur players had more injuries to the ankle that

accounted for up to 20% of all soccer injuries with the sprains of the ankle constituting 77% of all ankle injuries. The study reported that professional players had more injuries on the knee, consisting of up to 18% of severe knee injuries presenting in hospital emergency departments. However, in a review done by Pfirrmann et al (2016), they found that more injuries are occurring in matches compared to training among professional footballers. Injury incidents range between 3.3 to 15.3 times higher during matches than during training in adult professional soccer players. In youth soccer players, the incidence rate was 2.3 to 4.9 times higher during matches than during training sessions. One of the reasons amateur footballers had a high injury rate could have been attributed to lower fitness and coordination levels compared to elite footballers.

In a cohort surveillance study conducted by Hall et al (2020), the most common injury types and locations in high-level male youth soccer players were identified. The study yielded the following outcomes: there were 58% of non-contact injuries recorded, with most of the injuries (42%) settling between the range of eight and 28 days. Most injuries (74%) occurred in the lower limbs, with the muscle recorded to be the most regularly harmed tissue. About 31% to 41% of all non-contact injuries in soccer include the muscles, with most happening on the upper leg (Bezuglov et al., 2020). In a report by van Beijsterveldt et al (2012), it has been documented that most soccer injuries are related to the lower extremities, and muscle injuries are among the major issues. The above-mentioned report by Beijsterveldt et al (2012) has a common observation as other studies that have documented similar injury reports.

In a study done by Bezuglov et al (2020), hamstring muscles were recorded to represent up to 37% of all muscle injuries in soccer players, and this is a number on the increase. The second and third most common injuries are the injuries of the adductor muscles of the hip and the quadriceps femoris muscle which are 23% and 19% respectively. The occurrence of non-contact anterior cruciate ligament injury goes from 0.006 to 3.7 every 1000 hours of dynamic soccer playing bringing about a great many front cruciate tendon tears consistently (Alentorn-Geli et al., 2008). Demands in football such as sudden acceleration and deceleration could be one of the contributing factors to the number of hamstring injuries occurring in football. However, a holistic approach that has been outlined by Hawkins et al. (2001) may be implemented to understand the problem and minimise injury risks.

The rate of outdoor football injuries is among the highest of all different sporting codes, more specifically for adult male soccer players. In the Netherlands, it has been documented that outdoor soccer results in the largest number of injuries each year (18% of all sports injuries), amounting to a total of approximately 620000 injuries (van Beijsterveldt et al., 2012). There are high-intensity

demands in soccer that are characterised by continuous change of direction and high-load actions, high-speed running and many other characteristics and therefore participating in this sport imposes high demands on neuromuscular control, agility and both eccentric and concentric strength.

A study conducted by Anderson et al (2004) investigated the mechanisms of soccer injuries and revealed the following results: "It showed that 23% of the injuries were non-contact, where 15% occurred during running and 8% of the injuries occurred during landing after heading the ball". The study included injury analysis of 17 European 1st division teams and found that approximately 90% of the injuries involved the lower limbs. Hamstring injuries accounted for an average of 12% of the total injuries over two competitive seasons with which majority of these being non-contact injuries. Certain player profiles such as wingers who were older demonstrated a higher incidence. The study indicated that having a previous hamstring injury was the single most significant factor predisposing participants to injury. Preseason hamstring tightness was also noted to increase the risk factor of acquiring an injury in football.

Zeren and Oztekin (2007) reported an interesting finding that 6% of football players injured themselves while celebrating after scoring a goal. Of these injuries, 60% were non-contact sliding-type injuries during goal celebrations. The researcher has not observed any other study that has reported an incidence of injuries during the celebration after scoring a goal. Tyler et al (2006) also recorded an interesting finding that players who are overweight with a previous history of an ankle sprain are 19 times more likely to sustain another non-contact ankle sprain than a player that has normal weight with no previous injury. These reports and stats on injuries are raising an alarm to implement preventative strategies that will assist in minimising injury risk factors among male footballers.

In a study done by Griffin et al (2000), they documented that out of 80,000 to 100,000 ACL injuries that occur annually in the USA, 40-79% were non-contact injuries and were associated with medical costs of $1.5 billion annually. In 2002, the US Consumer Product safety commission reported that there were more than 477,500 soccer-related injuries that were treated in US hospitals annually. Irrespective of the given data and statistics, Griffin and colleagues noted that of the 3572 Medline citations under the ACL topic heading, only 133 articles were sub-headed 'prevention' and less than 10 of these articles dealt with prevention of injury rather than prevention of surgical complications. Studies and reports on medical costs due to football injuries in South Africa were not found by the researcher and it is recommended to start an initiative regarding the matter.

Due to the demand and popularity of soccer, non-contact injuries of the lower limbs are a constant challenge among professional and amateur footballers. These types of injuries incur costs to players and their respective teams, leading to the unavailability of those players. Record keeping in football is an important aspect of monitoring the severity of injuries, patterns, cost covered due to injuries and many other aspects to improve and minimise the incidence rate of football injuries.

2.4 Injury risks in football

The incidence and prevalence of documented statistics regarding injuries among male professional and amateur footballers raise the alarm for intervention. There are potential causes and risk factors for injuries in football that have been identified and leading to the injury incident rate that has been discussed in the previous subheading. Some of these risk factors may include player-to-player contact, history of injury in combination with inadequate rehabilitation, increased age of the player, leg dominance, fatigue status, and matches compared to training conditions. There are also modifiable risk factors in football that have been investigated, that are still under investigation and those that need to be investigated further (McCall et al., 2015).

Posture is one of the possible contributing risk factors to non-contact lower limb injuries that can be modified (McCall et al., 2014). Posture is considered an important aspect of injury screening and prevention among athletes, but it has not been well investigated (Snodgrass et al., 2021). Some of the studies investigating posture and injury incidence reported increased lumbar lordosis or lumbar extension to be associated with a variety of injuries in footballers (Snodgrass et al., 2021), and this factor needs further research and investigation as another strategy to minimise non-contact lower limb injuries among male footballers.

Myer et al (2005) defined leg dominance as an imbalance in strength, coordination, and control between the two lower limbs. The key predictor of injury is a discrepancy exceeding 15% between the two limbs. Due to the asymmetry between the limbs, there is additional stress on the weaker leg, compromising performance and predisposing athletes to various injuries during various movement actions. In a study done by Zebis et al (2009), they identified that during a cutting manoeuvre, ACL rupture occurred more frequently on the preferred push-off leg. Statistical analysis done by Brophy et al (2010) reported that 74.1% of non-contact ACL injuries among male footballers occurred on their dominant leg.

In a study done by Andersen et al (2004), they conducted an extensive video analysis of the mechanisms for ankle injuries in football. They revealed various numerous dominant positions that predisposed the lower limbs to injury and these were: awkward landings, decelerating and

pivoting, “out of control” play, plant-and-cut with the knee in valgus, external rotation of the foot relative to the knee, straight-leg landing with a flat foot and knee in extension, and lastly the one-step-stop with hip and knee extended and centre of gravity behind the knee. The study they did was focusing on intrinsic risk factors that lead to non-contact lower injuries.

Following the identification of the above-mentioned positions, a different study done by Lloyd et al (2001) concluded that external knee loading patterns during sidestep cutting put the ACL at the most risk for injury. They reported that when the knee is in that position, it is forced into valgus and rotation placing it at risk of injury. Due to these findings, the study suggested that stability and balance training suppress muscle stretch reflexes and therefore enhance co-contraction in return. The authors concluded that plyometric training may reduce voluntary activation times so that players can perform more rapid and unexpected sports manoeuvres. From these results, it can be recommended for future studies to monitor injury incidence among teams that incorporate plyometric training and compare to teams that don’t include plyometric training in their training programmes.

Altered neuromuscular control during static and dynamic activities has been identified as one of the key mechanisms for lower limb ligament injuries (Hewett et al., 2002). In a study done by Li et al (1998), it was reported that deficits in the neuromuscular system which has direct control over excessive stress to the passive ligamentous structure, will lead to excessive tensile threshold resulting in mechanical failure. There are specific neuromuscular imbalances that have been identified by Hewett et all (2002) which are: quadriceps dominance, leg dominance, ligament dominance, trunk dominance, neuromuscular activation patterns and dynamic stability.

Disproportionate knee moments that occur between the recruitment of the quadriceps and hamstrings may reflect an imbalance in force absorption. Dynamic actions during soccer activities which require rapid decelerations (such as landing, cutting and pivot movements) involve eccentric muscle force contraction from the knee extensors, thus increasing the risk of non-contact ligament injuries (Daneshjoo et al., 2013). During these actions, the anterior shear of the tibia relative to the femur is counteracted by the ACL, the medial collateral ligament (MCL) and co-activation of the knee flexors (Read et al., 2016). Iga et al (2009) reported that alterations in the functional hamstring: quadriceps ratio (H: Q) may be present due to muscle loading patterns that strengthen the quadriceps more than the hamstrings during repetitive sporting activities and it has been identified as one of the risk factors for non-contact lower limb injury among male footballers.

Neuromuscular inhibition of the hamstrings occurs following hamstring injury and those types of injuries occur more regularly among elite male youth soccer players (McCall et al., 2014). The knee flexors act as antagonists and are involved with knee joint stabilization. These knee flexor muscles demonstrate deficits in eccentric contraction rather than concentric strength (Daneshjoo et al., 2013). As the load accumulates, reduced hamstring activation relative to the quadriceps increases injury risk among male soccer players. It is therefore important to assess the H:Q imbalance and thereafter implement an intervention strategy to minimise the risk of injury from the imbalance (Bahr et al., 2015).

Yanfei et al (2021) documented in their study that the injury rate in adolescents participating in sports activities is high. Compared to adults, adolescents are found to be more vulnerable to sports injuries due to the stage of maturation in growth cartilage and the musculoskeletal system. These acute and overuse injuries in growth cartilage may cause permanent changes in bone and muscle growth, which may lead to a long-term disability at a later stage of their lives. Although contact injuries account for some injuries among adolescents, non-contact injuries are found to be the most common injuries affecting them. These non-contact injuries are often associated with some of the modifiable risk factors such as neuromuscular disorders, overtraining and being physically unfit.

Guan et al (2021) reported a range of risk factors for sports injuries among adolescents such as training duration, age, sex, previous injury, amount of physical activity and stage of maturity of an individual. The study highlighted that the risk of non-contact lower-limb injuries increased with age across different age groups. The increased risk of sports injury with increasing age could be attributed to an increased level of competition and time spent in a sporting activity. It is therefore recommended that adolescent athletes may need close monitoring for injury risks as they get older.

Yanfei et al (2021) indicated in their study that the risk of non-contact lower limb injury among adolescents increased with increased training frequency. They reported that an increase of one training session per week increased the risk of non-contact lower-limb injury by 1.36 times. From their findings, it has been suggested that coaches in youth sports training may need to reduce and manage their training frequency to minimise this type of risk factor among adolescents. Coaches need to consider young athletes who participate in more than one sporting code and try to collaborate with other coaches when they plan their training sessions. It also applies to athletes who play for more than one team of the same sporting code, the respective coaches need to communicate with each other to discuss load management among these athletes.

Participating in football exposes athletes to injuries both contact and non-contact. However, non-contact injuries may be contributed by risk factors which are classified as external or internal risk factors. These risk factors may be further classified as modifiable or non-modifiable factors. Each team and everyone may be exposed to these risks depending on various factors such as age, level of competition, neuromuscular status etc. It is important to assess and identify these risk factors that athletes may be exposed to and implement strategies to minimise these injury risks.

2.5 Strategies to Prevent Injury Risks

Sports injuries occur frequently due to risks exposed to athletes and treating these injuries is often difficult, expensive, and time-consuming, and therefore preventative strategies are justified on medical and economic grounds. Data collection of pre- and post-intervention on the extent of injuries is associated with positive injury surveillance and prevention outcomes (Kaplan Yonatan., 2007). Van Mechelen et al (1992), proposed a four-stage analysis in which the first stage is called problem analysis. This stage includes injury incidence and severity of the assessed subject area. The second stage is followed by the aetiology and mechanism involved in that sport. The third stage consists of the analysis of preventative measures and the last stage is the new analysis to evaluate the preventative effect of the interventions taken and their resulting consequences regarding their effectiveness in reducing the number of injuries.

Injury prevention methodologies typically focus on risk factors (both intrinsic and extrinsic) that might be modified, for example, gear, rules of the specific game, actual wellness, physical fitness and so forth, risk variables and injury rates might be impacted by various parts: biomechanical, mental, psychosocial, field surfaces and actual activity. Compelling injury avoidance systems are powerful in lessening the occurrence of injuries among footballers. These techniques should be customised to explicit games an individual takes an interest in or they need to focus on specific injuries (Leppanen et al., 2014).

Practice preparing in sports includes learning suitable activity strategies, like getting the limits of the scope of movement of the joints and staying away from positions that place the anatomic designs of the joint in danger of injury (Stephenson et al., 2021). Practice preparation programme for the most part includes a blend of solidarity, neuromuscular preparation, proprioceptive and balance penetrates that are significant for working on athletic execution and injury avoidance (Herman et al., 2012). Aaltonen et al (2007) reported other strategies for injury prevention included psychological intervention, equipment usage and nutritional intervention. However, there is a lack

of evidence to support the effectiveness of equipment and nutrition-related interventions for injury prevention purposes and therefore more studies are needed on these strategies.

Leppanen et al. (2014) did a systematic survey on various intervention strategies to prevent injuries in sports. The authors used injury rate or number of injured people as their result. One of the parts assessed was preparing programmes as mediation to prevent sports-related injuries. They partitioned these mediations into six subgroups: balance board preparing, multi-intervention with balance board preparing, other multi-intervention, warm-up programs, strength preparing, and evaluated running projects. Balance board preparation further developed both static and dynamic standing equilibrium upgrading postural control during sports which might decrease the risk of injury. Balance board preparation is likewise successful in decreasing the risk of lower limb injuries, and with neuromuscular preparation, other non-contact injuries of the lower extremities are reduced.

It has been observed and noted that non-contact ankle inversion sprains in football have a high probability of re-injury. Proprioception is one of the significant parts of balance control that is essential in lessening the risk of lower limb injury or re-injury. It delivers better development control during hopping and arriving in football, in this way it diminishes the mechanical pressure and eventually lessens injuries in the lower appendages. By including static and dynamic balance exercises, we may reduce the risk of non-contact ankle inversion sprains and we may also reduce the risk of reinjury if there is a history of injury on that ankle (Oluwatoyosi et al., 2018).

One of the exercises for strength training as a preventative strategy emphasised eccentric strengthening for the hamstring muscles. The most common eccentric hamstring exercises that were implemented were the Nordic hamstring exercise and the Nordic hamstring lowers. In a study done by Suarez-Arrones et al (2020) where the Nordic hamstring exercise was included in 27 sessions during 10 weeks in the midseason break, the authors found that the rate of new and recurrent hamstring injuries among footballers decreased. Bel et al., (2021) did a review on the impacts of lower limb exercise-based injury prevention on performance. The study revealed that combined Nordic hamstring exercise with warm-up and stretching protocol once or twice per week during both the preseason and regular season has shown this combination to be effective in reducing hamstring strains among footballers.

There is another study by Ishoi et al (2016) investigated the eccentric hip adduction strength gained from this strengthening programme. A strength training protocol called the Copenhagen Adduction Exercise was used. Two under-19 football teams that comprised 24 football players

were included and randomised into intervention and control groups. This protocol was done for eight weeks. The study recorded that optimising the length-tension relationship using eccentric training is relevant in the prevention of adductor muscle injuries. In a review by Perez-Gomez et al (2020), they included a study in strength training protocol called the Adductor Strengthening Programme (ASP). The protocol was done two to three times per week during the preseason (6-8 weeks), and it was performed once per week during in season for 28 weeks. The results showed to be effective in reducing the risk and prevalence of groin injuries by 41% in male footballers.

Eccentric strength training has been found to decrease the risk of hamstring injuries among soccer players (Porter and Rushton., 2015). It has been observed that this outcome is consistent with other studies. Notwithstanding, strength preparation was viewed not as compelling among footballers who were fortifying the evertor muscles to lessen the repeat of non-contact ankle sprains. A portion of the multicomponent mediations included strength or power preparing parts. Many of these multicomponent consolidated components from both strength and power and coordination and balance training. In these examinations, it was exceptionally difficult to distinguish which part of the preparation mediation was the compelling part and which one had no effect on the risk of injury. The conclusion was that the preventative effect could be a result of the combination of the different components because it was hypothesised that two single elements may not be effective in isolation from each other but have a positive outcome in combination (Brunner et al., 2019).

Fanchini et al (2020) did a systematic review of exercise-based strategies to prevent muscle injury in elite footballers. The objective of the study was to evaluate the effectiveness of exercise-based muscle injury prevention strategies in adult elite football. In their review, they found studies that supported eccentric exercises, neuromuscular training programs with stabilization core exercises, and balance and flexibility exercises to reduce the rate of hamstring injury. In the study, it was also noted that there is low evidence to support eccentric, balance, and static stretching as preventative strategies. Randomised controlled trial studies that were reviewed showed contradicting results with some studies supporting eccentric exercises and other studies not supporting eccentric exercise for muscle injury prevention. There was a high-risk bias found in some studies through the usage of the ROBIS tool. In the studies that revealed a low risk of bias, it was found that there is no high level of scientific evidence to support the effectiveness of exercise strategies to minimize muscle injuries.

Football is also related to a higher risk of injury to the anterior cruciate ligament compared with other games. Alenton-Geli et al. (2009) referenced that the anterior cruciate ligament injury causes the most time lost from football prompting a solid exploration concentration to its causes. Most of

these ACL injuries in soccer players are non-contact in nature. Most normal non-contact ACL injury systems incorporate a deceleration with high knee inward expansion force joined with dynamic valgus revolution with the body weight moving over the harmed leg while the plantar surface of the foot is fixed level on a superficial level. Dynamic adjustment accomplished through the neuromuscular control framework assists with safeguarding the knee joint during dynamic assignments. A few natural and extraneous elements have been recognized as causative risk factors for ACL injury. Preventative procedures included: neuromuscular preparation, lower appendage plyometrics and dynamic balance.

The sequence of prevention model by Van Mechelen al. states that by constant assessment, injury mechanisms and risk factors are identified, highlighting the fact that collecting and recording data is a core approach for preventing injuries (Van Mechelen, Hlobil and Kemper, 1992). There is likewise a comparative methodology that expresses that evaluating epidemiological data in groups with comparative qualities, starting administration designs, and assessing and surveying chance might assist with injury prevention (Clarsen, Myklebust and Bahr, 2012; Fuller et al., 2007). Different tools are accessible for use in a clinical setting for information collection and recording. These tools may incorporate yet are not restricted to the accompanying: Functional Movement Screening Tools, Landing Error Scoring System, Y-Balance Test, and Star Excursion Balance Test.

However, the utilization of screening tools alone has been accounted for as not being viable in anticipating injury to the lower extremities. Gosnell, Aurelio, and Romero (2015) recommended that screening tools should be included in physical examination to pinpoint the athlete's risk for injuries. The referenced author characterized the hazard of injury as a blend of episode likelihood and outcomes of an unfavourable impact estimated. The risk factor is what is happening that incline toward an unfriendly occasion. When you estimate and evaluate the risk level, it is called risk assessment. If the risk level of the activity together with the risk level of an individual is considered too high, then preventative measures need to be applied to minimize the risk.

The study directed by Christopher et al., (2020), which was a writing survey, was to decide the precision of evaluating devices for normal soccer injuries. To use these tools effectively in clinical practice, and more specifically in the football environment, their validity and reliability are important. Different investigations have detailed doubt about the viability of hazard-calculating screening apparatuses anticipating injury because of the absence of examination proof. The review result showed there's high sensitivity and high specificity among the screening tools they included for preventing and predicting common injuries in soccer players.

The anterior cruciate ligament breaks can be anticipated utilizing the Functional Movement Screening instrument. The landing error scoring system is a variety of drop bounce tests that are utilized for assessing landing designs and subsequently can be utilized to anticipate and prevent anterior cruciate ligament injury in world-class soccer competitors. The landing error scoring system has high precision as an evaluating apparatus for the forecast and anticipation of normal soccer injuries. For other injuries, the literature recommends that overall joint laxity is a prescient measure for lower limb injuries (Dallinga et al., 2012). In a review done by Grygorowicz et al. (2017), they examined ordinary hamstring to quadriceps proportion to anticipate and prevent hamstring injuries. The outcomes showed the screening apparatus to be of critical worth. To validate it further, a rising age, lower hamstring/quadriceps proportion and a diminished scope of movement of hip snatching may likewise predict the occurrence of leg injuries.

When reviewing the literature, it is notable that hamstring injuries are high compared to other muscles of the lower limb. Various researchers have therefore done their studies on hamstring injuries and preventative strategies. This trend could be supported by the high number of injuries that have been noted in the literature. There are studies on adductor muscle injuries but few studies on prevention of quadriceps injury have been found. Other studies have been found on prevention of the ACL injury. Preventative studies on other anatomical sites of the knee (i.e., MCL, LCL, PCL, meniscus, fat pad etc.) need to be done to treat the knee holistically. Many studies emphasize primary prevention strategies, but more studies on secondary and tertiary prevention strategies need to be done. Many other studies focused on intrinsic risk factors more than extrinsic risk factors, therefore more studies are recommended that aim to minimise injury risks due to extrinsic factors.

