UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCREENING TOOLS FOR COMMON SOCCER INJURIES: A SYSTEMATIC REVIEW

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DECLARATION

I, RAPHAEL CHRISTOPHER, declare that this dissertation is my own work. It is being submitted for the degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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22 July 2019

DEDICATION

This dissertation is dedication to God Almighty

From whom my life found, favour, grace, love, happiness and satisfaction.

Equally dedicate this dissertation to my lovely Mom, a pillar to my every success.

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To my family and friends, words cannot express the gigantic love that flows through my veins. Your continuous support and encouragement will forever keep a print in my life. Thank you.

Finally, to the department of physiotherapy at the University of the Witwatersrand. I have found beautiful smiles and support in your company. Thank you.

ABSTRACT

Background: Soccer is associated with a significant chance of injury either during training or during the course of an actual match. A review of literature shows that soccer injuries occur commonly in the lower extremities, often resulting in extensive downtime of players depending on the severity of the injury. This necessitates the need to investigate injury risk factors for the sake of predicting possible injury occurrences and proactively seeking to prevent them. Although several screening tools exist for the prediction of injury occurrences, the effectiveness of these screening tools in predicting injury to a satisfactory level of accuracy has been questioned.

Purpose: The purpose of this study was to conduct a review on common injuries in soccer, risk factors and the accuracy of available screening tools to predict these injuries among soccer players.

Methods: A systematic review was performed based on the JBI procedure for conducting systematic reviews. Databases such as SPORT Discus, Cinahl, Medline, Science Direct, PubMed and grey literature were used to access suitable studies. Some of the key terms applied in the perusal of these databases included: soccer injuries or football injuries, injury screening, screening, screening tool accuracy, risk factors, epidemiology, injury incidence, injury prevalence, injury prediction, accuracy, validity, specificity, reliability, sensitivity. Studies dating back to the year 2000 were focused on and only full text articles in English were included. Studies such as observational studies were also included in this review. Data was obtained using a standardized data extraction tool which permitted the extraction of similar information and significant data from the studies under review. The data extracted focused on literature-identified risk factors such as demographic, geographic, social, seasonal and other risk factors. Other factors taken into consideration include: setting/location, dates of survey or intervention, definitions of conditions and populations, inclusion and exclusion criteria, mean age, sex, sample size, statistical methods used to analyse data in the selected studies, and estimates of prevalence and incidence.

Analysis: Extracted data was analysed using Stata statistical software, version 15.1. To address heterogeneity in extracted data, the data extracted was analysed using a forest plot. The initial literature search on CINAHL, SPORT Discus, Science Direct, and PubMed, returned more than 26 citations. Incidence rates and odds ratios, as well as sensitivity and

specificity were analysed within their respective 95% confidence intervals. The I^2 statistic was used to determine the proportion of variation across studies. A qualitative analysis was used to synthesize the pooled data from the included studies in this systematic review

Statistics included in the forest plot varied based on the defined objectives of the study:

Common soccer injuries: shows the extracted variables of seven studies included in the incidence of injury. These variables were the statistics used in the forest plot analysis, which are shown below:

Incidence of 5.2 [0.9-2.7] injuries/1000h, incidence of 37.55 per 1000 match hours, incidence 24.6 injuries per 1000 player hours, incidence 48.7 injuries per 1000 hours, incidence match injury= (90% CI: 8.87–14.92), training injury = (90% CI: 3.95), incidence 4.9/1000 h, (95% CI: 4.11–5.12), 6.9/1000 h, (95% CI: 6.15–7.33). Incidence ($x^2 = 9.37$, df = 1, p = 0.002) 32.8 per 1000 h, Incidence 7.59 injuries per player per 1000 hours.

Risk factors for common soccer injuries: showed extracted variables of four studies included in the risk factors for common soccer injuries studies used. These variables were the statistics used in the forest plot analysis, they are shown below:

(OR=0.261; 95% CI 0.10 to 0.57; p=0.002, Odds ratio [OR] = 1.1 per year, P = 0.05). OR: 0.12, 90%CI: 0.08–0.94), OR: 0.54, 90%CI: 0.41–0.85), OR = 4.52, p = 0.011), (OR = 4.52, p = 0.011).

Screening tools and accuracy for common soccer injuries: showed extracted variables of three studies included in the screening tools and accuracy studies used. These variables were the statistics used in the forest plot analysis they are as follows:

Sensitivity of 0.579 (CI95= 0.335 to 0.798), specificity of 0.737 (CI95=0.488 to 0.909). sensitivity of 86%. 18.3, 95% CI 14.9– 21.7) = 0.17), A specificity of 64%. 18.3, 95% CI 14.9– 21.7) = 0.17), (specificity of 46.9% vs. 24.1%, respectively; t = 229.0, p<0.0001), (specificity of 46.9% vs. 94.5%, respectively; t =153.0,p<0.0001).

Results: A total of 26 studies were included for the analysis - 13 studies were analysed quantitatively while the remaining 13 were analysed qualitatively**.** This results obtained from this systematic review found that there is a high incidence of soccer injuries at an incidence rate of 6.83 per 1000 hours of play. The pooled results also showed evidence of risk factors and the likelihood of injury occurrence in relation to these risk factors (OR=1.12 95% CI 1.07; 1.17). The screening tools assessed for the prediction of common soccer injuries that emerged from this systematic review include the Functional Movement Screening (FMS™), the Landing Error Scoring System (LESS), the Tuck Jump Assessment, the Soccer Injury Movement Screening (SIMS), and the conventional hamstrings to quadriceps ratio. The accuracy of screening tools was of high reliability, sensitivity and specificity (calculated as ICC (0.68 95% CI: 52-0.84 and 0.64 95% CI: 0.61-0.66, respectively).