2.6 Conclusion

Preventative strategies to minimize non-contact injuries include but are not limited to strength training, dynamic warm-up, balance, and mobility training to the training sessions. These preventative strategies best produce positive outcomes when implemented as a combination rather than using them in isolation. ACL injury prevention strategies included some of these exercise programs utilised to minimise muscle injuries. The finding supports the statement that these exercise programs work more effectively when implemented as a combination rather than using them in isolation. Screening tools that are valid and reliable may also be used as preventative strategies for non-contact lower limb injuries by identifying the probability of injury risks. Therefore, a study that collates and describes collected data on “non-contact” lower limb injuries

among male footballers may be meaningful both for footballers and members of the technical team.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The title of this review has been registered on the Open Science Framework before the researcher commenced with the study to ensure that there are no duplicates. Open Science Framework organisation ensures openness, integrity, and reproducibility of scientific research. The PRISMA group guidelines and the JBI reviewer's manual were used to guide the methodology of this review (Moher et al., 2009; Paters et al., 2015). A PRISMA-ScR checklist (Appendix I) has been specifically used to ensure the reporting of essential items to be included in this scoping review (Tricco et al., 2018).

3.2 Defining the review question

The researcher consulted experts in the field of sports medicine to assist in the refining of the research question. The research question was defined as follows: What were the preventative strategies implemented to minimise the risks of non-contact lower limb injuries among male footballers?

3.3 Type of Study

The type of this study was a scoping review. A scoping review is a tool to determine the coverage of a body of literature on a certain topic and it also gives a clear indication of the volume of literature and studies available (Zachary et al., 2018). This scoping review has identified and mapped available evidence of preventative strategies for lower limb non-contact injuries among male footballers.

3.4 Identification of Relevant Studies

After defining the research question, a comprehensive process of identifying and selecting relevant studies available from different databases was conducted by one independent researcher and a research assistant. A workshop for internet search strategy was attended which was conducted by a librarian from Witwatersrand University who is experienced in the methods of searching for literature sources.

To identify studies that were relevant to this review, the systematic approach to scoping review literature search strategy development was used as summarized by Peters et al (2015). This was substantiated in the PRISMA-ScR (Tricco et al., 2018). The process of identifying relevant studies

included: 1) defining the eligibility criteria, 2) defining information sources, 3) developing a search strategy, and 4) defining the study selection process. (Peters et al. 2015 framework).

3.5 Eligibility criteria

The research utilised the PCC (population, concept, and context) framework to evaluate the inclusion and exclusion criteria for the review accurately (Peters et al., 2015).

3.5.1 Population

This scoping review has considered studies that included professional and amateur football players of different age groups. In a study done by Merron et al (2006), he investigated and compared injury incidence and severity among professional (senior) and amateur (youth) soccer players. In the study, players between 16 years and older were included. The study found that there was a slight difference in injury patterns between senior and youth team players, but injury incidence was similar. For this review, a broader age range was included.

The information in lines 2-5 gives support on how inclusion and exclusion of age were decided.

3.5.2 Concept

The review considered all preventative strategies for non-contact lower limb injuries (i.e. Nordic hamstring exercises, strengthening exercises etc.) as they play an important role in football to minimize the exclusion of footballers from the squad due to these injuries such as hamstring injuries, groin injuries etc.

Non-contact injuries have been defined under the “Operational definitions” section.

3.5.3 Context

The review focused on research papers concerned with the game of football. Studies done in all geographical, cultural, and social backgrounds that had male professional and amateur footballers were considered.

3.5.4 Exclusion criteria

Studies done on preventative measures for injuries and not specific to non-contact injuries, studies that included female footballers, those studies that included other sporting codes and other injuries that are not of the lower limbs were excluded from the study.

3.6 Types of Evidence Sources

The review included randomised controlled trials, case-control studies, prospective nonrandomized test-retest designs, randomized clinical trials, crossover study designs, cohort studies, cluster-randomised trials, commentary, systematic review, and experimental designs. Articles published in English for the past 10 years were reviewed. Articles on grey literature were considered but no article was found.

3.7 Search strategy

Search	Actions	Details	Query	Results	Time
#5			Search: (((((((soccer) OR (football)) AND (injury)) AND (risk factor)) AND (lower limb)) AND (non-contact)) AND (prevention)) AND (strategy)) OR ((((("Soccer"[Mesh]) AND ("injuries" [Subheading] OR "Wounds and Injuries"[Mesh])) AND "Risk Factors"[Mesh]) AND "Lower Extremity"[Mesh]) Filters: in the last 10 years, Humans, English, Male.	43	11:10:09

Figure 3. 1 Search builder in PubMed

The librarian was consulted regarding the search strategy and advised the search strategy that has been used.

These are the Mesh terms that have been used: (((((((soccer) OR (football)) AND (injury)) AND (risk factor)) AND (lower limb)) AND (non-contact)) AND (prevention)) AND (strategy)) OR ((((("Soccer"[Mesh]) AND ("injuries" [Subheading] OR "Wounds and Injuries"[Mesh])) AND "Risk Factors"[Mesh]) AND "Lower Extremity"[Mesh]). The following were the filters used: last 10 years (2012-2022), humans, English, male. (This information was removed from section 4.2 as per the examiners' recommendation).

The literature search was performed using a systematic approach as recommended in the JBI reviewers' manual. The first step included a search on MEDLINE (PubMed) and CINAHL The second step analysed text words within the title and abstracts of the articles selected. Primary keywords included "football" OR "Soccer", "injury", "risk factor", "lower limb", "non-contact", "prevention", and "strategy". A second search was done using all identified keywords and index terms undertaken across various databases. Other databases that were searched include Physiotherapy Evidence Database (PEDro), Science Direct, SPORTDiscus with Full Text, CINAHL Plus with Full Text (EBSCO), Cochrane Library, and SCOPUS. The third step used references from identified articles to search for additional articles related to the topic.
To align the selection of studies with the review question, a PRISMA flow diagram has been used (Appendix II) (Moher et al., 2009).

3.8 Evidence selection

Source selection was performed by two reviewers independently screening titles, abstracts, and full text. Disagreements that were encountered were solved by consensus and some with the assistance of a third reviewer's decision.

3.9 Data extraction

The researcher developed a data charting table (Appendix III). The following was extracted: Name of the author(s), the title of the study, publication, the aim of the study, study setting, Study population & sample size, sampling method & size, study design, data collection methods, data analysis, conclusion, outcome, most relevant findings, limitations, comment.

Before the commencement of the study, the data charting table, and the process of the review were piloted. Two members of the review team did the pilot step. The purpose of this pilot study was to test the data collection method for quality and appropriateness to the review question. The other purpose of this pilot study was to assist the researcher in practising strategies that were going to be implemented in the research methodology and determine if the results support a larger volume of investigation (Van Teijlingen et al., 2002).

3.10 Analysis of Results

In this review, results were extracted from included papers and mapped descriptively. There was a narrative summary together with the tabulated results and a description of how the results align with the review objectives and the research question (Peters et al., 2015). Towards the end of the review process, there was additional valuable information from the extracted papers which were muscle groups targeted by injury prevention exercise, and results were further refined by the reviewers.

3.11 Presentation of results

The results of this review were presented as a map of the data extracted from the included papers in a tabular and pie form that aligned with the objectives and the scope of the review. Preventative strategies for non-contact lower limb injuries among male youth and senior footballers guided how the data were mapped.

3.12 Ethical Considerations

No human participants were involved in the study, therefore there was no need to apply for ethical clearance through the University of the Witwatersrand's Human Research Ethics Committee.

3.13 Funding

The was no funding allocated for the study.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter reports identified and collated data from existing quantitative and qualitative studies on preventative strategies for non-contact injury risk factors among male footballers. Collected data on these preventative strategies have been described descriptively and logically. The results of this study have mapped the range of literature relating to preventative strategies implemented to minimize risk factors associated with non-contact lower limb injuries among male footballers.

4.2 Study selection

Different search engines yielded the following number of articles: PubMed had 43 articles, CINAHL had 303 articles, PEDro had 45 articles, Science Direct had 33 articles, SPORTDiscus with Full Text had 111 articles, Cochrane Library had nine articles and Scopus had 73 articles.

The total number of articles searched was 617 (Figure 4.2). There were 68 duplicates identified and removed from the list of articles resulting in 549 articles left for title and abstract evaluation. There were 485 articles excluded post title and abstract evaluation. Sixty-four articles were sorted for retrieval and five articles could not be retrieved (one article was not published in English and it was published in the German language. The authors were contacted via email but there was no reply from them. The other four articles were for sale and the study did not have any funding).

Fifty-nine articles were included for full-text review plus an additional record identified from the citation search. Twenty-five articles met the inclusion of the study. Thirty-five articles were excluded due to the following reasons: “studies included female footballers, contact injuries were included, studies on injuries of the upper limbs and upper body, studies including other sporting codes and not football only, studies done on recreational soccer players, studies including participants with short hamstring syndrome (SHS) and studies aiming to investigate intervention as rehabilitation strategies”.

Font cannot be increased because the template was filled out in the JBI Scoping review website, copied, and pasted on the research report document.

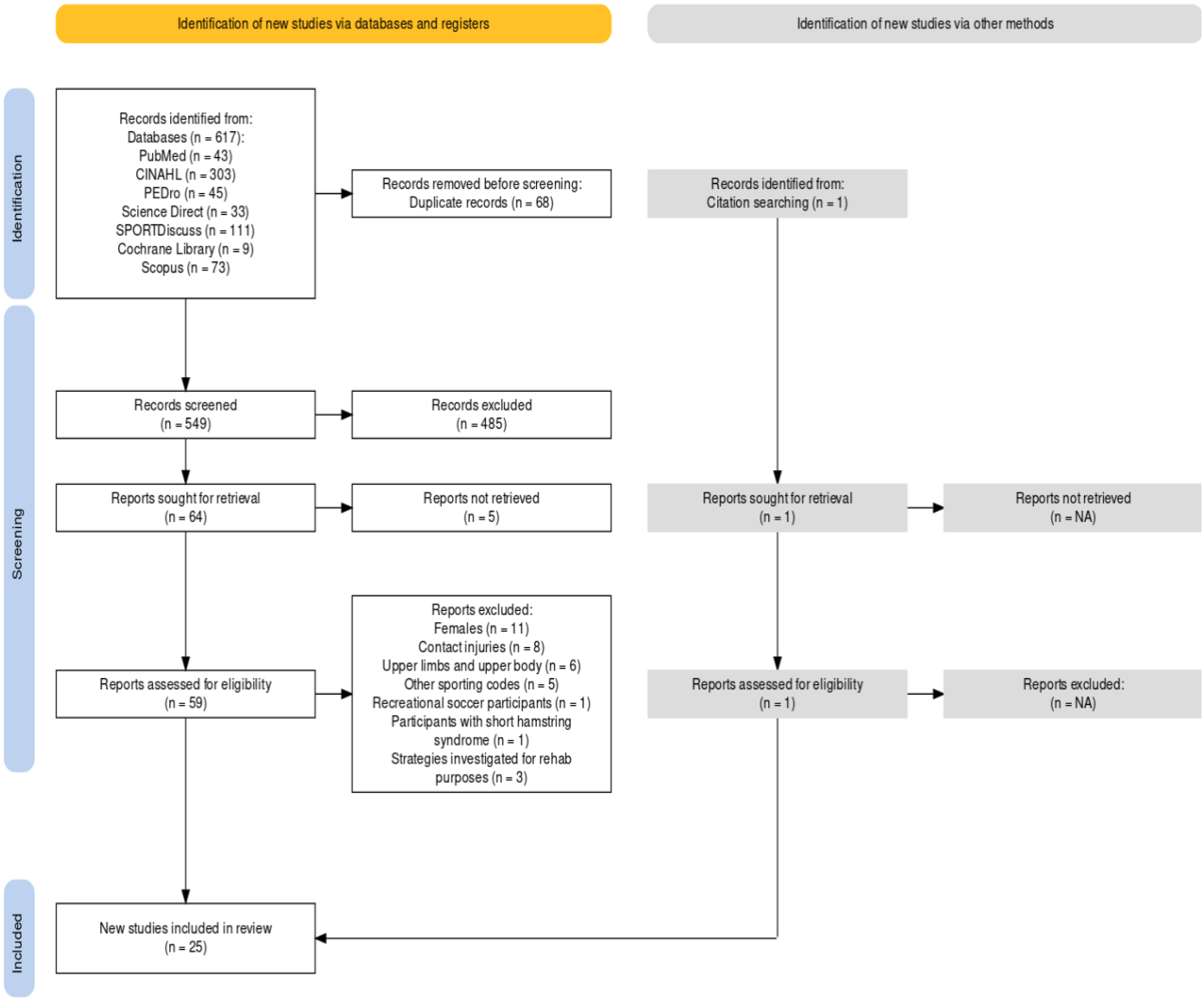


Figure 4. 1 Study selection flow chart detailing the search process

4.3 Summary of the studies

4.3.1 Study designs

Of the 25 included articles, there were 11 randomised control trials, three cohort studies, three case-controlled studies, three experimental designs and one of each the following designs: retrospective survey, prospective non-randomised test-retest design, systematic review, crossover study design and commentary article.

4.3.2 Study population

The review selected articles that had male football participants, both amateur and professional footballers. Study selection had no geographic limitations. Some studies specified how many participants were part of the study, whereas some studies only mentioned the number of teams included.

4.3.3 Outcomes and Methodology

Studies that have been reviewed focused on preventative strategies for non-contact lower limb injuries among male footballers. These studies had different methodologies for the strategies that investigated non-contact lower limb injuries among male footballers. The studies' outcomes and methodology relating to each intervention are presented in Appendix III.

Table 4. 1 Summary of articles included (n = 25)

Author(s)	Title	Design	Setting	Participants	Findings	Conclusion
Azuma and Someya (2020)	Injury prevention effects of stretching exercise intervention by physical therapists in male high school soccer players	Randomised controlled trial	Japan	Hundred and twenty-four players from two high schools who competed in the national tournament soccer games were randomly divided into intervention and control groups	The intervention group showed significant improvements in the heel-buttock distance, straight leg raises, hip rotation and ankle dorsiflexion angles between 12 and 52 weeks	Instructed stretching exercises designed by physical therapists to address muscle tightness improved range of motion and trunk flexibility with positive effect for non-contact injuries
Bahr, Kristian and Ekstrand (2015)	Evidence-based hamstring injury prevention is not adopted by the majority of champions league or Norwegian Premier League football teams: the Nordic Hamstring survey	Retrospective survey	Norway	Fifty professional football teams of which 32 participated in the UEFA Champions League, and 18 from Tippeligaen	Of the 50 clubs, 35 reported having a formal hamstring injury prevention policy for the first squad. Education on the Nordic Hamstring programme was delivered in the 2014 season by 19 of 50 clubs	Adoption and implementation of the Nordic Hamstring exercise programme at the highest levels of male football in Europe is low, lowering the expectations on overall effect on acute hamstring injury rates
Bakken et al (2018)	Muscle strength is a poor screening test for predicting lower extremity injuries in professional male soccer players	Case-control study	Qatar	A total of 369 professional male soccer players from 14 teams representing 42 nationalities	Greater bilateral adductor strength adjusted for body weight was associated with a lower risk for any knee injury	Strength testing cannot be recommended as a screening tool to predict injuries; however, it is possible to intervene with strength training to reduce lower extremity injuries in soccer
Best et al (2014)	Residual mechanical effectiveness of external ankle tape before and after competitive professional soccer performance	Prospective nonrandomized test-retest design	Germany	Seventeen professional male outfield players without any signs of chronic ankle instability	Tape restricted the maximum passive inversion range of motion of the uninjured ankle significantly to 50.3%. The protection declined almost completely after 45 minutes	Ankle tape does not assure a protective mechanical effect against ankle sprains over the period of a soccer halftime

Cohen et al (2015)	Angle-specific eccentric hamstring fatigue after simulated soccer	Case-control study	London	Nine male soccer players aged 25 from semi-professional soccer clubs	Hamstring strain prevention programs for soccer players should include both exercises that specifically strengthen the hamstrings eccentrically at long lengths	Injury-risk screening could be improved by evaluating the eccentric hamstrings torque-angle profile and hamstring strength-endurance
Coratella et al (2014)	Fatigue affects peak joint torque angle in hamstring but not in quadriceps	Case-control study	Italy	Twenty-two healthy male soccer amateur players age between 20 and 24 years	Peak joint torque angle significantly increased in knee flexors only. No changes were found in quadriceps peak joint torque angle.	Trainers and conditioners should use hamstrings lengthening exercise to adapt hamstrings length-tension profile towards a safer contraction ability
Daneshjoo et al (2012)	The effects of injury preventive warm-up programs on knee strength ratio in young male professional soccer players	Experimental design	Iran	Thirty-six male professional soccer players	The conventional strength ratio in the non-dominant leg showed significant differences between the 11+, HarmoKnee and control group	FIFA 11+ have the potential to improve conventional strength ratio and dynamic control ratio as well as preventing knee injuries in soccer players
De Castro et al (2013)	Incidence of decreased hip range of motion in youth soccer players and response to a stretching program: A randomized clinical trial	Randomized clinical trial	Brazil	Two hundred and sixteen athletes of the youth professional soccer teams.	Hip-rotation range of motion decreases over the years in soccer players. Therefore, adherence to a stretching program improved external hip-rotation in the nondominant limb	Playing soccer can restrict rotation range of motion of the hip, and adherence to stretching exercises may increase hip external range of movement and therefore decreasing the harmful effects on the hip joints
Forbes et al (2013)	The effect of prophylactic ankle support during simulated soccer activity	Crossover study design	Germany	Ten male amateur soccer players were recruited	Application of prophylactic support significantly decreased active ROM in plantarflexion and inversion with the tape performing better than the brace. However, tape lost its restrictive benefits by 15 minutes	The clinical usefulness of the ankle-joint prophylactic support is limited if the aim is to restrict ROM and improve proprioceptive capability under soccer-specific conditions

Grooms et al (2013)	Soccer-specific warm-up and lower extremity injury rates in collegiate male soccer players	Cohort study	USA	Forty-one male collegiate athletes aged 18-25 years	The intervention season had reductions in the relative risk of lower extremity injury of 72%	The F-MARC 11+ program reduced overall risk and severity of lower extremity injury compared with controls in collegiate-aged male soccer athletes
Haroy et al (2017)	Including the Copenhagen adduction exercise in the FIFA 11+ provides missing eccentric hip adduction strength effect in male soccer players	Randomized controlled trial	Norway	Forty-five eligible players from two under 19 elite male soccer teams were recruited.	There was an increase in eccentric hip adduction strength in the group performing the Copenhagen adduction exercises	Including the Copenhagen adduction exercise in the FIFA 11+ program increased eccentric hip adduction strength, and therefore potentially increasing the preventative effect on groin injuries
Ishoi et al (2015)	Large eccentric strength increase using the Copenhagen adduction exercise in football: A randomized controlled trial	Randomized controlled trial	Denmark	Two under 19 sub-elite football teams which included 24 football players were randomized to either an 8-week supervised progressive training program in addition to the usual training, or to continue training as usual	The intervention group demonstrated an increase in eccentric hip adduction, eccentric hip abduction and eccentric hip adduction: eccentric hip abduction ratio	Optimizing the length-tension relationship using eccentric training seem to be relevant in the prevention of adductor injuries
Krist et al (2020)	Preventive exercises reduced injury-related costs among adult male amateur soccer players: a cluster-randomised trial	Cluster-randomised trial	Netherlands	Four hundred and seventy-nine adult male amateur soccer players aged between 18-40 years	There were no significant differences in the proportion of injured players and injury rate between the two groups. However, overall costs in the intervention group were lower compared to the control group	Exercises did not reduce the number of injuries significantly, but it significantly reduced injury-related costs

Malone et al (2017)	High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk?	Observational cohort study	Australia	Thirty-seven elite soccer players from one elite squad were involved in a one-season study	Players who completed moderate high-speed running were at reduced injury risk compared to low high-speed running. Injury risk was higher for player who experienced large weekly changes in high-speed running and sprint running	Higher chronic training loads and better intermittent aerobic fitness off-set lower limb injury risk associated with these running distances in elite soccer players
Mansfield et al (2018)	A review advocating caution with major league soccer expansion and investment in more rehabilitation professionals	Commentary	USA	Twenty-two teams participating in the Major League Soccer	Major League soccer has lengthened the regular season with the increase in number of teams participating in the league. This has resulted to increased injury rates in games compared to practice sessions	Current evidence suggests the implementation of a proper preseason preparation, one game per week frequency and implementation of injury prevention strategies would best promote player health and well-being
Perez-Gomez et al (2020)	Physical exercises for preventing injuries among adult male football players: A systematic review	Systematic review	Spain	A total of 2512 studies were identified initially but only 11 studies met the inclusion criteria	Injury prevention programs in football have focused on strength training, proprioceptive training, multicomponent programs, and warm-up programs and have been found to be effective in lowering injury rate among male footballers	Football players can lower the incidence of match and training injuries by participating in dynamic warm-up programs that include preventive exercises before games or during training sessions, and by adding strength, balance, and mobility training to the training sessions
Petersen et al (2011)	Preventive effect of eccentric training on acute hamstring injuries in men's soccer	Randomized controlled trial	Denmark	Fifty Danish male professional and amateur soccer teams (942 players) were allocated to an intervention group (461 players) or a control group (481 players)	There were 52 acute hamstring injuries in the control group compared with the 15 injuries in the intervention group	Additional eccentric hamstring exercise decreased the rate of overall, new and recurrent acute hamstring injuries in male professional and amateur soccer players

Raya-Gonzalez et al (2021)	The effects of training based on Nordic hamstring and sprint exercises on measures of physical fitness and hamstring injury prevention in U19 male soccer players	Experimental design	Spain	Forty-nine under 19 players were randomly assigned to a control or experimental group	There were significant differences in injury burden in favour of the experimental group compared to the control group, while injury incidence was not different between the two groups.	Training program implemented in the study can improve sprint performance and reduce injury burden
Schuermans et al (2016)	Deviating running kinematics and hamstring injury susceptibility in male soccer players: Cause or consequence?	Cohort study	Belgium	Thirty soccer players with a recent history of hamstring injury and 30 matched controls	Injury occurrence was associated with higher levels of anterior pelvic tilting and thoracic side bending throughout the swing phases of sprinting, whereas no kinematic differences during running were found when comparing players with a recent hamstring injury history with their matched controls	Although sprinting encompasses a relative risk of hamstring muscle failure in every athlete, running coordination demonstrated to be essential in hamstring injury prevention
Sebelien et al (2014)	Effects of implementing Nordic hamstring exercises for semi-professional soccer players in Akersjus, Norway	Randomised controlled trial	Norway	Members of 10 adult level 3 and level 4 semi-professional Norwegian soccer teams ages between 18-39 were recruited for the study	There was a significant difference in the number of injuries between the control and Nordic hamstring groups	Incorporation of Nordic hamstring exercise protocol into regular practice sessions may be effective in reducing the number of hamstring injuries among soccer players
Silvers-Granelli et al (2017)	Does the FIFA 11+ injury prevention program reduce the incidence of ACL injury in male soccer players?	Randomised controlled trial	USA	Two-hundred and ninety-nine teams met the inclusion criteria, 65 institutions consented to participate with the male participants from the institution ranging from 18-25 years	A lower proportion of athletes in the intervention group experienced knee injuries compared with the control group including ACL injury	The FIFA 11+ program has the potential to decrease the rate of ACL injury in competitive soccer players if implemented correctly

Silvers-Granelli et al (2015)	Efficacy of the FIFA 11+ injury prevention program in the collegiate male soccer player	Randomised controlled trial	USA	Sixty-five teams were randomized into control group with 34 teams consisting of 850 plyers and intervention group with 31 teams consisting of 675 players	Control group reported 665 injuries and the intervention group reported 285 injuries	The FIFA 11+ significantly reduced injury rates by 46.1% and decreased time loss to injury by 28.6% in the competitive male collegiate soccer player
Van Beijsterveldt (2012)	Effectiveness of an injury prevention programme for adult male amateur soccer players: a cluster-randomised controlled trial	Cluster-randomised controlled trial	Netherlands	Eleven teams consisting of 223 players in the intervention group and 12 teams in the control group which consisting of 233 players	Injury incidences were almost equal between the two study groups: 9.6 per 1000 sports hours and 9.7 for the control group	No significant differences in the overall injury incidence and severity between the intervention and control groups
Van de Hoef et al (2018)	Does a bounding exercise program prevent hamstring injuries in adult male soccer players? - A cluster-RCT	Randomised controlled trial	South Africa	Thirty-two soccer teams consisting of 400 players competing in the firs-class amateur league were recruited	Out of 400 players there were analysed, there were 57 players that sustained 65 hamstring injuries but there were no statically significant differences in hamstring injury incidence or severity between the two groups	No evidence found for plyometric training in its current form to reduce hamstring injuries in amateur soccer players
Van der Horst et al (2015)	The preventive effect of the Nordic hamstring exercise on hamstring injuries in amateur soccer players	Randomised controlled trial	Netherlands	Male amateur soccer players from 40 teams were randomly allocated to an intervention (n=20 teams, 292 players) or control group (N=20 teams, 287 players)	The risk of hamstring injuries was reduced in the intervention group compared with the control group and it was statistically significant.	Incorporating the Nordic hamstring exercise protocol in regular amateur training significantly reduces hamstring injury incidence but does not reduce hamstring injury severity

4.3.4 Analysis of Results

Table 4. 2 Analysis of results

Study/article characteristics	n/ 25 (%)	Study/article characteristics	n/25%
Study designs		**Preventative strategies**	
Cluster randomized controlled trial	8(32)	Nordic hamstring program	6(24)
Randomized controlled trial	4(16)	F-MARCH 11+	4(16)
Case control	3(12)	Strength training	2(8)
Cohort	3(12)	External ankle tape	2(8)
Experimental design	1(4)	Stretching exercise intervention by physical therapists	2(8)
Commentary review	1(4)	Copenhagen adduction exercise	2(8)
Randomized clinical trial	1(4)	The 11	2(8)
Crossover study	1(4)	High chronic training loads and better intermittent aerobic fitness	1(4)
Systematic review	1(4)	Preseason preparation	1(4)
Prospective nonrandomized test retest	1(4)	Dynamic warm-up program, FIFA 11+, eccentric exercises, balance, mobility and strength training	1(4)

Running mechanics	1(4)
Bounding exercise program	1(4)

Study setting	
Real-world setting	16(64)
Laboratory	4(16)
Online	2(8)
Soccer match simulation	1(4)
University hospital	1(4)
40 meter running track	1(4)

Anatomic structures	
Lower limb injuries	12(48)
Hamstrings injuries	8(32)
Ankle injuries	2(8)
Adductor injuries	2(8)
ACL injuries	1(4)

Method of data collection	
Questionnaire	6(24)
Intervention	4(16)
Dynamometer	3(12)
Goniometer	3(12)
Fitness test	2(8)
Online search	2(8)
Web-based injury surveillance	2(8)
GPS	1(4)
Muscle tightness test	1(4)
Cybex	1(4)

Region where the studies were conducted	
USA	4(16)
Netherlands	3(12)
Germany	3(12)
Spain	2(8)
Denmark	2(8)
Norway	2(8)
Iran	1(4)
Italy	1(4)
Japan	1(4)
	1(4)

London	
Australia	1(4)
Belgium	1(4)
Qatar	1(4)
South Africa	1(4)
Brazil	1(4)

Table 4. 3 Summary of Preventative Strategies Included

Name of Strategy	Description of the strategy	Studies referred to strategy	Exercise prescription	Time period of the exercise prescribed	Performed in a group/individually/home exercise/supervised
Nordic Hamstring Exercise	Nordic hamstring exercise is an eccentric strength training exercise targeting the hamstring muscles.	Bah et al (2015)	The exercise was done once to three weekly training sessions with increasing number of sets and repetitions.	The initial program includes a 10-week exercise progression, after 10 weeks there is a maintenance program for the rest of the season.	Performed in a group.
		Coratella et al (2014)	There was a standardised soccer match simulation program given to participants.	The soccer match simulation consisted of five bouts which lasted 15 minutes for each bout.	Intervention was performed individually under supervision.
		Petersen et al (2011)	Teams in the intervention group performed 27 sessions of the Nordic hamstring exercise.	10-week progressive eccentric training program which was followed by a weekly seasonal program.	Performed in a group as a team.
		Sebelien et al (2014)	Teams in the intervention group performed their usual warm-up exercises in addition to the Nordic hamstring protocol.	The exercise prescription took place for 10 months.	Performed in a group.

		Van der Host et al (2015)	The intervention group performed 25 sessions of Nordic hamstring exercise.	The exercise was prescribed for 13 weeks.	Performed in a group.
Copenhagen Adduction Exercise	Copenhagen Adduction exercise is an eccentric exercise that may be performed with an assistance of a partner. It can be used as a high-intensity exercise on the field before or after soccer related activities.	Haroy et al (2017)	Players in the intervention group performed Copenhagen adduction exercise. They did one set o 3-15 repetitions.	The exercise was prescribed for three weeks.	Performed in a group.
		Ishol et al (2015)	Players in the intervention group were prescribed an 8-week progressive training program.	The intervention exercise was prescribed for eight weeks.	Intervention group did the exercise under supervision.
Muscle Strengthening	The maximal isokinetic knee flexion and extension were tested using an isokinetic dynamometer.	Bakken et al (2018)	There was no exercise prescribed for the participants.	The association between the hip and muscle strength and the risk of lower extremity injuries were examined over a period of two seasons.	Not relevant to this study as there was no intervention prescribed.

	After a standardized warm-up, subjects performed an isokinetic assessment of the hamstrings and quadriceps peak torques with their dominant leg.	Cohen et al (2015)	Participants underwent a 90-minute simulated soccer activity, the Loughborough Intermittent Shuttle Test (LIST).	Participants performed two tests of five maximal repetitions at 120 degrees per second with a 2-minute recovery period between.	Intervention strategy was done individually under the supervision of the researcher.
Stretching Exercises	Stretching exercises that were designed by the physiotherapist.	Azuma and Someya (2020)	Stretching exercises that were designed by the physiotherapist.	There was a 12-week stretching intervention that was done.	Stretching was done in a group instructed by the physiotherapist.
	Active stretching exercises with emphasis on improving flexibility of the hip internal and external rotators.	De Castro et al (2013)	Active stretching exercises were designed for the intervention group.	Intervention period was 12 weeks.	Stretching was done in groups supervised by their respective athletic trainers.
Ankle Taping	The tape was applied by a qualified experienced team physiotherapist who was experienced in professional soccer sports.	Best et al (2014)	There was no exercise prescribed for the participants.	There was no exercise prescribed, however, participants were investigated before and after a 45-minute soccer-specific field intervention.	The intervention and the main outcome of the study was performed individually on each participant.

	The tape used an open basket-weave technique, and the brace was an AirCast AirSport brace.	Forbes et al (2013)	There was no prescribed exercise, but a tape or a brace we applied.	A soccer-specific aerobic field was done for 90 minutes.	Intervention was done individually under supervision.
FIFA 11	An injury prevention program consisting of 10 exercises designed to improve core stability, muscle strength, co-ordination, proprioceptive training and flexibility of the trunk and hips.	Krist et al (2013)	The intervention group were given exercises to be done for two to three sessions per week.	The intervention was done over a period of one soccer season.	The intervention program was performed in a group, administered by their respective coaches.
		Van Beijsterveldt (2012)	The11 was integrated in the warm-up of each practice session at least twice a week.	Intervention took place over a period of one soccer season from September 2009 to May 2010.	Coaches of the teams in the intervention integrated The11 in their team warm-up.
FIFA 11+	The FIFA11+ is an advanced version of the FIFA 11 program for prevention of lower extremity injuries.	Daneshjoo et al (2012)	The FIFA11+ takes approximately 20-25 minutes to complete.	The exercises were performed three times a week over a period of two months.	The coaches and team managers of their respective teams administered the intervention in a group fashion.
		Grooms et al (2013)	The fifa11+ was completed before every practice session.	The intervention program was completed during the preseason and in-season, and it lasted for 12 weeks.	The training sessions and exercise program progression were monitored by a certified athletic trainer.

		Silvers-Granelli et al (2017)	The FIFA+ was implemented to be performed two to three times a week before training sessions and games.	The exercise program was conducted over the course of one competitive soccer season.	The intervention program was performed in a group, and it was administered by certified athletic trainers of each team.
Preseason Preparation	Preseason preparation includes approximately six weeks of training sessions and friendly matches prior to the start of the new soccer season.	Mansfield et al (2018)	MLS offseason training preparations as per teams participating in the league.	Preseason preparation take approximately six weeks.	Preseason preparation is performed in a group by their respective fitness coaches.
Running Mechanics	High speed running involves providing the body center of mass with acceleration and velocity to achieve a fast horizontal displacement through horizontal force production.	Schuermans et al (2016)	There was a kinematic analysis of the linear acceleration to full speed sprinting which was conducted on a 40-meter running track.	Initially there was a static trial, and four functional joint trials were recorded. Duration of the trial was not stipulated.	The trial was performed individually under supervision.
Higher Chronic Training Loads	Chronic training loads were calculated through the collection of weekly GPS variables on an average of 2-day of loading.	Malone et al (2017)	Participants completed the 15-30 intermittent fitness test which consists of 34 stages of 30 shuttle runs.	Participants were exerted for a higher 21-day chronic training loads.	Training loads were performed in a group under supervision.

Bounding Exercise Programme	BEP is a build-up program consisting of concentric to eccentric and plyometric exercises.	Van de Hoef (2018)	Exercise program consisted of walking lunges, tripling's and drop lunges, and bounding jumps.	The exercise is a 12-week build-up program.	The exercise program was performed in a group under the supervision of the coaches or physiotherapists of the respective teams.
Strength, Balance, Mobility training, core stability and multicomponent programs	Physical exercises implemented for prevention of injuries.	Perez-Gomez (2020)	There were different articles that studied exercise programs with various prescriptions.	There were different time periods form different studies that were documented.	Exercise programs were performed in a group.

Most research articles that were included in this study were conducted in developed countries where most studies were done in the USA. South Africa is one of the developing countries that had one research article included in this review. Studies included in this review were mostly undertaken in a real-world setting and classified as cluster randomized controlled trials. Strengthening strategies including Nordic hamstring and Copenhagen exercises had more articles included in this review and these intervention strategies were found to produce significant results. Articles included in the study investigated preventative strategies for non-contact lower limbs, hamstring, ankle, adductor muscle and ACL injuries. There were no studies on quadriceps and gastrocnemius muscle groups found.

4.3.5 Actual outcomes/content

The actual outcomes and content of this review were categorised according to the name of the exercise or the type of exercise. Some studies included in this review were found to investigate Nordic hamstring exercises, Copenhagen Adduction Exercises and strengthening exercises in a general fashion. Other studies that were included in this review investigated FIFA 11 and FIFA11+ warm-up programs. Other articles were included in this study that investigate strength, balance, mobility training, core stability and multi-component programs. A bounding exercise program was also one type of intervention that was included in this review. High chronic training loads, running mechanics and preseason preparation were other intervention strategies included in this review. The articles were discussed under the following sub-topics:

- **Nordic Hamstring Exercises**

  Bahr et al (2015) investigated the implementation of the Nordic Hamstring exercise programme at the highest level of football in Europe (UEFA Champions League). The study compared this implementation to the Norwegian Premier League, Tippeligaen, since the pioneering research on the Nordic Hamstring programme was conducted. The study found that there was no difference in compliance between the UEFA Champions League (UCL) and Tippeligaen in any season. Adoption and implementation of the Nordic Hamstring exercises programme at the highest levels was found to be low and, therefore too low to expect any overall effect on acute hamstring injury rates.

  In a study done by Coratella et al (2014), where authors investigated peak joint torque angle changes recorded during an isokinetic test before and after a fatiguing soccer match

simulation. The secondary aim was to investigate functional hamstring to quadriceps ratio changes due to fatigue. Peak joint torque angle increased significantly in knee flexors only. Both eccentric and concentric contractions resulted in increment that occurred in both limbs. There were no changes that were found in quadriceps peak joint torque angle. The results of this study suggest that trainers and conditioners use eccentric based training programme such as Nordic Hamstring exercises to adapt hamstring length-tension profile towards a safer contraction ability.

Another study on eccentric training on acute hamstring injuries in men's soccer was done by Petersen et al (2011). The authors of the study investigated the preventive effect of eccentric strengthening of the hamstring injuries in male soccer players. The control group had 52 acute injuries and the intervention group had 15 injuries. The study concluded that additional eccentric hamstring exercise decreased the rate of overall, new, and recurrent acute hamstring injuries in male professional and amateur soccer players.

Raya-Gonzales et al (2021) did a study to analyse the effects of a training program based on Nordic hamstring and sprint exercises on physical performance and hamstring injuries among young male soccer players. The study found that there were significant differences in injury burden in favour of the experimental group compared to the control group, while injury incidence was not different between the two groups. Therefore, training program implemented in the study can improve sprint performance and reduce injury burden.

In a study done by Sebelien et al (2014), it was examined if Nordic hamstring exercises (NHE) decreased injury rates, increased sprinting speed, and increased hamstring speed and increased hamstring and quadriceps muscle strength among semi-professional soccer players. There was a significant difference in the number of injuries between the control and Nordic hamstring groups. In conclusion: the incorporation of Nordic hamstring exercise protocol into regular practice sessions may be effective in reducing the number of hamstring injuries among soccer players.

Van der Horst et al (2015) conducted the study to investigate the preventive effect of the Nordic Hamstring Exercise (NHE) on the incidence and severity of hamstring injuries in male amateur soccer players. The overall injury incidence rate was significantly different between the intervention and control groups in favour of the intervention group. The risk of hamstring injuries was reduced in the intervention group compared with the control group and it was statistically significant. There was no statistical significance difference

identified between the intervention and control groups with regards to injury severity. The study concluded that incorporating the Nordic hamstring exercise protocol in regular amateur training significantly reduces hamstring injury incidence but does not reduce hamstring injury severity.

- **Copenhagen Adduction Exercise**

  Haroy et al (2017) did an investigation on eccentric hip adduction strength on the FIFA 11+ warm up program with and without the Copenhagen adduction exercise. The results of the study revealed an increase in eccentric hip adduction strength in the group performing the Copenhagen adduction exercise, whereas there was no change in eccentric hip adduction strength in the group not performing this exercise. This study concluded that by including the Copenhagen adduction exercise in the FIFA 11+ program increased eccentric hip adduction strength, therefore potentially increasing the preventative effect on groin injuries.

  In a study done by Ishol et al (2015), they examined the eccentric hip adduction strength gain (EHAD) gain using the Copenhagen adduction exercise in-season. In the intervention group, there was an increase in EHAD, eccentric hip abduction strength (EHAB), and EHAD/EHAB ratio. In the control group, there was no significant within-group differences found. The study concluded that optimizing the length-tension relationship using eccentric training seems to be relevant in the prevention of adductor injuries.

- **Muscle strengthening**

  Bakken et al (2018) reported the association between hip and thigh muscle strength, and the risk of lower extremity injuries in professional male soccer players. The study found that greater quadriceps concentric peak torque at 300 deg/s was the only strength measure identified as significantly associated with a risk of the lower extremity in multivariate analysis. Greater quadriceps concentric peak torque at 60 deg/s was associated with the risk of overuse injuries, and bilateral adductor strength adjusted for body weight was associated with a lower risk for knee injuries. Therefore, it was concluded that strength testing was not recommended as a screening tool to predict injuries, however, it is possible to intervene with strength training to reduce lower extremity injuries in soccer.

  Cohen et al (2015) evaluated the effect of simulated soccer on the hamstring's eccentric torque-angle profile and angle of peak torque, and on the hamstrings: quadriceps torque ratio at specific joint angles. The dominant-limb isokinetic concentric and eccentric knee

flexion and concentric knee extension before and after they completed the Loughborough Intermittent Shuttle Test (LIST). Eccentric hamstring peak torque declined significantly, but there were no significant changes in hamstrings or quadriceps concentric peak torque. The findings of the study suggested that injury-risk screening could be improved by evaluating the eccentric hamstrings torque-angle profile and hamstrings strength-endurance, and therefore the development of hamstrings fatigue resistance and long-length eccentric strength may reduce injury incidence.

- **Stretching exercises**

  In a study done by Azuma and Someya (2020), they assessed injury prevention effects of stretching exercises performed by physical therapists in male high school soccer players. The intervention group showed improvements in heel-buttock distance, straight leg raises and hip rotation angles, and it also showed significant improvements in ankle dorsiflexion angles. This study concluded that: instructed stretching exercises that are designed by physical therapists to address muscle tightness, improved the range of motion and trunk flexibility, which ultimately has a positive effect on the injury rate among male high school soccer players especially for non-contact injuries.

  De Castro et al (2013) conducted a randomized clinical trial to assess decreased hip rotation and the influence of stretching exercises on the behaviour of the hip joint in youth players. Over the years of focusing on the management of anterior cruciate ligament injuries which is one of the most common soccer-related injuries, it has been concluded that soccer players have a wide range of variation in joint biomechanics. This has resulted in research switching focus on the morphological factors that could contribute to anterior cruciate ligament trauma. One of those factors is decreased hip-rotation range of motion which may be due to compensatory musculoskeletal changes occurring in response to longstanding soccer practice from childhood. Adherence to stretching exercises may decrease the harmful effects

- **Ankle taping**

  Best et al (2014) investigated the preventive residual mechanical effectiveness usage of adhesive elastic ankle tape after a nonlaboratory realistic soccer-specific outfield intervention reflecting soccer halftime. They found that tape restricted the maximum passive inversion range of movement of the uninjured ankle significantly to 50.3%, however, the protection declined after 45 minutes of outfield soccer performance.

Forbes et al (2013) did a study to illustrate the effects of tape and brace on selected proprioceptive components and range of motion before, after, and during a soccer-match-simulation protocol. The application of prophylactic support significantly decreased the active range of motion in plantarflexion and inversion with the tape performing better than the brace. However, the tape lost its restrictive benefits by 15 minutes. The study concluded that the clinical usefulness of ankle-joint prophylactic support is limited if the aim is to restrict the range of motion and improve proprioceptive capability under soccer-specific conditions.

- **FIFA 11**

  Krist et al (2013) investigated if an injury prevention program, which is also known as the FIFA 11, consisting of 10 exercises designed to improve stability, muscle strength, coordination, and flexibility of the trunk, hip, and leg muscles, if it is cost-effective in adult male amateur soccer players. Results of the study showed no significant differences in the proportion of injured players and injury rate between the two groups, however there were statistically significant cost differences in favour of the intervention group.

  Van Beijsterveldt (2012) did a study to investigate the effect of the FIFA 11 injury prevention programme on injury incidence and injury severity among male amateur soccer players. Injury incidences were almost equal between the two study groups and therefore concluding that there were no significant differences in the overall injury incidence and severity between the intervention and control groups.

- **FIFA 11 + warm-up program**

  Daneshjoo et al (2012) conducted a study that aimed to investigate the effect of FIFA 11+ and HarmoKnee injury preventive warm-up programs on conventional strength ratio, dynamic control ratio, and fast/slow speed ratio in young male professional soccer players. The conventional strength ratio and the fast/slow speed ratio in the quadriceps of the non-dominant leg increased by 8% in the FIFA 11+. Improvement of the conventional strength ratio and fast/slow speed ratio by the FIFA 11+ has the potential to prevent knee injuries among soccer players.

  Grooms et al (2013) investigated the effects of a soccer-specific warm-up program which is (F-MARC 11+) on lower extremity injury incidence among male collegiate soccer players. The study had a reduction in injury rate, relative risk of lower extremity injury and

time lost due to lower extremity injury. The (F-MARC 11+) program reduces the d overall risk and severity of lower extremity injuries compared with the control group.

Silvers-Granelli et al (2015) examined the efficacy of the FIFA 11+ program in men's collegiate United States National Collegiate Athletic Association (NCAA) Division I and Division II soccer. The FIFA 11+ significantly reduced injury rates by 46.1% and decreased time loss to injury by 28.6% in competitive male collegiate soccer players.

Silvers-Granelli et al (2017) commenced investigating if the FIFA 11+ injury prevention program can reduce the overall number of ACL injuries in men who play competitive college soccer whether there was any reduction in the rate of ACL injuries based the on game versus practice setting, player position, level of play or field type. A lower proportion of athletes in the intervention group experienced knee injuries compared with the control group including ACL injury. Therefore, the study concluded that the FIFA 11+ program has the potential to decrease the rate of ACL injury in competitive soccer players.

- **Preseason preparation**

  Mansfield et al (2018) did a commentary study to make recommendations for the prevention of non-contact lower limb injuries among Major League Soccer (MLS) players regarding the proposed league expansion. The lengthening of the regular season in conjunction with an addition of MLS teams from 14 to 19 teams from the 2008 through to 2012 led to increased injury rates in games compared to practice sessions with many injuries occurring later in the season. The study recorded that current evidence suggests the implementation of proper preseason preparation, one game per week frequency and implementation of injury prevention strategies would best promote player health and well-being.

- **Running mechanics**

  Schuermans et al (2016) did a study aimed to objectify the importance of lower limb and trunk kinematics during full sprint in hamstring injury susceptibility. Injury occurrence was associated with higher levels of anterior pelvic tilting and thoracic side bending throughout the swing phases of sprinting, whereas no kinematic differences during running were found when comparing players with a recent hamstring injury history with their matched controls. Although sprinting encompasses a relative risk of hamstring muscle failure in every athlete, running coordination is demonstrated to be essential in hamstring injury prevention.

- **Higher chronic training loads**

  In a study done by Malone et al (2017), they investigated the association between high-speed running (HSR) and sprint running (SR) and injuries among elite soccer players. The study also investigated the impact of intermittent aerobic fitness and high chronic workloads as potential mediators of injury risk. Players who completed moderate high-speed running were at reduced injury risk compared to low high-speed running. Injury risk was higher for players who experienced large weekly changes in high-speed running and sprint running. The study also concluded that higher chronic training loads and better intermittent aerobic fitness offset lower limb injury risk associated with these running distances in elite soccer players.

- **Bounding exercise programme**

  Van de Hoef et al (2018) determined the preventive effect of the Bounding Exercise Program (BEP) on hamstring injury incidence and severity in adult male amateur soccer players. Out of 400 players, there were analysed, there were 57 players sustained 65 hamstring injuries but there were no statistically significant differences in hamstring injury incidence or severity between the two groups. Therefore, the study concluded that there is no evidence found for plyometric training in its current form to reduce hamstring injuries in amateur soccer players.

- **Strength, balance, mobility training, core stability & multicomponent programs**

  Perez-Gomez (2020) did a study to review the physical exercise training programs that have been effective in lowering the incidence of injuries among male football players. A total of 2512 studies were identified initially but only 11 studies met the inclusion criteria. Injury prevention programs in football have focused on strength training, proprioceptive training, multicomponent programs, core stability and warm-up programs and are effective in lowering injury rates among male footballers.

4.3.6 Presentation of results

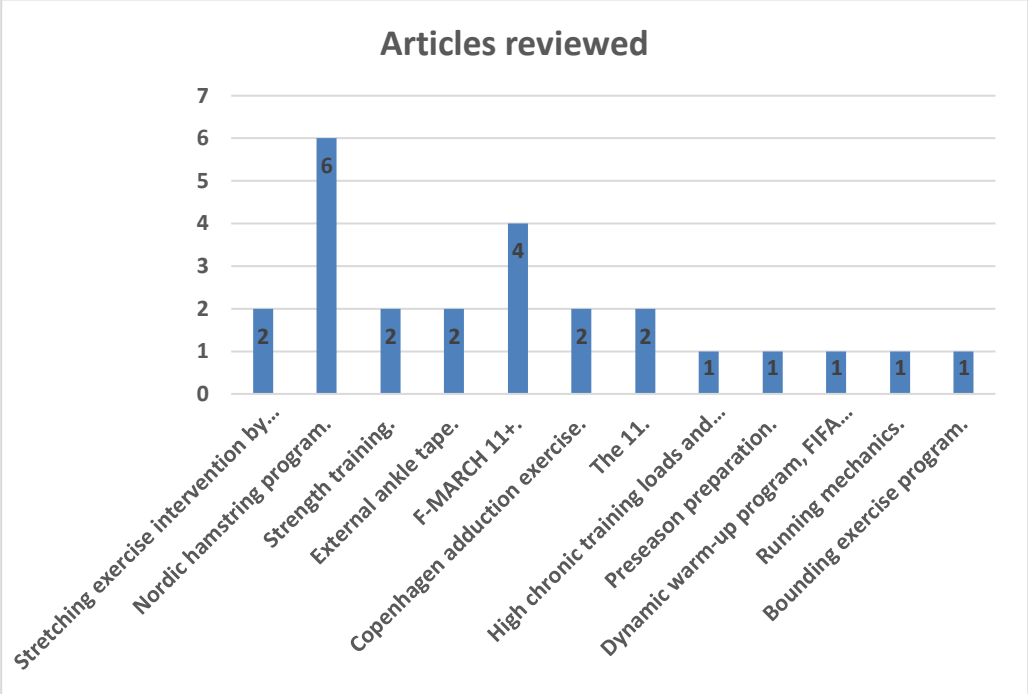


Figure 4. 2 Bar chart presentation of results.

25 articles were reviewed, and 12 themes emerged from a different number of articles there were reviewed: Nordic hamstring exercises from six studies, Copenhagen adduction exercise from two studies, muscle strengthening emerged from two articles, stretching exercises from two articles, ankle taping emerged from two studies, FIFA 11 programme from two articles, FIFA 11+ warm-up programme from 4 studies, preseason preparation from one study, running mechanics from one study, higher chronic training loads from one study, bounding exercise program from one study and strength, multi-component programmes emerged from one study.

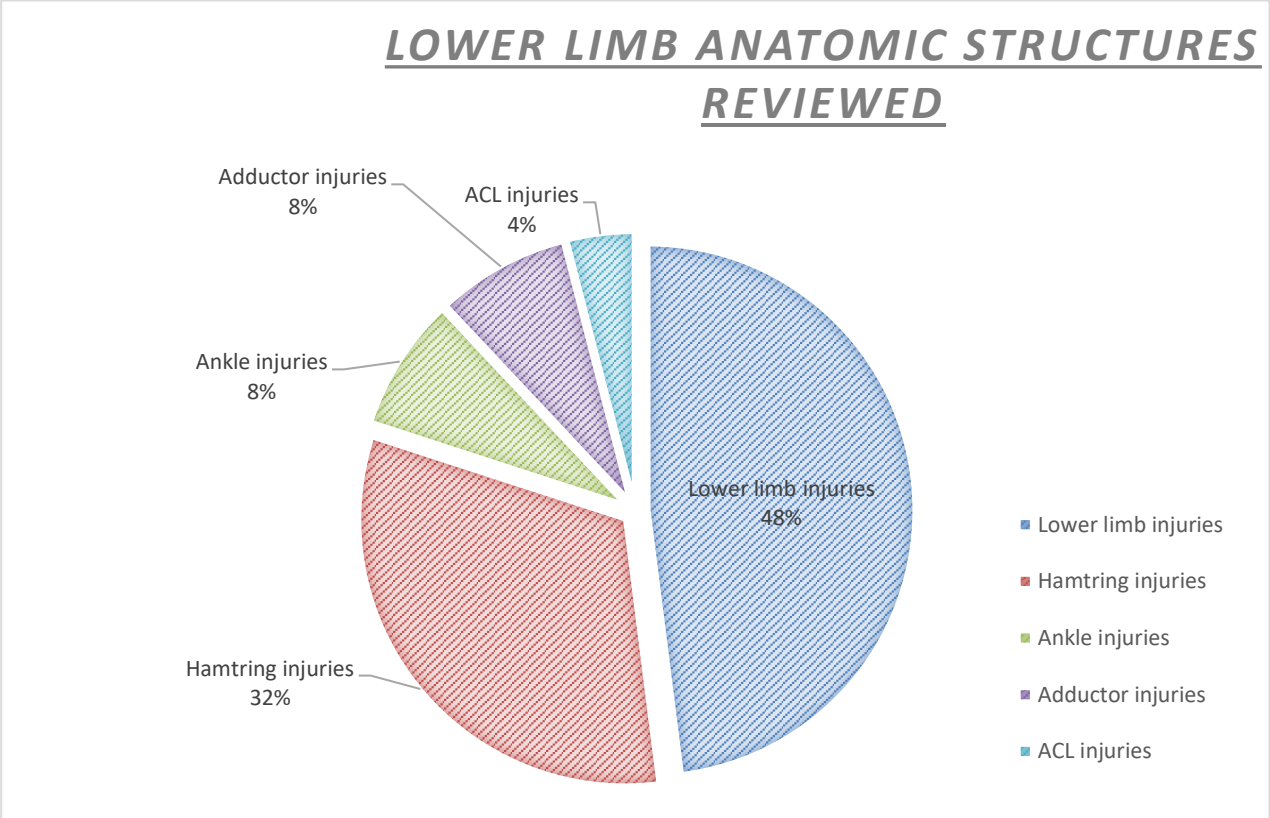


Figure 4. 3 Pie-chart of the lower limb anatomic structures reviewed.

The included reviewed articles on preventative strategies for non-contact lower limb injuries among male footballers targeted the following anatomic structures: eight percent of the articles were on ACL, adductor muscle injuries, and ankle injuries, 32% were on hamstring injuries, and the other 48% of the studies focused on the whole lower limb for injury prevention.

4.3.5 Conclusion

There have been different preventative strategies identified for non-contact lower limb injuries among male footballers with the upper leg having the greatest number of studies found. The number of hamstring prevention strategies found in this review supports the finding by Bezuglov et al (2020) reported that hamstring injuries are continuously increasing, therefore more studies are being done to mitigate the problem. There were no articles found by the reviewer on preventative strategies for injuries of the quadriceps and gastrocnemius muscles.

CHAPTER 5: DISCUSSION

This scoping review aimed at mapping the range of literature relating to preventative strategies implemented to minimise risk factors that are associated with non-contact lower limb injuries among male footballers. Twenty-five articles have been reviewed and 12 preventative strategies emerged from the reviewed articles: Nordic hamstring exercises, Copenhagen adduction exercise, muscle strengthening, stretching exercises, ankle taping, FIFA 11 program, FIFA 11+ warm-up program, preseason preparation, running mechanics, higher chronic training loads, bounding exercise programme and strength, balance, mobility training, core stability and multi-component programmes. Most articles that met the inclusion criteria were conducted in developed countries, and there was only one study that was conducted in South Africa.

Nordic hamstring exercises are one of the intervention strategies used to minimise non-contact hamstring injuries. Of the 25 selected articles, six articles were done on Nordic hamstring exercises, which was the theme in most articles that were found in this review. Hamstring injuries are one of the most prevalent injuries affecting athletes mostly those in team ball sports or track and field sports (Chalker et al., 2018). Five out of six articles reported positive outcomes with the implementation of Nordic hamstring exercises (Bahr et al., 2015; Coratella et al., 2014; Petersen et al., 2011; Raya-Gonzales et al., 2021; Sebelien et al., 2014; Van der Horst et al.,2015). However, one study investigated the implementation of the Nordic Hamstring exercise programme at the highest level of football in Europe and found that the adoption and implementation of the programme are low (Bahr et al., 2015). More studies are needed to examine the barriers and facilitators of adopting this programme since it has produced significant results in decreasing hamstring injury rates among footballers.

The Nordic hamstring (NH) exercise was formerly known as the ‘Russian hamstring exercise’ (Al Attar., 2017). The exercise is performed in pairs with one person executing the exercise and the other holding the other person’s feet. The NH exercise can be easily executed on the pitch or inside the gym without any special equipment. The NH exercise involves one player trying to resist a forward-falling motion from a kneeling position, using the hamstring muscles to maximise loading in the eccentric phase. Clarke et al (2005) suggested that since most hamstring strains occur during eccentric contraction of the hamstring muscles, increased torque in an extended knee position may reduce the occurrence of hamstring strains. A group of scientists from the Oslo Sports Trauma Research Center (OSTRC) hypothesised in their randomized controlled trial that NH could prevent some hamstring strains. The OSTRC group then developed a study to investigate the effect of NH exercise and tested its protocol. The NH exercise produced a large increase in eccentric torque production in week 10 post-training.

Arnason et al. (2008), investigated the effect of eccentric strength training and flexibility training on the incidence of a hamstring strain in soccer players and the study took place in Iceland and Norway. The incidence of hamstring strains was 65% lower in teams that used eccentric training programmes than in teams that used flexibility training programmes alone. In a different study, Brooks et al (2007) studied the effects of the NH exercise on the incidence and severity of hamstring strain among 546 professional rugby union players. The intervention group had a significantly lower hamstring injury rate and severity compared to the strengthening and stretching group. Haroy et al (2017) documented that NH exercise has been reported to prevent hamstring injuries effectively both as an isolated exercise and a part of a warm-up program.

As previously mentioned in the injury prevalence section, a study done by Bezuglov et al (2020), reported that hamstring muscle injuries represent up to 37% of all muscle injuries in soccer players, and this is a number on the increase. Hamstring injuries are the most common non-contact injuries in sports such as soccer, rugby, American football, Australian football, baseball, and cricket (Al Attar., 2017). Hamstring injuries may require treatment and prolonged rehabilitation periods with a high recurrence rate of 12-33% (Al Attar., 2017). Therefore, Nordic hamstring exercises may be beneficial for athletes who participate in sports that require high-speed running loading the hamstring eccentrically. Clinicians may also implement the exercise programme as it does not need any equipment and may be implemented with ease.

The FIFA association and its Medical Assessment and Research Centre developed injury prevention programmes, which were initially named FIFA 11 and then later changed to FIFA 11+ with the addition of the CA exercise (Silvers-Granelli et al., 2015). The objective of developing FIFA 11 and FIFA 11+ was to improve lower limb muscle strength and reduce the rate of different injuries sustained because of participating in football (Silvers-Granelli et al., 2015). The FIFA 11 consists of 10 exercises aimed at improving stability, muscle strength, coordination and flexibility of the trunk, hip, and leg muscles. The review retrieved two articles that met the inclusion criteria of the study that were done on the FIFA 11 programme. Both studies showed no significant differences in injured players and injury rates between the interventions and control groups. More studies are recommended on the FIFA 11 programme to establish the effectiveness and usefulness of the programme among male footballers.

The FIFA 11 programme was modified with the addition of Copenhagen adduction exercises, and the development of a dynamic warm-up programme that addressed major deficiencies that were found to be general to soccer athletes (Silvers-Granelli et al., 2015). It has since been named FIFA

11+ (F-MARCH 11+). There were four studies that were reviewed on the FIFA 11+. The first study found that this programme increased the strength ratio and the fast/slow speed ratio in the quadriceps of the non-dominant leg and therefore the potential to prevent knee injuries among male soccer players. Grooms et al (2013) recorded that the F-MARC 11+ reduced injury rate and time lost due to lower extremity injuries. The other finding by Grooms et al (2013) was that F-MARC 11+ reduced the overall risk and severity of the lower extremity injuries compared to the control group. Silvers-Granelli et al (2017) concluded in their study that the FIFA 11+ programme has the potential to decrease the rate of ACL injury in competitive male soccer players.

The major difference between FIFA 11 and FIFA 11+ is that the latter includes the Copenhagen adduction exercise. However, two articles (Krist et al., 2013; Van Beijsterveldt., 2012) that were included in FIFA 11 did not show significant results between the intervention and control groups. On the contrary, all four studies on FIFA 11+ showed positive outcomes when compared to the control groups. With just one exercise added to the FIFA 11 programme, more studies are recommended to establish why FIFA 11 did not yield positive outcomes and yet FIFA 11+ yielded positive outcomes. Compliance with FIFA 11 could have been one of the contributing factors to yielding non-significant results and there could be other unknown barriers to the studies that may have not been documented.

Both FIFA 11 and FIFA 11 + programmes have been evaluated among both sexes; in recreational and amateur and semi-professional soccer; and in court-based sports such as basketball (Longo et al., 2012). Longo et al (2012) did a cluster randomised controlled trial among male basketball players. The aim of the study was to determine if the FIFA 11 + programme was effective in reducing the rates of injury in male basketball players. The authors had 11 teams that participated in the study and seven teams were allocated to the intervention and four to the control group. The intervention group had lower injury rates per 1,000 athlete-exposures compared to the control group. The authors reported that the FIFA 11+ warm-up programme was effective in reducing the rates of injuries among male basketball players.

The FIFA 11+ programme has also been shown to be effective in reducing injury rates and incidences in basketball (Longo et al., 2012). This exercise programme was designed in a football environment with the aim of reducing injury rates, but it has also been proven to reduce injury rates among elite basketball players. Sports practitioners may empower their knowledge and skills with this exercise programme as a guideline to reduce injury rates within different sporting codes. However, more studies are recommended to validate the effectiveness of FIFA 11+ among male

basketball players and other elite athletes who participate in sports that require frequent jumping, high-speed running, quick change of direction, etc.

Another preventative strategy that was found in this review was the Copenhagen adduction (CA) exercise. Two studies on CA exercise met the inclusion criteria. The CA exercise is a simple eccentric exercise done with a partner and does not require any equipment (Haroy et al., 2017). In field-based sports such as rugby, soccer, American football etc., weak hip adduction strength has been shown as an intrinsic risk factor for sustaining an adductor muscle injury (Ryan et al., 2014. The CA exercise can be utilised as a high-intensity exercise on the field of play before or after an in-field sports activity to minimise the risk of non-contact adductor muscle injury.

Ishol et al (2015) found that the CA exercise programme increased the EHAD, EHAB strength and the EHAD/EHAB ratio. Bezuglov et al (2020) reported that the second most common lower limb injuries among male footballers are of the adductor muscle of the hip. The exercise programme optimises the length-tension relationship by using eccentric training and therefore minimising the risk of non-contact lower limb injuries. Perez-Gomez et al (2020) reported that eccentric strengthening of the adductor was effective in reducing the risk and prevalence of groin injuries by 41% in male footballers. A study done by Haroy et al (2017) found that adding CA exercise increased the eccentric hip adduction strength and therefore increased the preventative effect of non-contact groin injuries among male footballers.

The adductor muscle injuries have been documented to be the second most common muscle injuries in football (Ekstrand et al., 2011) and the most frequent acute groin injury in athletes (Serner et al., 2015). Preventative strategies to increase eccentric hip adduction strength may be a relevant intervention strategy to minimise the risk of non-contact adductor muscle injuries in football and other in-field sports. Clinicians working with male athletes who participate in in-field sports may include the CA exercise to strengthen the adductors muscles with the aim of minimising risks associated with injuries of these muscles. Ryan et al (2014) found that low adductor strength showed a risk factor for groin injuries in athletes in field-based sports. Therefore adductor strengthening with CA exercise may reduce the risk.

The other preventative strategy found was muscle strengthening exercise. Four articles met the inclusion criteria and identified strength as another preventative strategy. Muscle strength is considered a significant cause of predisposing players to non-contact lower limb injuries (Bakken et al., 2018). The management of sports injuries can be troublesome, time-consuming, and expensive, but prevention in the form of strength training has proved to be accessible, effective,

and cost-effective for populations in sports (Lauersen et al., (2018). The role of muscle strength as a risk factor for non-contact lower limb injuries has been widely discussed (Creaby et al., (2016). Poor or low isokinetic quadriceps and hamstring muscle strength have been associated with the risk of non-contact lower limb injuries, more particularly for acute muscle injuries and knee ligament injuries in team and non-team sports for both male and female athletes (Meyer et al., 2009).

A study done by Bakken et al (2018) found that greater quadriceps concentric peak torque at 60 deg/s was associated with the risk of overuse injuries and bilateral adductor strength adjusted for body weight was associated with a lower risk for knee injuries. In their study, they reported that it is possible to intervene with strength training to reduce non-contact lower extremity injuries among male footballers. However, in a study done by Cohen et al (2015), they evaluated the effect of simulated soccer on the hamstring's eccentric strength. Their findings suggested that the development of hamstring fatigue resistance and long-length eccentric strength may reduce injury incidences. The two studies on muscle strengthening recommend both concentric and eccentric strengthening to minimise injury risk factors among male footballers, whereas studies on Copenhagen and Nordic hamstring exercises put emphasis on eccentric strengthening of the adductor and hamstrings respectively. Therefore, implementing CA strengthening exercises and NH exercises may have a positive effect in reducing non-contact adductor and hamstring injuries respectively among male soccer players. It may also reduce the rate of non-contact lower limb injuries among male footballers and other in-field sporting activities.

Lauersen et al (2018) reported that strength training has been proven to be effective for fall prevention in the elderly, general health gains or other specific musculoskeletal injuries. Coppack et al (2011) introduced a 14-week program that included four daily strength training exercises which were designed to invoke functional concentric and eccentric contractions of the hip and knee extensors to prevent overuse of anterior knee pain (AKP) in military recruits for both genders. Acute sports injuries have been successfully reduced through various mechanisms (Lauersen et al., 2018). Lauersen et al (2018) reported that acute injuries in different in-field sports were successfully reduced by different mechanisms through strength training. Walden et al (2015) achieved a 64% ACL injury reduction by an indirect mechanism focusing on improved core stability, pelvis control and extremity coordination. Therefore strength training shows to be an effective strategy that may be utilised by clinicians working with different populations in different sports to minimise the risk of non-contact lower limb injuries.

Stretching exercises were another preventative strategy found in this review and various articles that were included in the study reported stretching as one of the injury prevention strategies for non-contact lower limb injuries. Stretching before participation in athletic activities is a standard practice for different levels of sports, competitive or recreational (Thacker et al., 2004). There are various methods of stretching to increase flexibility including passive, static, isometric, ballistic and proprioceptive neuromuscular facilitation (Thacker et al., 2004). Effective injury prevention programmes in sports may benefit a wide spectrum of individuals who are participating in any form of exercise (Lauersen et al.,2018).

Recent research has found a strong association between soccer and decreased hip-rotation motion (De Castro et al., 2013). Systematic involvement in soccer is associated with musculoskeletal changes that have an insidious onset and gradual development over the career of the athlete. These musculoskeletal changes have a negative impact on flexibility and may decrease performance or even lead to the premature end of an athlete's career (De Castro et al., 2013).

Azuma and Someya (2020) did a study to assess the injury prevention effects of stretching exercises performed by physical therapists on male high school soccer players. The study comprised male soccer players without injuries at the beginning of the study. The study concluded that instructed stretching exercises that are designed by physical therapists had a positive effect on the non-contact lower limb injury rate among male high school soccer players. This study was limited to high school soccer players from two schools as their study population and therefore more studies were recommended on more and different groups of population of male footballers.

The other study done by De Castro et al (2013) was to assess decreased hip rotation and the effects of stretching exercises among youth players. Research has switched focus on the morphological factors that could contribute to anterior cruciate ligament injuries, and they found that decreased hip-rotation range of motion could have been due to compensatory musculoskeletal changes that occur in response to longstanding soccer activities from childhood. The study concluded that adherence to stretching exercises may decrease the harmful effects that accumulate from childhood because of participating in soccer. However, more studies are needed and recommended on which specific stretching exercises have the benefits of minimising non-contact lower limb injuries.

Stretching is also associated with various adverse effects; therefore clinicians and athletes need to be aware of them. Thacker et al (2004) reported the following adverse effects of stretching: stretching has been associated with temporary strength deficits for up to one hour and increased arterial blood pressure, it has also been associated with adverse effects on jump performance and

plantar flexion, lastly, increased flexibility decreases running economy and peak performance. There are different approaches identified to determine whether the lack of flexibility puts athletes at risk for injury or whether stretching is effective in preventing injury (Thacker et al., 2004). One approach is to assess flexibility specifically to determine whether they are associated with injury. The second approach uses the cohort or case-control methods, and flexibility and stretching are among several risk or protective factors included. Clinicians and athletes may benefit from positive results of minimising non-contact lower limb injuries by implementing stretching exercises. However, adverse effects awareness associated with stretching needs to be made common knowledge.

Ankle taping was found to be one of the many strategies implemented to minimise the risk of non-contact ankle injuries. Prophylactic taping is a popular external stabilizing technique that is used to minimise the risk of ankle injuries during sports (Handoll et al., 2005). It has been shown that tapping may reduce both the incidence and the severity of ankle sprain injuries (Bahr et al., 1997). Taping can limit the excessive range of motion at the tibiotalar, and subtalar joints and it may also increase local proprioceptive output (Beynnon et al., 2001). Taping is increasingly used both in prevention and during treatment or recovery after sustaining ligament injury at all levels of sports activity (Zwiers et al., 2016).

A study by Best et al (2014) investigated the preventive residual mechanical effectiveness usage of adhesive elastic ankle tape. They found that the tape only restricted the maximum passive inversion range of movement to 50.3%, but the protection declined after 45 minutes of soccer performance. Given the above-mentioned results of the study, it has been recommended that ankle taping should be redone during half-time to counteract the decline of tape protection after 45 minutes. However, more studies are needed to investigate the percentage of the protection of ankle tape significantly in reducing non-contact ankle injuries among male footballers, and therefore more cost-effective recommendations for ankle taping.

Forbes et al (2013) illustrated the effects of tape and brace proprioceptive components and range of motion before, during and after a simulated soccer match. The study found that the tape yielded better results including prophylactic support, but it lost its restrictive benefits by 15 minutes. In the study, it has been concluded that the clinical usefulness of ankle-joint prophylactic support was limited if the aim of the tape is to restrict the range of motion and improve proprioceptive capability under soccer-specific conditions. One of the limitations of the study is that it only had two participants and the other limitation was that the study was not done in a real-world setting. More similar studies need to be done in a real-world setting depending on the feasibility of the study to

get more meaningful and applicable outcomes. However, ankle taping limits the motion of the ankle which ultimately increases mechanical stability and therefore minimises the risk of non-contact ankle injury. This effect may be beneficial for athletes who participate in sports to assist with decreasing injury risks for the ankle.

Preseason preparation was one of the strategies found to be implemented to mitigate the risk of non-contact lower limb injuries. There was only one article found that met the inclusion criteria on this topic. MLS expanded their season and increased the number of teams in the league abruptly. This resulted in an increased rate of non-contact lower limb injuries among male soccer players towards the end of the season. The study recommended the introduction of proper prolonged preseason preparations and suggested one game per week frequency. A study done by Gabbett (2004) investigated if diminutions in preseason training loads would decrease the incidence of injuries during training among rugby league players. The study found that training load reductions during preseason may reduce training injury rates in rugby league players and it also resulted in greater improved maximal aerobic power. In consideration of these two studies, prolonged preseason preparation in combination with reduced training loads may be recommended to reduce the rate of injuries among male soccer players. However, studies to reduce training loads during preseason are needed among male soccer players so that the strategy may also be implemented among soccer players.

Schuermans et al (2016) conducted a study with the aim of objectifying the importance of lower limb and trunk kinematics during full sprint in hamstring injury susceptibility. There was only one study on this theme that met the inclusion criteria. The authors of the study concluded that sprinting comprehends some risk of muscle failure among male soccer players, however, improved coordination was demonstrated to be imperative in hamstring injury prevention. Higher chronic training loads was one of the strategies that was found in this review and there was one article that met the inclusion criteria under this theme. Malone et al (2017) investigated the association between high-speed running, sprint running and injuries among elite male soccer players. The study concluded that players who completed moderate HSR and high SR distances were at reduced injury risk compared to those exposed to low HSR and low SR. Given the two mentioned studies and the outcomes, a combined study on running mechanics and high chronic training may be recommended to assist clinicians improve on injury prevention strategies regarding these two components. (This is my recommendation).

Van de Hoef et al (2018) did a study to determine the preventative effect of the bounding exercise program on hamstring injury incidence and severity among adult male amateur soccer players.

Nordic hamstring exercise program has been developed to prevent these injuries but due to poor compliance the effectiveness of this program is limited (Van de Hoef., 2018). Van de Hoef et al (2018) reported that studies suggest the timing of hamstring muscle activation and the timing and amplitude of gluteal and abdominal muscle activation which are important variables for preventing hamstring injuries.

A new functional soccer-specific program called the Bounding Exercise Program (BEP) was developed with the hypothesis that it would reduce hamstring injuries by improving long-term compliance and increasing both eccentric strength and neuromuscular control. However, the study did not show evidence that plyometric training could reduce hamstring injuries among amateur soccer players. The authors reported that the poor ability of the program to produce significant results could have been attributed to the low compliance that was observed in the study. Compliance was recorded to be 71% which was lower when compared to Nordic Hamstring Exercise (NHE) compliance. It has been reported that hamstring injuries are on the rise, and it could be attributed to poor compliance with the NHE. Van de Hoef et al (2018) also reported that BEP did not produce significant results due to poor compliance. Therefore, more studies are needed to assess barriers and facilitators of implementing effective injury prevention strategies that affect compliance with these exercise programs.

Perez-Gomez (2020) did a systematic review of physical exercise training programs that are effective in lowering the incidence of injuries among male footballers. Studies that met the inclusion criteria found the following exercise programs aimed at minimising the risk of non-contact lower limb injuries: strength training, proprioceptive training, multicomponent programs, core stability and warm-up programs. Strength training supports two articles in this review that identified strength training as one of the preventative measures. The multi-component program is contrary to the study that did BEP as it did not show any benefits of the program in reducing hamstring injuries. Core stability is one of the components that Perez-Gomez (2020) found to be effective in the prevention of non-contact lower limb injuries, whereas in this review the was one study that found non-contact lower limb injuries effectiveness of core stability among male footballers, but it was not published in English and was excluded from the study. More studies are recommended on core stability and BEP in preventing non-contact lower limb injuries among male footballers.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

6.1 Conclusions

Non-contact lower limb injuries are a challenge among male footballers. They are conditions that are caused by multifactorial factors which may be intrinsic or extrinsic. This study has identified a range of preventative strategies that are in use within clinical practice to minimise risk factors associated with these non-contact injuries. These strategies include Nordic hamstring exercises, Copenhagen adduction exercises, muscle strengthening, stretching exercises, ankle taping, FIFA 11, FIFA 11+, preseason preparation, running mechanics, higher chronic training loads, bounding exercise program and multicomponent exercise program. Some of these strategies have been found to produce positive outcomes and others did not produce significant results in the selected study of this review.

Considering different dynamics within different teams at different levels, these strategies may be used as a guide in implementing prevention injury programmes among male footballers. The study could not provide comprehensive injury prevention programme strategies due to the diversity of non-contact lower limb injuries among male footballers. Therefore, further injury prevention studies should be done to address other factors that may lead to non-contact lower limb injuries among male footballers to minimise the risk of non-contact injury and re-injury.

6.2 Strengths of this study

The researcher had a research assistant who played a role in assisting with searching for articles, title and abstract review, and full-text review of the initially selected articles from the search strategy. There was a third review when the first and second reviewers disagreed. The data charting process was piloted before the commencement of the actual data charting by the first and second reviewers.

6.3 Limitations of this study

The study included studies implemented on preventative strategies to minimise lower limb injuries irrespective of whether the study yielded significant or not significant results statistically.

6.4 Clinical Recommendations

The study may be used by technical and medical team members of male football teams as a guide in implementing injury prevention programmes for non-contact lower limb injuries among male

footballers in their respective teams. These strategies may be implemented with consideration of external and internal factors that may be affecting their football players.

6.5 Recommendations for Future Studies

A systematic review study is recommended to determine the effectiveness of the included prevention studies in this research report. The other recommendation is to design reliable and valid tools that measure and evaluate the outcomes of the injury prevention strategy implemented within a soccer team. Measuring and evaluating progress helps the clinician plan their programmes and assist in deciding when to modify the programme if there is a need.

REFERENCE LIST

Al Attar, W.S.A. and Alshehri, M.A., 2019, 'A meta-analysis of meta-analyses of the effectiveness of FIFA injury prevention programs in soccer', *Scandinavian Journal of Medicine & Science in Sports*, (29), 1846–1855.

Al Attar, W.S.A; Soomro, N; Pappas E; Sinclair P.J. and Sanders R.H., 2017 'Adding a post-training FIFA 11+ exercise program to the pre-training FIFA 11+ injury prevention program reduces injury rates among male amateur soccer players: a cluster-randomised trial [with consumer summary]', *Journal of Physiotherapy*, (63), 235-242.

Azuma N. and Someya F., 2020, 'Injury prevention effects of stretching exercise intervention by physical therapists in male high school soccer players [with consumer summary]', *Scandinavian Journal of Medicine & Science in Sports*, (11), 2178-2192.

Best, R., Mauch, F., Böhle, C., Huth, J., Brüggemann, P., 2014, 'Residual Mechanical Effectiveness of External Ankle Tape Before and After Competitive Professional Soccer Performance', *Clinical Journal of Sports Medicine*, (24), 51–57.

Brooks, M.A., Schiff, M.A., Koepsell, T.D. and Rivara, F.P., 2007 'Prevalence of preseason conditioning among high school athletes in two spring sports', The American college of sports medicine, (07), 0195-9131.

Calvo-Gonell, A., Pina Romero, J.A., Soler, L.M., 2015. 'Relationship between the Y balance test scores and soft tissue injury incidence in a soccer team', *International Journal of Sports Physical Therapy* (10), 955–966.

Daneshjoo, A: Mokhtar, A.H; Rahnama N; Yusof A, 2012, 'The effects of injury preventive warm-up programs on knee strength ratio in young male professional soccer players. PLoS ON, (12)

De Castro, J.V., Machado, K.C., Scaramussa, K., Gomes, J.L.E., 2013, 'Incidence of Decreased Hip Range of Motion in Youth Soccer Players and Response to a Stretching Program: A Randomized Clinical Trial. *Journal of Sport Rehabilitation* (22), 100–107.

Forbes, H., Thrussell, S., Haycock, N., Lohkamp, M., White, M., 2013, 'The Effect of Prophylactic Ankle Support During Simulated Soccer Activity', *Journal of Sport Rehabilitation* (22), 170–176.

Haroy, J., Thorborg K., Serner, A., Bjorkheim, A., Rolstad, L.E., Holmich, P., Bahr, R., Andersen, T.E., 2017, 'Including the Copenhagen adduction exercise in the FIFA 11+ provides missing eccentric hip adduction strength effect in male soccer players: a randomized controlled trial', *The American Journal of Sports Medicine* (13), 3052-3059.

Krist, M.R., Van Beijsterveldt, A.M.C., Backx, F.J.G., De Wit, A.G., 2013, 'Preventive exercises reduced injury-related costs among adult male amateur soccer players: a cluster-randomised trial [with consumer summary]', *Journal of Physiotherapy* (59), 15-23.

Longo, U.G., Loppini, M., Berton, A., Marinozzi, A., Maffulli, N., Denaro, V., 2012, 'The FIFA 11 program is effective in preventing injuries in elite male basketball players: a cluster randomized controlled trial', *The American Journal of Sports Medicine* (40), 996-1005.

Mansfield, C.J., Ferkovic-Mack, C., Eibensteiner, J., Zwolski, C., 2019, 'A review advocating caution with Major League Soccer expansion and investment in more rehabilitation professionals', Physical Therapy in Sport (37), 190–196.

McCall, A., Carling, C., Davison, M., Nedelec, M., Le Gall, F., Berthoin, S., Dupont, G, 2015 'Injury risk factors, screening tests and preventative strategies: a systematic review of the evidence that underpins the perceptions and practices of 44 football (soccer) teams from various premier leagues'. British Journal of Sports Medicine (49), 583-589.

Mendiguchia, J., Martinez-Ruiz, E., Morin, J.B., Samozino, P., Edouard, P., Alcaraz, P.E., Esparza-Ros, F., Mendez-Villanueva, A., 2015, 'Effects of hamstring-emphasized neuromuscular training on strength and sprinting mechanics in football players', *Scandinavian Journal of Medicine & Science in Sport*s (25), 621–629.

Perez-Gomez J., Adsuar, J.C., Alcaraz, P.E., Carlos-Vivas, J., 2022, 'Physical exercises for preventing injuries among adult male football players: a systematic review [with consumer summary]', *Journal of Sport and Health Science* (1), 115-122.

Naidoo., M.A, 'The Epidemilogy of soccer injuries sustained in a season of a professional soccer team in South Africa., 2007.

Petersen, J., Thorborg, K., Nielsen, M.B., Budtz-Jorgensen, E., Holmich, P., 2011, 'Preventive effect of eccentric training on acute hamstring injuries in men's soccer: a cluster-randomized controlled trial', *The American Journal of Sports Medicin*e (11), 2296-2303.

Raya-Gonzalez, J., Torres, M.L. Beato, M., Rodriguez-Fernandez, A., Sanchez-Sanchez, J., 2021, 'The effects of training based on Nordic hamstring and sprint exercises on measures of physical fitness and hamstring injury prevention in U19 male soccer players', Research in Sports Medicine 2021 Nov 27.

Read, P.J., Jimenez, P., Oliver, J.L., Lloyd, R.S., 2018, 'Injury prevention in male youth soccer: Current practices and perceptions of practitioners working at elite English academies', *Journal of Sports Sciences* (36), 1423–1431.

Ryan, J., DeBurca, N., McCreesh, K., 2014, 'Risk factors for groin/hip injuries in field-based sports: a systematic review', *Br J Sports Med*. (14), 1089-1096.

Sebelien, C., Stiller, C.H., Maher, S.F., Qu, X., 2014, 'Effects of implementing Nordic hamstring exercises for semi-professional soccer players in Akershus, Norway', Orthopaedic Physical Therapy Practice (2), 90-97.

Silvers-Granelli, H., Mandelbaum, B., Adeniji, O., Insler, S., Bizzini, M., Pohlig, R., Junge, A., Snyder-Mackler, L., Dvorak, J., 2015, 'Efficacy of the FIFA 11+ injury prevention program in the collegiate male soccer players', *AM, J. Sports Medicine*, (43) 2628-2637.

Silvers-Granelli, H.J., Bizzini, M., Arundale, A., Mandelbaum, B.R., Snyder-Mackler, L., 2017, 'Does the FIFA 11+ injury prevention program reduce the incidence of ACL injury in male soccer players?', Clinical Orthopaedics and Related Research (10), 2447-2455.

Szymski, D., Krutsch, V., Achenbach, L., Gerling, S., Pfeifer, C., Alt, V., Krutsch, W., Loose, O., 2022, 'Epidemiological analysis of injury occurrence and current prevention strategies on international amateur football level during the UEFA Regions Cup 2019', Archives of Orthopaedic & Trauma Surgery (142), 271–280.

Van Beijsterveldt, A.M.C., Van de Port, I.G.L; Krist, M.R., Schmikli, S.L., Stubbe, J.H., Frederiks, J.E., Backx, F.J.G., 2012, 'Effectiveness of an injury prevention programme for adult male amateur soccer players: a cluster-randomised controlled trial', *British Journal of Sports Medicine*, (46), 1114–1118.

Wilkerson, G.B., Colston, M.A., 2015, 'A Refined Prediction Model for Core and Lower Extremity Sprains and Strains Among Collegiate Football Players', *Journal of Athletic Training (Allen Press)* 50, 643–650.

Zakaria, A.A., Kiningham, R.B., Sen, A., 2015, 'Effects of static and dynamic stretching on injury prevention in high school soccer athletes: a randomized trial', *Journal of Sport Rehabilitation* (3), 229-235.

Zarei, M., Abbasi, H., Namazi, P., Asgari, M., Rommers, N., Rossler, R., 2020, 'The 11+ kids warm-up programme to prevent injuries in young Iranian male high-level football (soccer) players: a cluster-randomised controlled trial [with consumer summary]', *Journal of Science and Medicine in Sport* (5), 469-474.

APPENDIX I: PRISMA-ScR

Topic	No.	Item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Cover page
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	17
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	18
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	21
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	17

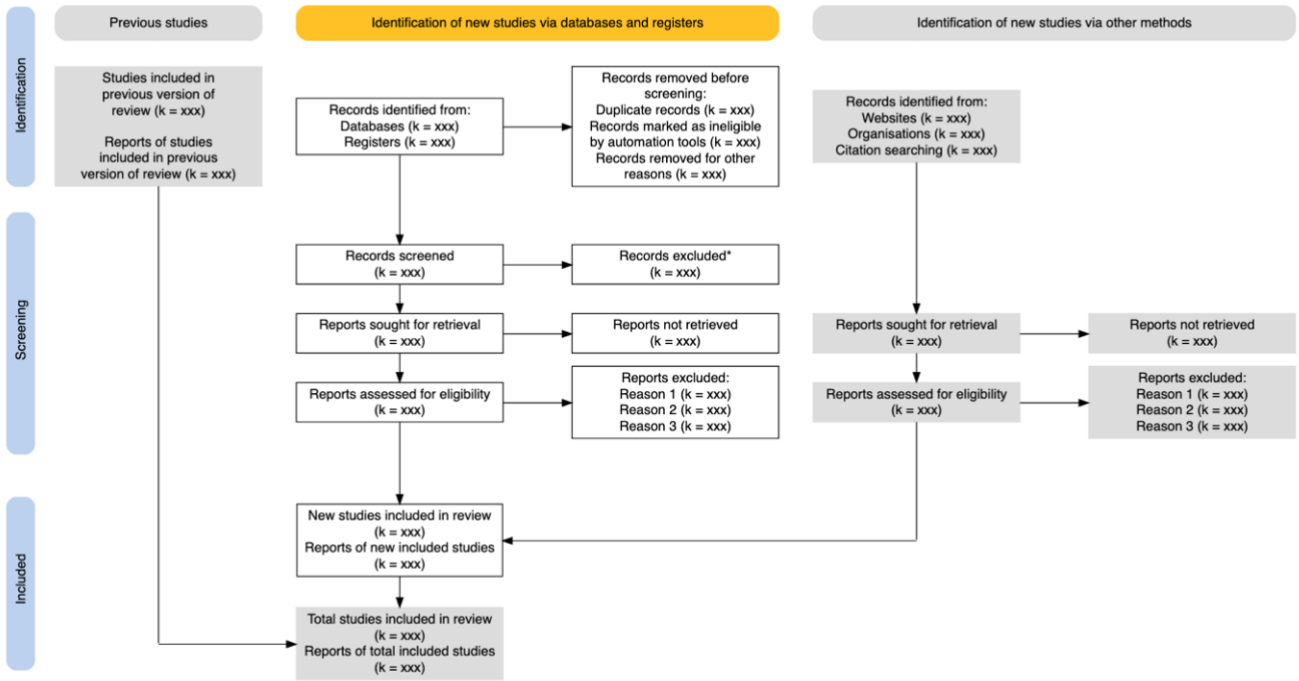
Topic	No.	Item	Location where item is reported
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	17
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	23
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	20
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	N/A
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item 5)).	19
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	20

Topic	No.	Item	Location where item is reported
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	20
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	21
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	N/A
Study characteristics	17	Cite each included study and present its characteristics.	22
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	N/A
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	22

Topic	No.	Item	Location where item is reported
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	N/A
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	49
	23b	Discuss any limitations of the evidence included in the review.	48
	23c	Discuss any limitations of the review processes used.	48
	23d	Discuss implications of the results for practice, policy, and future research.	42
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	16
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	N/A

Topic	No.	Item	Location where item is reported
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	20
Competing interests	26	Declare any competing interests of review authors.	N/A
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	56

APPENDIX II: Prisma Flow Diagram



APPENDIX III: Data charting form

Data items	
Name of the author	Mansfield et al (2019).
Title of study	A review advocating caution with Major League Soccer expansion and investment in more rehabilitation professionals.
Publication	Physical therapy in sport.
Aim of study	The aim of the commentary was twofold: 1) to highlight the expansion goals of Major League Soccer (MLS) in addition to the strategies MLS has previously employed to accommodate additional teams to the league, and 2) to make recommendations for the prevention of injuries among MLS players with respect to proposed league expansion.
Study setting	Online setting.
Study population & sample size	No human participants were included.
Sampling method & size	This study relied on articles published in other leagues with the stats and data available from MLS.
Study design	Commentary review.
Data collection methods	Due to paucity of evidence to assist MLS to make changes to the league, MLS had to rely on articles published in other leagues and other sports while continuing to collect data through its own research
Data analysis	Data analysis revealed that there were 197 of the 256 injuries and resulted in time loss from competition
Conclusion	Findings of the study suggest that the implementation of a proper preseason in addition to the once-per-week game frequency would best promote player health and well-being. Players may have a positive benefit from in-season injury prevention protocol and weekly load monitoring
Outcome	Data from the inaugural MLS season found injury rates were higher in games compared to practice sessions, and more injuries were seen later

Data items	
	in the season. Due to the expansion of MLS, anterior cruciate ligament tears appeared to have increased every year
Most relevant findings	The clinical commentary recommended that the season start early rather than March. It has also been suggested that preseason time may be increase for approximately six weeks. Players, coaches, medical staff, and owners need to be invested in injury prevention as it can affect the team rankings, physical health, and profit
Limitations	The study is a commentary type of study with regards to the expansion of MLS
Comment	With the sudden increase in numbers of teams in the MLS, available data from the league and literature were used as a unit to advocate caution with the expansion of the league and to invest in more rehabilitation professionals. This study highlight the importance of data and record keeping helping and support when we need to intervene

3.9.2

Data items	
Name of the author	Cohen et al (2014).
Title of study	Angle-specific eccentric hamstring fatigue after stimulated soccer.
Publication	International Journal of Sport Physiology and Performance.
Aim of study	To investigate the effect of simulated soccer activity on the hamstrings eccentric torque-angle profile and angle of peak torque and on the angle-specific ratios of eccentric hamstrings to concentric quadriceps.
Study setting	The study was conducted in a laboratory were players participated in a 90-minutes simulated soccer activity called the Loughborough Intermittent Shuttle Test (LIST).
Study population & sample size	Nine male soccer players, age 25.3 plus minus 0.8 years, height 178.8 plus minus 2.9, body mass 77.0 plus minus 3.7 kg were recruited from semi-professional soccer clubs.

Data items	
Sampling method & size	Participants were tested on two separate occasions one week apart for preliminary and main testing.
Study design	Case-control study that consisted of standardized warm-up, thereafter participants performed an isokinetic assessment of hamstrings and quadriceps peak torques with the dominant leg. Then it was followed with 90-minute stimulated soccer activity: the Loughborough Intermittent Shuttle Test(LIST). After the LIST participants repeated the isokinetic tests.
Data collection methods	Participants performed the Multistage Fitness Test which consisted of running between two cones placed 20 meters apart at a progressively increasing speed and controlled by audio bleeps. The final level reached during the test was used to estimate VO2max and the running speed corresponding to 55% and 95% of maximal aerobic speed.
Data analysis	Data analysis was performed using the SPSS statistical software version 19.0. The parametric nature of the data was checked by the Shapiro-Wilk test. An analysis of variance (ANOVA) with repeated measures was used to test the effect of angle and fatigue on angle-specific torques and Hcc:Qconc
Conclusion	The study concluded that selective decrements in hamstrings strength and hamstring-quadriceps strength balance at an angle close to full extension after soccer-specific activity. It also revealed a shift in the eccentric hamstrings angle of peak torque to a less extended position.
Outcome	The LIST resulted in significant decrease in eccentric hamstrings torque at 60°, 50°, and 10°. There was a 21.8% decrease in Hcc:Qconc.
Most relevant findings	Findings of this study suggests that HSS-prevention programs for soccer players and other multiple-sprint should include both exercises that specifically strengthen the hamstrings eccentrically at long lengths. This strategy may ensure adequate angle-specific eccentric hamstrings strength and conditioning to promote hamstring strength-endurance and to minimize high-intensity-activity induced strength decline, more specifically at long lengths.
Limitations	This is a simulated soccer study design to mimic a real football match that consisted of nine male soccer players.

Data items	
Comment	Results of this study emphasise on long-length eccentric strengthening and for the development of hamstrings strength-endurance to minimise the risk of hamstring strain injuries.

3.9.3

Data items	
Name of the author	Schuermans et al (2017).
Title of study	Deviating running kinematics and hamstring injury susceptibility in male soccer players: Cause or consequence?
Publication	Elsevier.
Aim of study	To objectify the importance of lower limb and trunk kinematics during full sprint in hamstring injury susceptibility.
Study setting	The kinematic analysis of the linear acceleration to full speed sprinting was conducted on a 40-meter running track that was surrounded by eight cameras for 3D motion capturing.
Study population & sample size	Thirty soccer players who had a recent hamstring injury that occurred within the past season or two seasons before between the age of 18 and 35 years, and another 30 matched controls were included in the study.
Sampling method & size	In the second half of the 2013 season, 30 soccer players with a recent history and 30 matched controls who were participating in the same amateur league were recruited.
Study design	Cohort study.
Data collection methods	After warming up, all participants were instructed to sprint over a distance of at least 30 meters trying to reach maximal sprinting speed as quick as possible. 3D data collection and step detection were conducted simultaneously throughout the 10m measuring volume.
Data analysis	Joint and segment angle profiles were compared between groups using two-tailed independent t-tests.

Data items	
Conclusion	Sprinting encompasses a relative risk of hamstring muscle failure among athletes, but running coordination demonstrated to be essential in hamstring injury prevention.
Outcome	Injury occurrence was associated with higher levels of anterior pelvic tilting and thoracic side bending throughout swing phases of sprinting. However, there was no kinematic differences during running that were found when comparing players who had a recent hamstring injury history with their matched controls.
Most relevant findings	Clinicians need to appreciate the importance of proper running technique in muscle injury rehabilitation and prevention among soccer players.
Limitations	Sample size for statistical analysis was small and medical records of the injury history of the participants were not obtained from their respective teams.
Comment	The study puts emphasis on running mechanics as a preventative measure as previous studies have identified sprinting as one of the activities leading to hamstring injuries.

3.9.4

Data items	
Name of the author	Van de Hoef et al (2018).
Title of study	Does a bounding exercise program (BEP) prevent hamstring injuries in adult male soccer players?
Publication	Scandinavian Journal of Medicine and Science.
Aim of study	To assess the preventive effect of a functional, soccer-specific BEP on the incidence and severity of hamstring injuries among adult male amateur soccer players.
Study setting	The BEP was investigated in a real-world setting among male amateur soccer players in the first-class amateur league. Players had two training sessions and one match a week during the 39-week soccer season on average.

Data items	
Study population & sample size	Male amateur soccer players aged between 18 and 45 years and playing in a first-class league soccer team.
Sampling method & size	There were thirty-two soccer teams competing in the firs-class amateur league who were randomized into the intervention or control group. Both groups were instructed to perform their regular training program, and the intervention group had a BEP added.
Study design	A cluster-Randomized Controlled Trial.
Data collection methods	Players in the control group received four questions and those in the intervention group received five questions on a weekly basis with regards to the incidence of hamstring and other injuries, training, and match exposure. Questions with exercise compliance were given to the intervention group only.
Data analysis	Data was analysed with the statistical language and software program "R". Due to a total average close to 50% of missing data points from the weekly self-reports, multilevel multivariate imputation by chained equations. was performed to impute missing data for weekly match and training exposure, therefore accounting for the repeated measurement structure of the data by using the mice R-package. Multilevel logistic regression analysis was performed on imputed data to evaluate and test differences in hamstring injuries occurring between the intervention and control groups during the soccer season. Compliance with the program was taken as a covariate in this model.
Conclusion	In this study, there was no evidence found for plyometric training to reduce hamstring injuries among amateur soccer players.
Outcome	There were 57 players who sustained 65 hamstring injuries between both groups. The injury incidence was 1.12/1000 hours in the intervention group and 1.39/1000 hours in the control group. There were no significant difference in hamstring injury incidence or severity between the groups.
Most relevant findings	Compliance is an important factor in reducing the incidence of injuries. However, overall compliance in this study was 71% which is lower to Nordic Hamstring Exercise (NHE) compliance. Lower compliance to

Data items	
	BEP could have been attributed by longer intervention period of the study compared to NHE studies.
Limitations	This was a large-scale intervention study and therefore the researcher could not monitor how effective individual players performed the BEP because of the large number of participants.
Comment	Injury prevention is dependent on multiple factors and when implementing injury prevention strategies, one needs to implement these strategies while monitoring and amending other relevant factors.

3.9.5

Data items	
Name of the author	Silvers-Granelli et al (2017).
Title of study	Does the FIFA 11+ injury prevention program reduce the incidence of ACL injury in male soccer players?
Publication	Clinical Orthopaedics and Related Research.
Aim of study	The aim of this study was to examine if the FIFA 11+ injury prevention program can reduce the overall number of ACL injuries in men who play competitive college soccer and whether any potential reduction in rate of ACL injuries differed based on game versus practice setting, player position, level of play or field type.
Study setting	The study was done in teams that participated in Division I and Division II National Collegiate Athletic Association (NCAA) men's soccer teams in the fall 2021 season.
Study population & sample size	There were 65 institutions consented to participate with the male participants from each institution ranging from the age of 18 to 25 years.
Sampling method & size	Sixty-five teams were randomized using a simple computer-generated randomization were 61 completed the study during the Fall 2021 season (August to December). There were 34 control institutions that had 850 athletes. 17 Division I teams that had 425 players and 17 Division II teams that had 425 players. Twenty-seven teams were intervention

Data items	
	groups that consisted of 675 athletes, of which 16 Division I teams had 400 players and 11 Division II teams had 275 players.
Study design	Cluster randomized controlled trial.
Data collection methods	Participants of the study utilized a secure Internet-based injury surveillance system. Every athletic exposure, injury incurred including ACL injury, mechanism of injury, and date of return to play were recorded weekly by the team's certified athletic trainer. The environmental conditions of the ACL injury were also considered with respect to field type: grass versus artificial turf.
Data analysis	Injury rates were calculated based on athletic exposures and were expressed as a rate per 1000 athletic exposures.
Conclusion	The FIFA 11+ has the potential to decrease the rate of ACL injury in competitive soccer players.
Outcome	There was a lower proportion of athletes in the intervention group who experienced knee injuries compared with the control group. Fewer ACL injuries were reported in the intervention group compared to the control group.
Most relevant findings	Results of the study showed the potential of the FIFA 11+ to decrease the incidence of ACL injuries in competitive collegiate male soccer players by 77%. Therefore, this knowledge can give more insight to help and reduce the rate of ACL injury in male soccer players, improve the efficacy of existing ACL injury prevention protocols and also improve secondary prevention strategies.
Limitations	Limitations of this study include that four intervention teams were lost to follow-up and an intent-to-treat analysis was not feasible.
Comment	ACL injuries are continuously and consistently impacting negatively on our professional athletes globally, therefore mitigating these impacts will be beneficial both for athletes and their prospective teams.

3.9.6

Data items	
Name of the author	Van Beijsterveldt et al (2012).
Title of study	Effectiveness of an injury prevention programme for adult male amateur soccer players.
Publication	Br J Sports Med.
Aim of study	To investigate the effect of The11 injury prevention programme on injury incidence and injury severity in adult male amateur soccer players.
Study setting	High level amateur soccer competitions.
Study population & sample size	Twenty-three teams that participated from two geographically separated districts in Dutch high-level male amateur soccer aged between 18 and 40 years were included.
Sampling method & size	Eleven teams compromising of 223 players were allocated to the intervention group and 12 teams compromising of 233 players into the control group.
Study design	Cluster-randomised controlled trial.
Data collection methods	The Web-Based Injury System (BIS) developed by the Netherlands Organization for Applied Scientific Research (TNO).
Data analysis	Overall injury incidences were almost equal for both groups. There were no significant differences found in injury severity. Other outcomes did not show significant differences between the groups as well excluding the percentage of knee injuries.
Conclusion	The study did not find significant difference in the overall injury incidence or injury severity between the intervention and control groups.
Outcome	There was no significant differences found in injury severity, but a significant difference was observed in the location of the injuries. Players who were in the intervention group sustained significantly less knee injuries.

Data items	
Most relevant findings	There are studies done on The11 to reduce injury rates in various populations, however, its effectiveness has not yet been studied in the largest group of active participants in soccer worldwide for male adult soccer players.
Limitations	Given the settings and methods in this trial, both practical and theoretical reasons made it impossible for randomization to be applied.
Comment	The11 injury prevention programme has been shown to reduce injury incidence in other studies by other studies, however, this study did not find significant results.

3.9.7

Data items	
Name of the author	Sebelien et al (2017).
Title of study	Effects of implementing Nordic Hamstring Exercises for semi-professional soccer players in Akershus, Norway.
Publication	Orthopaedic Practice.
Aim of study	The aim of the study was to examine if Nordic hamstring (NH) exercises decreased injury rates, increased sprinting speed, and increased hamstring and quadriceps muscle strength among semi-professional soccer players.
Study setting	The study took place in adult level three and four semi-professional Norwegian soccer teams.
Study population & sample size	One hundred and nineteen semi-professional male soccer players aged between 18 and 39 years.
Sampling method & size	A computer randomly divided players into two groups, a control group, and a NH group.
Study design	Randomized control trial.
Data collection methods	Members of both groups participated in strength testing using a Cybex 6000, and a 40-m sprint test.

Data items	
Data analysis	Differences in strength that was recorded by the Cybex 6000 and running speed calculated during the 40-m sprint test were collected for analysis at three testing sessions (pre, beginning and mid-soccer season).
Conclusion	There were no significant changes in strength or sprinting speed were found between a control group and an intervention group.
Outcome	There was a significant difference in the number of injuries in the intervention group compared to the control group.
Most relevant findings	The incorporation of the NH exercise protocol into regular practice sessions may or may not be effective in reducing the number of acute hamstring injuries in soccer players.
Limitations	There were several limitations to the study, but one of the limitations was that of the 119 participants who volunteered and completed the injury data section of the study, only 27 were able to complete the testing protocol.
Comment	NH exercises may be used as a preventative strategy to minimize the risk of non-contact hamstring injuries among male soccer players.

3.7.8

Data items	
Name of the author	Silvers-Granelli et al (2015).
Title of study	Efficacy of the FIFA 11+ injury prevention program in the collegiate male soccer player.
Publication	The American Journal of Sports Medicine. (USA).
Aim of study	To examine the efficacy of the FIFA 11+ program in competitive male soccer athletes in the collegiate setting.
Study setting	The study was conducted in the United States National Collegiate Athletic Association (NCAA) Division I and Division II soccer.
Study population & sample size	There were 61 institutions compromising of student athletes who were participating in the NCAA Division I and Division II.

Data items	
Sampling method & size	Thirty-four control institutions consisting of 850 athletes and 27 intervention institutions consisting of 675 athletes.
Study design	Cluster randomized controlled trial.
Data collection methods	Each team gave a roster to be entered into the HealthAthlete injury surveillance system.
Data analysis	Statistical analyses were conducted utilizing the SPSS for Windows version 22.
Conclusion	The study has shown FIFA 11+ to reduce the rate of injury and time loss due to injury in the competitive male collegiate soccer player.
Outcome	The control group had a significantly higher number of injuries per team compared with the intervention group.
Most relevant findings	When the data were stratified by division of play and type of injury, control groups had higher number of game injuries and injury rates respectively compared to the intervention group.
Limitations	The study was conducted over the course of a single NCAA season from August 2012 to December 2012 compromising of 18 games.
Comment	This study has shown the efficacy of FIFA + injury prevention program among collegiate soccer athletes on various factors such as injury type and level of sport.

3.7.9

Data items	
Name of the author	Bahr et al (2015).
Title of study	Evidence-based hamstring injury prevention is not adopted by the majority of Champions League or Norwegian Premier League football teams: the Nordic Hamstring survey.
Publication	Br J Sports Med.
Aim of study	To examine the implementation of the Nordic Hamstring (NH) programme at the highest level of male football in Europe, the EUFA Champions League (UCL), and to compare it to the Norwegian Premier

Data items	
	League, Tippeligaen, where the origin of the NH programme was conducted.
Study setting	The study was conducted in professional football teams from the UCL and Tippeligaen.
Study population & sample size	Fifty professional football teams, 32 from the UCL and 18 from Tippeligaen were invited and recruited to participate.
Sampling method & size	All teams were given a questionnaire based on Reach, Efficacy, Adoption, Implementation and Maintenance framework. The key issues that were addressed related to the implementation of the NH programme during three seasons from 2012 through 2014.
Study design	Retrospective survey.
Data collection methods	Club representatives were provided access to the questionnaire using online survey software.
Data analysis	Data was analysed based on the team's questionnaire responses. Teams were classified as fully compliant, partly compliant, or as non-compliant.
Conclusion	Adoption and implementation of the NH exercise programme at the highest levels of male football in Europe was found to be too low.
Outcome	Adoption and implementation of the NH exercise programme at the highest level of male football was found to be equally low between UCL and the Norwegian Premier League.
Most relevant findings	Teams that participated on the study did not adopt and implement NH with a well-documented effect on both injury and re-injury risks. Instead, these teams preferred to use exercises with no or limited evidence.
Limitations	Recall bias could have been an issue as some medical staff for some teams had changed during the period of the study.
Comment	It has been documented that the rate of hamstring injuries have not decreased over the past decade among male elite footballers. Could it be due to poor implementation of NH exercise that have been shown to reduce the rate of acute non-contact hamstring injuries?

3.9.10

Data items	
Name of the author	Coratella et al (2015).
Title of study	Fatigue affects peak joint torque in hamstrings but not in quadriceps.
Publication	Journal of Sports Sciences.
Aim of study	To evaluate the peak joint torque angle modifications in the hamstrings and in the quadriceps recorded during an isokinetic test before and after a soccer game simulation test.
Study setting	A standardized soccer match simulation setting.
Study population & sample size	Twenty-two healthy male soccer amateur players.
Sampling method & size	All participants were involved in two separate testing sessions namely: the Yo-Yo intermittent recovery test level I and the standardized simulated soccer protocol.
Study design	Case control study design.
Data collection methods	VO2 peak was calculated following the Yo-Yo intermittent recovery test, Loughborough Intermittent Shuttle Test was used as a soccer match simulation and hamstrings and quadriceps peak torque were evaluated using an isokinetic dynamometer.
Data analysis	Pre and post data analysis was performed using SPSS. Primary dependent variable changes and secondary dependent variable changes were analysed.
Conclusion	Greater torque exerted by hamstrings against quadriceps action is moved towards shorter hamstring muscle length. When hamstrings move towards longer muscle length, their ability to resist to quadriceps torque will be impaired.
Outcome	The peak joint torque angle increased indicating movement along the hamstring length-tension curve towards a shorter length both concentrically and eccentrically.

Data items	
Most relevant findings	The higher rate of hamstring strain injuries towards the end of the game could be attributed to a greater fatigability of hamstrings compared to quadriceps.
Limitations	This is a case-controlled study done in a soccer match simulation setting with a study population of 22 participants.
Comment	Trainers and conditioners involved with male footballers may use hamstring lengthening exercise such as Nordic hamstring programme to adapt hamstring length-tension profile towards a safer contraction ability.

3.9.11

Data items	
Name of the author	Malone et al (2017).
Title of study	High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk?
Publication	Journal of Science and Medicine in Sport 21. (Australia).
Aim of study	To determine whether high-speed running (HSR) and sprint running (SR) distances were associated with an increased risk of lower limb non-contact injury in elite football players.
Study setting	The study was done during training sessions and match play session during the 2015/2016 season.
Study population & sample size	Thirty-seven elite soccer players from one elite squad.
Sampling method & size	One elite European soccer team competing in Liga Nos in Portugal.
Study design	Observational Prospective Cohort Study.
Data collection methods	Participants of the study had their running distances collected via global positioning system (GPS) and session rating of perceived exertion collected via a bespoke analysis system.
Data analysis	The study used SPSS Version 22.0 to analyse data. Descriptive statistics for HSR and SR during the season were expressed as mean standard deviation (SD) and 90% confidence intervals.

Data items	
Conclusion	The study has demonstrated a relationship between workload measures and injury risk in elite football players. Football players are at increased risk of injury if they had high cumulative HSR and SR workloads or large week-to-week changes in these workloads.
Outcome	Irrespective of aerobic fitness and training load, players who completed moderate HSR and high SR distances were at reduced injury risk compared to low HSR and low SR groups.
Most relevant findings	Exposing players to large and rapid increases in HSR and SR distances increased the chances of injury risks. However, practical implication of the study has found that athletes who do not have the required physical qualities to tolerate the physical demands of competition are likely to have reduced playing performance and increased injury risk.
Limitations	The study was done in one team over a period of one season, therefore difficult to translate the findings of the study to other teams across different leagues.
Comment	The study collected data from a real-world setting and analysed how the team's training and match sessions had an impact on players injuries. If football players are exposed to higher chronic training loads and better intermittent aerobic fitness, these factors may reduce the risk of lower limb non-contact injuries associated with the running distances.

3.9.12

Data items	
Name of the author	De Castro et al (2013).
Title of study	Incidence of decreased hip range of motion in youth soccer players and response to a stretching program: A randomized clinical trial.
Publication	Journal of Sport Rehabilitation.
Aim of study	To assess decreased range of movement (ROM) in soccer players and determine the stage of body development at which this decrease begins or starts to pose a risk to the athlete.

Data items	
Study setting	The study was done at the university hospital and the researcher recruited male soccer players.
Study population & sample size	There were 216 youth soccer players between the age of 10 and 18 years.
Sampling method & size	The study compromised of youth soccer system of professional soccer teams in Brazil which were subdivided into eight age-specific youth categories. Final sample of 162 athletes were randomly allocated into intervention and control groups.
Study design	Randomized clinical trial.
Data collection methods	Assessment of the hip on subjects measuring the external and internal rotation of both lower extremities using a goniometer was done by two examiners. After 12 weeks of the stretching-exercise program, athletes in both groups underwent measurements of hip rotation to establish if any differences in hip mobility had occurred from baseline.
Data analysis	Qualitative variables were expressed as mean and SD and categorical variables as relative frequencies. One-way and 2-way analysis of variance (ANOVA) for repeated measures and Student t test were used for analysis of within-and between-group differences.
Conclusion	Participating in soccer can restrict rotation ROM of the hip and adherence to stretching exercises may decrease the harmful effects on the hip joints.
Outcome	The outcome of the study suggest that hip-rotation ROM decrease over the years among soccer players. Results of the study sample revealed that stretching program improved only external hip-rotation ROM in the nondominant limb.
Most relevant findings	In this clinical trial, participants in the intervention group followed a program of stretching exercises that was meant to improve flexibility of the external and internal hip rotators with the aim of maintaining arthrokinematics and osteokinematics. Literature is inconclusive as to the end effects of stretching; however other authors maintain that stretching increases articular ROM. Given this hypothesis, the greater the flexibility of the athlete the lower the incidence of injury.

Data items	
Limitations	There were some players who were participating in the study but were lost due to cutting of players in their respective teams characterizing selection bias. There was a greater sample loss in the intervention group compared to the control group.
Comment	More research is needed to investigate if participating in soccer lead to decreased hip ROM and what are the ultimate harmful effects on these soccer players. Thereafter preventative strategies may be investigated and implemented .

3.9.13

Data items	
Name of the author	Haroy et al (2017).
Title of study	Including the Copenhagen adduction exercise in the FIFA 11+ provides missing eccentric hip adduction strength effect in male soccer players.
Publication	The American Journal of Sports Medicine.
Aim of study	To investigate the effect on eccentric hip adduction strength of the FIFA 11 + warm-up program with or without the Copenhagen adduction (CA) exercise.
Study setting	Study took place to their respective teams and physiotherapist working with the included teams conducted warm-up sessions and were not blinded to group assignment.
Study population & sample size	There were 45 football players from two elite male U19 soccer teams.
Sampling method & size	Players were randomly allocated into two different training groups. There were 22 players in the CA group and 23 players in the Nordic hamstring (NH) exercise group.
Study design	A randomized controlled trial.
Data collection methods	All tests were done four days before the first training session in the intervention period (January 2016) and within four days post completion of the last training session (March 2016). Players performed eccentric strength tests and a 20-m sprint test.

Data items	
Data analysis	Outcome variables were analysed according to the protocol principle conducted with a minimum compliance limit set at 16 training sessions.
Conclusion	Including the CA exercise in the FIFA 11+ program increased eccentric hip adduction strength, while the standard FIFA 11+ program does not.
Outcome	Between group analysis revealed a greater increase in eccentric hip adduction strength in favour of the group that was performing the CA exercise. There was no change in eccentric hip adduction within the group that was performing the standard FIFA 11+ program.
Most relevant findings	In a study examining acute groin injuries in sports indicated that kicking and change of direction were the most frequent injury mechanisms for soccer players and it may be hypothesized that the adductor longus is at greatest risk of injury when muscle activity and rate of stretching are maximal in the swing phase of the kick. Therefore, optimizing the length-tension relationship by using an exercise that includes heavy eccentric training may be relevant to prevent adductor injuries.
Limitations	The study included two teams only and it was conducted within in three months in pre-season. Players were not blinded to intervention type and contamination of results could have occurred but reduced to minimum.
Comment	The study has shown that CA exercise improves the eccentric hip adduction strength which can be used as preventative strategy for non-contact groin injuries among footballers.

3.9.14

Data items	
Name of the author	Azuma Nobuhide and Someya Fujiko (2020).
Title of study	Injury prevention effects of stretching exercise intervention by physical therapists in male high school soccer players.
Publication	Scandinavian Journal of Medicine and Science.

Data items	
Aim of study	To examine the prevalence of injury after physical therapy intervention for muscle tightness and injury prevention in male high school players.
Study setting	The study was done in a real-world setting with their respective teams were assessment and intervention was done.
Study population & sample size	There were 124 players from two high schools among the 29 high schools who competed in the national tournament soccer games.
Sampling method & size	Sixty-four players were randomly allocated into the intervention group and 60 players in the control group using a list of serial numbers corresponding to the players.
Study design	A randomized controlled trial.
Data collection methods	Muscle tightness tests of the lower limbs included the heel-buttock distance (HBD), straight leg-raise (SLR), hip joint rotation angle, and ankle dorsiflexion angles under knee joint extension and flexion for both legs.
Data analysis	One of the factors analysed was the difference between the intervention and control groups were compared with respect to the dominant leg side and playing position using the chi-square test.
Conclusion	Stretching exercises that are designed by physical therapists to address muscle tightness, improved the range of motion and trunk flexibility, and had a positive effect on the injury rate in male high school soccer players.
Outcome	The intervention group showed a significant improvement in the HBD , SLR angle, hip rotation angles, and ankle dorsiflexion angles. Injuries were also recorded as significantly lower with intervention during the 40-week observation period.
Most relevant findings	Findings of the study revealed that the beneficial effect of the stretching intervention was particularly strong for non-contact disorder injuries during training and for severe injuries that require a long time to return to play as well.
Limitations	The study compromised of male high school teams from two schools only and injury occurrence may have biases with respect to different

Data items	
	factors such as age, peak-height velocity, bio-landing, competition level etc.
Comment	This study has shown the positive effects of stretching exercises designed by physical therapists to minimize the risk of lower limb non-contact injuries among male high school footballers.

3.9.15

Data items	
Name of the author	Ishoi et al (2016).
Title of study	Large eccentric strength increase using the Copenhagen Adduction exercise in football: A randomized controlled trial.
Publication	Scandinavian Journal of Medicine and Science.
Aim of study	The aim of the study was to examine the effect of an 8-week progressive resistance training program on eccentric hip adduction strength (EHAD) using the CA.
Study setting	The study was conducted in a real world setting in-season (October to December 2014) where each club had a median of 3 football training sessions and a median of 1 match per week. Testing was done in treatment rooms of each football club.
Study population & sample size	Study population comprised of 24 U-19 sub-elite football players.
Sampling method & size	There were two clusters with the intervention consisting of 13 players and 11 players were allocated to the control group.
Study design	Cluster-randomized trial with two clusters only.
Data collection methods	A handheld dynamometer was used to measure EHAD and eccentric hip abduction strength (EHAB). Maximal endurance of the lateral abdominal musculature (LABM) was determined using a side-bridge.
Data analysis	Mean differences in EHAD and EHAB, EHAD/EHAB ratio and LABM were assessed by using a mixed model analysis of variance (mixed ANOVA) to test for interaction between the intervention and control groups.

Data items	
Conclusion	Increased eccentric hamstring strength has previously been shown to decrease the rate of hamstring injuries in football, therefore the large increase in EHAD therefore shows the ability of prevention of the adductor-related groin injuries in football.
Outcome	The results showed that an 8-week supervised resistance training program produced significant increase in EHAB, EHAB and an improvement in EHAD/EHAB ratio.
Most relevant findings	Optimizing the length-tension relationship using eccentric training may be relevant in the prevention of non-contact adductor injuries. It has also been found that resistance training performed in a fatigued state, i.e., following football training, may counteract the influence of fatigue.
Limitations	The study only consisted of two clusters and therefore it may be considered as a small study susceptible to the researcher not being able to control for potential confounding factors such as differences in football training between the clubs.
Comment	More studies on increasing eccentric hip adduction strength need to be done on more clusters to compare results of these studies.

3.9.16

Data items	
Name of the author	Bakken et al (2018).
Title of study	Muscle strength is a poor screening test for predicting lower extremity injuries in professional male soccer players.
Publication	The American Journal of Sports Medicine.
Aim of study	To assess whether hip and thigh muscle strength are associated with an increased risk for lower extremity injuries in professional male soccer players. Secondarily, the researcher assessed whether muscle strength represented a risk factor for acute lower extremity injuries, overuse injuries of the lower extremities or knee injuries.
Study setting	The study took place in a real-world setting where first division soccer teams in Qatar were invited to participate in the study. Testing was

Data items	
	done at Aspetar Orthopaedic and Sports Medicine Hospital in Doha, Qatar.
Study population & sample size	The study had professional male soccer players from 14 teams in Qatar.
Sampling method & size	There were a total pf 369 players who completed strength tests and had registered injury and exposure data.
Study design	Case-control study.
Data collection methods	Data was collected by testing concentric and eccentric quadriceps and hamstring isokinetic peak torques, eccentric hip adduction and abduction forces and bilateral isometric adductor forces using a handheld dynamometer.
Data analysis	Cox regression analyses was used to examine the relationship between any lower extremity injury with muscle strength scores and other potential risk factors such as anthropometric data, player position, previous injury, time of the season and the dominant leg.
Conclusion	The study identified a weak association with the risk of lower extremity injuries for two strength variables: quadriceps concentric muscle strength at high and low speeds. These associations were found to be too small to identify the individual player at risk of injuries.
Outcome	The main finding of the study was that only 2 strength variables of 20 examined participants, greater quadriceps concentric muscle strength at (1) high and (2) low speeds, were associated with an increased risk of lower extremity injuries.
Most relevant findings	Results of the study suggest that muscle strength testing is not useful as a screening tool to identify the individual players at risk of injuries, however it does not mean that clinicians may not use muscle strength testing in preseason screening. It has been documented that it is possible to intervene with strength training to reduce lower extremity injuries in soccer.
Limitations	Medical staff responsible for injury and exposure reporting were not blinded to the muscle strength scores. The other limitation to the study was that the researcher did not control for the preventative measures

Data items	
	that may implemented based on the player's strength score during the study period.
Comment	The findings of the study suggest that strength testing is a poor predictor of injury risk among soccer players, however it does not conclude that strength training should not be used as an intervention to reduce lower extremity injuries in soccer.

3.9.17

Data items	
Name of the author	Perez-Gomez et al (2020).
Title of study	Physical exercises for preventing injuries among adult male football players: A systematic review.
Publication	Journal of Sport and Health Sciences.
Aim of study	The aims of the study were to (1) focus on physical exercise factors influencing injuries, (2) identify injury prevention programs and intrinsic factors related to injuries that have been described in the literature, and (3) establish some recommendations for coaches and physical fitness trainers that might reduce the overall number of injuries among adult male football players.
Study setting	Online setting on two different databases.
Study population & sample size	The study had 11 articles that consisted of professional or amateur male football players that were included in the review.
Sampling method & size	There was a total of 2512 studies that were initially identified but 11 studies met the inclusion criteria,
Study design	A systematic review.
Data collection methods	Relevant studies were identified in the PubMed and EMBASE electronic databases and was conducted up to the 24 January 2020. The selected articles were searched using the terms "soccer" AND "injury" AND "prevention". The search and selection were performed by two independent reviewers.

Data items	
Data analysis	Data of the results was analysed with a table that consisted of: the study, exercise program duration, frequency, sample, age and conclusion.
Conclusion	Based on the results from the analysed studies, football players can lower the incidence of match and training injuries by participating in dynamic warm-up programs that include preventive exercises before games or during training sessions, and by adding strength, balance, and mobility training to the training sessions.
Outcome	There were 2512 studies that were initially identified in the two databases. After removing duplicates, a total of 1597 articles were screened. After reading the titles and abstracts, 1505 articles were excluded in the study. The remaining 92 full-text articles were read and assessed for eligibility, and 81 did not meet eligibility criteria and were excluded. Therefore, 11 articles were included in the review. Results of the study showed that injury prevention programs in football include strength training, proprioceptive training, multicomponent programs such as: balance, core stability and functional strength and mobility, and warm-up programs.
Most relevant findings	Given the scientific research analysed in this review, the researcher has recommended the following exercise prescription to reduce injuries among adult male football players: (1) incorporate 15-20 min of a dynamic warm-up program into the training regimen (the FIFA 11+), (2) perform 2-3 sets of 5-12 repetitions of an eccentric exercise such as NHE, and (3) perform balance, mobility and strength training at least twice a week during football training sessions.
Limitations	The review searched only two databases and it could have missed other relevant studies from different databases.
Comment	In the review, different components of injury prevention such as warm-up, strength training, balance and mobility have been shown to reduce the number of non-contact injuries among male footballers. The study has also recommended exercise frequency and repetitions; however it should be taken as a guide for a specific group one is working with.

3.9.18

Data items	
Name of the author	Petersen et al (2011).
Title of study	Preventive effect of eccentric training on acute hamstring injuries in men's soccer.
Publication	The American Journal of Sports Medicine.
Aim of study	To investigate whether a 10-week training program using the Nordic hamstring exercise could lower the incidence of new and recurrent acute hamstring injuries in the soccer season, and lead to less severe hamstring injuries compared with no additional hamstring exercises.
Study setting	Real-world setting were the study that was introduced in the midseason break because that was the only time of the year in which the unaccustomed exercise did not conflict with the competition season according to the researcher.
Study population & sample size	There were 50 Danish male professional and amateur soccer teams that had 942 players.
Sampling method & size	Intervention group had 461 players and control group had 481 players. Players who were allocated to the intervention group conducted a 10-week progressive eccentric training program, whereas players in the control group followed their usual training program.
Study design	Cluster randomized controlled trial.
Data collection methods	A standardized injury registration form was designed for this trial to collect data. The injury type was recorded so that contusion injuries could be excluded. The time until the injured player returned to full participation was also registered for all the players who had time-loss injuries.
Data analysis	The incidence of hamstring injuries in the Danish professional soccer were estimated at 14% based on data from Danish men's professional soccer teams. Cluster-specific statistical methods were used because clubs and not players were randomized.
Conclusion	Additional eccentric hamstring exercises decreased the rate of overall, new, and recurrent acute hamstring injuries among male professional and amateur soccer players.

Data items	
Outcome	A total of 67 acute hamstring injuries, 44 new and 23 recurrent injuries, in 67 players were registered. There were 15 injuries in the intervention group (12 new and 3 recurrent injuries) and there were 52 injuries in the control group (32 new and 20 recurrent injuries).
Most relevant findings	The eccentric training program was found to be effective in reducing the injury rate of new hamstring injuries by more than 60% and that of recurrent injuries by approximately 85%.
Limitations	Limitations of the study are, no record of compliance for the intervention group after the first 10 weeks, and that the trial was conducted as an open study with no blinding of the study participants. The researcher reported the number of injuries independent of exposure time which could be another limitation.
Comment	The perspective of this trial recommends implementation of eccentric strengthening of the hamstrings to minimize the risk of injury. This exercise is easy to be done, does not require equipment and it is cost-effective, technical and support staff working with male soccer players should be encouraged to adopt this program and implement it in their training programs.

3.9.19

Data items	
Name of the author	Krist et al (2013).
Title of study	Preventive exercises reduced injury-related costs among adult male amateur soccer players: a cluster-randomised trial.
Publication	Journal of Physiotherapy.
Aim of study	To evaluate if an injury prevention program consisting of 10 exercises designed to improve stability, muscle strength, co-ordination, and flexibility of the trunk, hip, and leg muscles was cost effective in adult male amateur soccer players.
Study setting	A real-world setting of two regional competitions from different regions of the Netherlands.

Data items	
Study population & sample size	The study included 23 teams from two first-class competition which is the second-highest Dutch amateur level. These teams comprised of 479 participants.
Sampling method & size	Eleven teams that entailed 236 participants were randomly allocated to the intervention group and 12 teams that had 243 participants in the control group.
Study design	Cluster-randomised controlled trial.
Data collection methods	All injuries that occurred during the season were recorded weekly in a web-based injury registration system by the paramedical staff of the team.
Data analysis	An intention-to-treat protocol was adopted for the analysis of differences in effects and costs between the two groups. Chi-square analysis was used to analyse the differences in the proportion of injured players between the groups.
Conclusion	Exercises in the intervention group failed to significantly reduce the number of injuries in male amateur soccer players within one season, but significantly reduced injury-related costs. The findings of the study suggest that the intervention program reduces the costliness of the injuries, which may be due to the preventive effect on knee injuries.
Outcome	The study revealed that the injury prevention program, The11, reduced the costs associated with soccer injuries among Dutch adult male amateur soccer players. On the contrary, the prevention program failed to reduce the number of injuries in the intervention group significantly.
Most relevant findings	There was a significantly lower proportion of knee injuries found in the intervention group compared to the control group, where the knee was the most frequent injury location in the control group. Knee injuries are often associated with lengthy and costly rehabilitation leading to high expenditure for medical care and substantial costs due to productivity losses.
Limitations	The study had limitations in relation to their cost recording method. Healthcare use and productivity losses associated with injury were reported on the recovery form that was completed after the player's full

Data items	
	recovery. This could have led to recall bias for injuries with a long and costly rehabilitation period. Another identified limitation was missing cost data because of the incomplete recovery forms and some completely missing recovery forms. The other limitation was that the study was performed from a societal perspective and did not include direct non-health costs in this economic evaluation. Direct non-healthcare costs consist of traveling expenses, cost for patient time or family members time, and other related costs.
Comment	Prevention of knee injuries have been found to significantly reduce costs related to sport injuries in male soccer players. The results suggest that knee injuries pose a threat on the medical expenditure compared to other injuries of the lower limbs.

3.9.20

Data items	
Name of the author	Best et al (2014).
Title of study	Residual mechanical effectiveness of external ankle tape before and after competitive professional soccer performance.
Publication	Clinical Journal Sport Medicine.
Aim of study	The aim of the study was to quantify the distinct mechanical inversion restriction of ankle tape before and after a realistic amount of competitive professional soccer performance and therefore discuss the presupposed gain of adhesive tape in preventing ankle injuries among professional soccer athletes.
Study setting	The study was done in a laboratory to take measurements and participants performed a 45-minute soccer-specific field intervention on a natural grass pitch with the rest of their team.
Study population & sample size	There were 17 professional male premier league outfield soccer players were included in the study.

Data items	
Sampling method & size	There was one group of soccer players who were investigated before and after a 45-minute soccer-specific field intervention.
Study design	A prospective nonrandomized test-retest design.
Data collection methods	Players were initially tested with the inversion apparatus before their training session without any tape protection. After the application of the ankle tape, all players were retested after 3 minutes of normal walking which was referred to as pre-test. After walking over the pitch, players participated in the soccer-specific training program. Thereafter, after 45 minutes of training, players were tested again while wearing the used tape and it was followed by a final retest without the tape.
Data analysis	The mean inversion-ROM decreased from 14.0-degree angle to 7.0-degree angle after tape application. The results reflects a statistically highly significantly decrease in ROM decline of 50.3%. Ankle inversion range of motion was found to have increased significantly after 45 minutes of soccer performance from 7.0-degree angle to 12.6-degree angle. The results reflects 90.3% Inversion-ROM of the primarily untapped scenario.
Conclusion	The initial significant protection of the external ankle-tape support was found to have declined almost completely without relevant remaining residual mechanical effect after 45 minutes, which reflects a soccer halftime.
Outcome	Tape restricted the maximum passive inversion ROM of the uninjured ankle significantly to 50.2 %. However, the protection of the tape declined nearly completely after 45 minutes of outfield soccer performance to a nonsignificant ROM restriction of 9.7%.
Most relevant findings	Findings of the study suggests that ankle tape does not assure a protective mechanical effect against ankle sprains over the period of a soccer halftime. These results implies that tape would have to be renewed at least twice per match, after warming up and halftime, to increase its preventive benefit.
Limitations	The study was monodirectional instead of a multidirectional recording of ROM; for an example, simultaneous recording of plantar flexion

Data items	
	would have allowed a better 3-dimensional evaluation of the ankle joint kinematics as plantar flexion increases the injury risk.
Comment	In deep view of the results of the study, irrespective of the loss of protective mechanical effect of external tape against ankle sprains after 45 minutes, more studies need to be done to evaluate the frequency and the severity of ankle sprains post halftime. Studies may be done in comparison to soccer players who play soccer without external tape.

3.9.21

Data items	
Name of the author	Grooms et al (2013).
Title of study	Soccer-specific warm-up and lower extremity injury rates in collegiate male soccer players.
Publication	Journal of Athletic Training.
Aim of study	To assess the effect of a sport-specific program implemented with athletic trainer supervision to track compliance, injury occurrence, and program performance quality.
Study setting	The study was done in a real-world setting within a one American collegiate soccer team followed for two seasons.
Study population & sample size	Study comprised of 41 male collegiate athletes between the age of 18-25 years.
Sampling method & size	The 2009 season players served as the control group whereas the players in the 2010 season were in the intervention group.
Study design	Single-cohort study design.
Data collection methods	Compliance with the training program was tracked at every in-season practice and game by the attending athletic trainer.
Data analysis	Mean time loss associated with lower extremity injury between group was examined with an independent t test and a priori alpha level set at P less than or equal to 0.05. The secondary analysis was performed

Data items	
	between the seasons analysing players who participated in both seasons.
Conclusion	The F-MARC 11+ program reduced overall risk and severity of lower extremity injuries compared with the control group in collegiate male soccer athletes.
Outcome	The 2010 intervention group demonstrated a lower extremity injury rate compared to the 2009 control group. The control group lost 291 days to injury whereas the intervention season lost 52 days to injury.
Most relevant findings	There were no ACL injuries or other severe internal knee derangements occurred during either season. Thigh muscle strains were the most common injury in both seasons. Muscle strains accounted for 217 days lost in the control season and only 10 days lost in the intervention season. Thigh muscle strains occurred 10 times in the control season and one time in the intervention season.
Limitations	The study took place at a single NCAA Division III institution with one male collegiate soccer program. The researcher did not account for previous injuries or other potential predisposing factors for injury in either year. Participants were included regardless of injury history. The F-MARC 11+ is a multifaceted program that limits the ability to identify any particular section of the intervention program that could be more effective for injury prevention.
Comment	The F-MARCH 11+ program is effective in preventing lower extremity injuries; however, its effectiveness is not specific on which muscle groups and joints does it have this positive outcome.

3.9.22

Data items	
Name of the author	Forbes et al (2013).
Title of study	The effect of prophylactic ankle support during simulated soccer activity.
Publication	Journal of Sport Rehabilitation.

Data items	
Aim of study	The aim of the study was to illustrate the effects of tape and brace on selected proprioceptive components and ROM before, during and after a soccer-match-simulation protocol.
Study setting	Soccer-Specific Aerobic Field Test (SAFT) that was performed in a laboratory.
Study population & sample size	Ten male amateur soccer players were recruited but two were forced to withdraw from the study due to injuries sustained during their continued normal football activity.
Sampling method & size	Eight male amateur soccer players who volunteered to participate in the crossover study design were actively participating in soccer training and games at least twice a week and had a dominant right foot that was used for testing.
Study design	A crossover study design.
Data collection methods	ROM at the ankle in the directions of planter flexion (PF) and inversion (INV) was measured in a seated non-weight-bearing (NWB) position using a goniometer. Ankle JPS in the sagittal plane was tested by the recreation of angles in weight-bearing (WB: unilateral standing) and NWB seated positions.
Data analysis	The researcher utilized the SPSS version 16 to perform a mixed-model analysis of variance which considered time and conclusion using a SIDAK correction.
Conclusion	Findings of the study suggest that under high intensity soccer-specific exercise conditions, tape had no restrictive benefit and also no positive proprioceptive effect after 15 minutes. This could mean that attenuation of injury or reinjury risk may disappear at this point.
Outcome	Application of prophylactic support decreased active ROM in PF and INV with the tape performing better than the brace. However, tape lost its restrictive benefits by 15 minutes while the brace maintained some effect until 45 minutes.
Most relevant findings	Findings of the study suggest that the clinical usefulness of prophylactic support of the ankle joint is limited if the aim is to restrict

Data items	
	ROM and improve proprioceptive capability under soccer-specific conditions.
Limitations	The study was done in a biomechanics laboratory at different intervals of a SAFT90 on the dominant leg only with a sample size of 8 participants.
Comment	The study concluded on the usefulness of ankle-joint prophylactic support if the aim is to restrict ROM and improve proprioceptive capabilities. However, more studies need to be done to determine if loss of ROM restriction after the stipulated time led to non-contact ankle injuries in either a real-world setting or a laboratory setting, and therefore determine the effect of prophylactic ankle support.

3.9.23

Data items	
Name of the author	Daneshjoo et al (2012).
Title of study	The effects of injury preventive warm-up programs on knee strength ratio in young male professional soccer players.
Publication	PLOS one.
Aim of study	To investigate the effect of FIFA 11+ and HarmoKnee injury preventive warm-up programs on conventional strength ratio (CSR), dynamic control ratio (DCR) and fast/slow speed ratio (FSR) among young male professional soccer players.
Study setting	Assessment of muscle strength was done in a laboratory and intervention exercises were done in a real-world setting with their respective teams.
Study population & sample size	Thirty-six young male professional soccer players between the age of 17 and 20 years were selected for the study.
Sampling method & size	Players from one team were randomly selected and assigned to one of the intervention groups. Each soccer team had approximately 30 professional players and only 12 players were randomly selected to

Data items	
	participate in the study. Each subject performed one of the selected warm-up programs only.
Study design	Experimental design.
Data collection methods	The researcher utilized a Biodex Isokinetic Dynamometer to assess the hamstring and quadriceps strength of the subjects.
Data analysis	The SPSS software was used for analysis of results. For comparing the isokinetic strength in pre-test and post-test between groups, (11+ vs HarmoKnee vs control), the one-way analysis of covariance was used with the pre-test values as covariate.
Conclusion	The FIFA 11+ improved CSR and FSR, but the HarmoKnee program did not demonstrate improvement on these components.
Outcome	After performing FIFA 11+ and HarmoKnee programs, the CSR and DCR of the knee muscles in both groups were found to be lower than the recorded normal values. However, CSR increased by 8% and FSR in the quadriceps of the non-dominant leg also increased by 8 % in the FIFA 11+.
Most relevant findings	Professional soccer players have higher predisposition of getting knee injuries because the hamstring to quadriceps ratio were found to be lower than the stipulated average values.
Limitations	The isokinetic dynamometer evaluates the net torque of force of knee flexion and extension but does not necessarily measure the torque of hamstring or quadriceps that it creates.
Comment	It has been reported that professional soccer players have higher predisposition of getting knee injuries. Therefore, the FIFA 11 + seem to be the choice of program to mitigate higher predisposition of getting knee injuries compared to the HarmoKnee program because it improved CSR and FSR.

3.9.24

Data items	
Name of the author	Raya-Gonzalez et al (2021).

Data items	
Title of study	The effects of training based on Nordic hamstring and sprint exercises on measures of physical fitness and hamstring injury prevention in U19 male soccer players.
Publication	Research in Sports Medicine.
Aim of study	To analyse the effects of a training program based on Nordic hamstring exercise (NHE) and sprint training on physical performance and hamstring injuries in U19 male soccer players.
Study setting	The study was a real-world setting where the experimental sessions were conducted immediately after regular soccer training session. The training program was applied one time per week at least 48h prior to the official match and the tests were done on an artificial turf.
Study population & sample size	There were 49 U19 players who played at the same soccer academy over the last two years. Players were included in the study if they participated in at least 80% of training sessions.
Sampling method & size	Forty-nine soccer players were randomly allocated into the control group and experimental group. Twenty-six participants were allocated into the control group and 23 participants were allocated into the experimental group.
Study design	A randomized-controlled trial.
Data collection methods	During the 14-week intervention period, participants performed their regular weekly in-season routine, and the experimental group (EG) included the NHE and sprint training program once a week. Players' physical performances were assessed in a single testing session in the following order to minimize the accumulation of fatigue: 30 m linear sprint (SPR30) test and change of direction (COD) sprint test with the dominant leg or non-dominant leg performing the turn on the outside.
Data analysis	Data was presented as mean plus minus standard deviations. To prove the normality of data distribution and homogeneity of variances, the researcher conducted the Kolmogorov-Smirnov and Leven tests. To examine the practical significance, Cohen's effect size (ES) was calculated, and the results were interpreted.

Data items	
Conclusion	The study reported that the application of a training program based on NHE, and sprint exercises is effective in improving sprint performance and reducing the burden of injuries in U19 soccer players.
Outcome	Analysis between groups revealed differences in linear sprint performance in favour of the EG. Pre-to-post performance increased significantly in the EG for 20 m and 30 m sprints, but there was a significant reduction in some COD parameters that were observed. In the CG, only a significant reduction in COD with dominant leg was recorded. There was significant differences in injury burden on the EG such as absence days/1000 h of exposure.
Most relevant findings	This training program can be easily implemented in soccer because of its low frequency which is one session per week for the duration of 14 weeks. However, the program led to reduction of some COD parameters and this needs to be considered by practitioners.
Limitations	The study was done in a soccer group with specific characteristics; therefore, outcomes of the study should be applied with cation within different levels of different teams. It should also be noted that the study was performed with a group of U19 players only and they may have limited strength experience. Due to the possibility of limited strength experience among this group, the NHE and sprinting volume used in this study need to be adjusted among soccer players with higher strength training experience.
Comment	Due to the reduction of certain COD parameters, the authors recommended that practitioners may need to add some specific COD exercise and strength training such as flywheel training that is focused on the improvement of braking action. This intervention could be beneficial for the performance of soccer players.

3.9.25

Data items	
Name of the author	Horst et al (2015).

Data items	
Title of study	The preventive effect of the Nordic hamstring exercise on the incidence and severity of hamstring injuries in amateur soccer players.
Publication	The American Journal of Sports Medicine.
Aim of study	To investigate the preventive effect of NHE on the incidence and severity of hamstring injuries in male amateur soccer players.
Study setting	The study was done in a real-world setting and intervention exercises took place immediately after the completion of the normal team training before cooling down.
Study population & sample size	Dutch male amateur soccer players between the age of 18 and 40 years were included in the study.
Sampling method & size	Male amateur soccer players from 40 different teams were randomly allocated to either intervention or control group. The intervention group comprised of 20 teams consisting of 202 players, and control group also had 20 teams and consisting of 287 players.
Study design	Cluster randomized controlled trial.
Data collection methods	Before the start of the intervention, the participants completed a questionnaire to record baseline characteristics such as date of birth, weight, height, field position etc. The medical staff of participating teams were responsible for registering all hamstring injuries. The frequency the player performed the NHE protocol, the number and duration of training sessions followed, and the number of matches played were recorded weekly for one year by the coach using a computer-based registration form.
Data analysis	The incidence of hamstring injury was analysed based on an intention-to-treat basis. Injury incidence was only calculated from players whose full training and match exposure during all 52 weeks of the study were registered.
Conclusion	Implementing the NHE protocol in regular amateur training significantly reduced the incidence of hamstring injuries, but it did not reduce hamstring injury severity.

Data items	
Outcome	The primary outcome of the study was hamstring injury incidence, and the secondary outcomes were injury severity and compliance with the intervention protocol. There was a total of 38 hamstring injuries that were recorded in the study for both groups. Injury incidence rate were significantly different between the intervention and control groups with the hamstring injuries found to be reduced in the intervention group compared to the control group. The difference in injury severity between the intervention and control groups was not statistically significant.
Most relevant findings	Klugl et al has reported that there is lack of research on the implementation and effectiveness of injury preventive strategies in a real-world context. The knowledge is essential as positive study results do not necessarily translate into injury prevention but as a guide for implementations of these strategies.
Limitations	There were two recurrent injuries that were recorded from the same player, but recurrent injuries were not included in the analyses of the study. The other limitation is that the study could have been limited by information bias as participants were not blinded during the study.
Comment	NHE has been found to be effective in reducing the incident rate of hamstring injuries but did not have a positive outcome in reducing the severity of hamstring injuries. More studies need to be done on the aetiology of the severity of hamstring injuries and the preventive measure needs to be investigated.

APPENDIX IV: JBI template

Scoping Review Details	
Scoping Review title:	X
Review objective/s:	X
Review question/s:	X
Inclusion/Exclusion Criteria	
Population	X
Concept	X
Context	X
Types of evidence source	X
Evidence source Details and Characteristics	
Citation details (e.g. author/s, date, title, journal, volume, issue, pages)	X
Country	X
Context	X
Participants (details e.g. age/sex and number)	X
Details/Results extracted from source of evidence (in relation to the concept of the scoping review)	
Actual outcomes	X
Preventative strategies	X
Anatomic structures	X

APPENDIX V: Turnitin report

Preventative strategies for non-contact lower limb injuries among male footballers

by Molebogeng Mmitsi

Submission date: 27-Nov-2023 11:49AM (UTC+0200)
Submission ID: 2239506516
File name: 2062_Molebogeng_Mmitsi_Preventative_strategies_for_non-contact_lower_limb_injuries_among_male_footballers_38368_214940411.docx (577.66K)
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APPENDIX VI: Plagiarism Declaration

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS
SENATE PLAGIARISM POLICY: APPENDIX ONE

I Molebogeng Bongani Mmitsi, (Student number: 0500535v),

I am a student registered for the degree of MSc Physiotherapy in Sport and Exercise in the academic year 2nd.
I hereby declare the following:
- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: M.B MMITSI Date: 01August 2024

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

CERTIFICATE OF SUBMISSION FOR EXAMINATION OF MASTERS RESEARCH REPORT / DISSERTATION OR PHD THESIS SIGNED BY HIGHER DEGREES CANDIDATES

Full name	Molebogeng Bongani Mmitsi
Student number	0500535v

Title of submitted Research Project:

Preventative Strategies For Non-Contact Lower Limb Injuries Among Male Soccer Players: Scoping Review

NB: If this title is different to your previously approved title, no further action can be taken by the Faculty Office un a change of title has been approved.

Contact no	0730853812	E-mail	

1. If you are likely to move in the next 6-12 months, please give the anticipated date of move: _____
2. I hereby submit my **Masters (research report) / Masters (dissertation) / PhD thesis for examination** (Select whichever is applicable)
3. I have checked all copies of my research report / dissertation / thesis and declare that no pages are missing or poorly reproduced.
4. I have submitted _____ bound copies and _____ copies on CD

5. **I confirm that I have:**
   a) A signed declaration indicating my understanding of the concept of plagiarism and a denial of plagiarism in my research document.
   b) A report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document included as an appendix.

6. **I confirm that I have:**
   a) Not used either human or animal tissue or records **Yes/No**
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   c) Done research using animals **Yes / No**
      If yes: I have included a copy of the animal ethics committee clearance certificate as an appendix in this document **Yes/No** N/A
   d) Done research using human subjects, human tissue or patient records **Yes / No**
      If yes: I have included a copy of the human ethics clearance certificate as an appendix to the research document **Yes/No** N/A

7. I understand that I may not graduate unless my University fees have been paid in full.
8. My Supervisor(s) names, departments, telephone numbers and email addresses are as follows:

Name	Dr. Siyabonga Kunene		
Department	Physiotherapy		
Telephone	(011) 717-3107	E-mail	siyabonga.kunene@wits.ac.za
Name			
Department			
Telephone		E-mail	
Name			
Department			
Telephone		E-mail	

List all publications, which you have published in peer-reviewed journals from your postgraduate research report/dissertation/thesis during the course of your studies in the Faculty of Health Sciences (Include authors, year, title of paper, name of journal, volume number and page numbers). This information is mandatory.

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Signature of candidate: M.B MMITSI Date: 01 August 2024

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

CERTIFICATE OF SUBMISSION FOR EXAMINATION SIGNED BY SUPERVISORS OF HIGHER DEGREES CANDIDATES

Full name	Molebogeng Bongani Mmitsi
Student number	0500535y

Candidate for the degree of: Master of Science in Physiotherapy MCA57

_____

has submitted his/her thesis/dissertation/research report

Entitled:

Preventative Strategies For Non-Contact Lower Limb Injuries Among Male Soccer Players: Scoping review.

Contact no	0730853812	E-mail	bmmitsi@gmail.com

Mark with an X on appropriate box	Yes	No
Has this thesis/dissertation/research report been submitted with the acquiescence of the supervisor?	X	
To the best of your knowledge are you able to verify that this is the candidate's work, except as otherwise stated by the candidate?	X	
The substance (nor any part of it) has not been submitted in the past nor is being submitted for a degree in any other university?	X	
The candidate has acknowledged wherever any information used in the thesis, dissertation or other work has been obtained by him/her while employed by, or working under the aegis of, any person or organization other than the University or its associated institutions?	X	
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Name of Supervisor 1: Dr Siyabonga Kunene____

Telephone: 0117173707_____ Email: siyabonga.kunene@wits.ac.za_____

Signature: _____  _____ Date: 6 Dec 2023_____

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IMPORTANT NOTICE WITH REGARD TO THE SENATE STANDING ORDERS:

A.22 Submission against advice of Supervisor

If the Supervisor is not prepared to agree to the submission of a thesis, the candidate shall still be entitled, if he or she wishes, to submit it for examination. When a thesis is submitted against the advice of the Supervisor, this should be recorded in the minutes of the Faculty Graduate Studies Committee. In such a case, no internal examiners are appointed but a Supervisor's report will still be required. After the examination process, the external examiner(s) will be advised by the Chairperson of the Faculty Graduate Studies Committee that the thesis was submitted against the advice of the Supervisor.

A.24 *Nomination of Examiners*:

Nomination of examiners should take place at least six weeks before submission of the thesis or dissertation. *(The Postgraduate Office will not accept any submission for examination without the confirmed appointment of the nominated examiners*.)

A.25 Confidentiality of names of examiners (both external and internal)

The names of the examiners should be confidential during the examination process and may only be revealed to the candidate with the acquiescence of the examiner once the final version of the thesis has been submitted to the Faculty and the process has been completed.