Conclusion: This systematic review found the incidence rate of common soccer injuries to be 6.83 per 1000 hours of play. This incidence rate is lower than values reported by majority of previous studies on the occurrence of common soccer injuries. Also, this systematic review confirmed that the most common soccer injuries are associated with the lower extremities. The most common injuries reported include ankle sprain, knee sprain, thigh strain, hamstring strain, quadriceps strain, hip strain, groin strain, and calf strain. In addition, the pooled results from this review showed evidence of risk factors being associated with certain injuries (OR=1.12 95% CI 1.07; 1.17). Some of the emergent risk factors identified from this systematic review include physical and traumatic stress following high work load (training and match load), eccentric knee flexor strength, short biceps femoris fascicles, large weekly changes of high-speed running, age of players, range of motion (ROM) of hip adductors, previous hamstring and groin strain, previous knee and ankle sprain, psychological factors, personality traits predictors, daily hassles, low hamstring-to-quadriceps strength ratio, and previous injury. It is note-worthy that high workload was the only extrinsic risk factor that emerged while the others were all intrinsic risk factors for common soccer injuries.

Recommendation: It was noted that although literature exists on screening tools for injuries, many of the studies were generic and did not focus specifically on soccer injuries. The studies found through the utilized databases also had low methodological quality which prevented many of the studies from meeting the inclusion criteria of this study. Hence, there is need for sport professionals and scholars to focus on conducting well-designed studies to determine the accuracy of screening tools for common soccer injuries.

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ABBREVIATIONS

ACL…………………..Anterior Cruciate Ligament

ACLR………………...Anterior Cruciate Ligament Rapture

ANOVA……………...Analysis of Variance

AU……………………Area Under

AUC………………….Area Under Curve

BMI…………………...Body Mass Index

BFIH………………….Biceps Femoris Long Head

CI…………………….. Confidence Interval

DJJ…………………....Drop Jump Test

DJST…………………..Drop Jump Scoring Test

ES……………………...Effect size

FIFA….......................... Fédération Internationale De Fut Ball Association

FPT…………………….Functional Performance Test

F-MARC……………....FIFA Medical and Research Council

F-MARC 11…………...FIFA Medical and Research Centre Eleven

F-MARC 11+…………FIFA Medical and Research Centre Eleven Plus

FMS™…………………Functional Movement Screening

FMS™™ …………… Functional Movement Score

GFMT…………………Gymnastic Functional Movement Tool

GLM…………………...General Linear Model

HCON…………………Conventional Hamstring

HSI…………………….Hamstring Strain Injury

HSR…………………....High Speed Running

H/Q…………………….Hamstring Peak Torque

ICC…………………….Intra-class Correlation Coefficient

KAM…………………...Knee Abduction Moment

LESS…………………..Landing Error Scoring System

MRI…………………....Magnetic Resonance Image

MANOVA…………….Multivariate Analysis of Variance

OR……………………Odd Ratio

PHE…………………...Periodic Health Examination

PPE……………………Participation Examination

PRO…………………...Professional

P..……………………...Power Value

QCON…………………..Conventional Hamstring

RAST…………………Running-Based Anaerobic Sprint Test

RESTQ……………….Recovery Stress Questionnaire for Athletes

ROM…………………Range of Motion

RPE…………………..Rate of Perceived Exertion

RR……………………Relative Ratio

SD……………………Standard Deviation

SEBT………………...Star Excursion Balance Test

SIMS………………...Soccer Injury Movement Screening

SPSS………………...Software Pack

SJ……………………Squat Jump

SR…………………...Sprint Running

SRPE………………...Rating Perceived Exertion-Based Estimation

TJA…………………..Tuck Jump Assessment

YBT…………………Y-Balance Test

CHAPTER 1: INTRODUCTION

1.1 Background

Soccer is the most commonly-played game in the world with an estimated 200,000 professional players and about 240 - 265 million amateur players (Junge *et al.*, 2002; Emery, Meeuwisse and Hartmann, 2005). Unfortunately, this game, which is loved by many is associated with a significant chance of injury either during preparation for a game or during an actual match (Junge *et al.*, 2002; Emery, Meeuwisse and Hartmann, 2005; Ekstrand, Hagglund and Walden, 2011). Studies have shown that between 65-91% of male soccer professional soccer players (Waldén, Hägglund and Ekstrand, 2005), and 48-70% of female soccer professional players are liable to sustain injuries during a season (Faude. *et al.*, 2005; Jacobson and Tegner, 2007). In fact, when compared to other sports such as basketball, cricket, volleyball, field hockey, cycling, boxing and swimming, soccer is considered to have the most injuries per player (Wong and Hong, 2005). Soccer players have been found to be prone to injuries due to the complexity of the game, contact during play, and the long length of a game (90 minutes divided into two halves of 45 minutes each) with the players covering relatively long distances (Arnason *et al.*, 2004; Requena *et al.*, 2009).

The biomechanics of play and techniques in soccer put players at risk of injury. These include kicking, running, jumping, heading, tackling, brushing shoulders, and diving (which is mostly employed by goalkeepers). Since these techniques are allowed in the game, there is no assurance of safety when executing them. As a result, and in connection with other factors, injury is rife amongst soccer players.

An injury can be defined as an occurrence during play that can deprive a player from playing for some time depending on the severity of the injury, which is often measured by the number of days missed (Hägglund *et al.*, 2005; Fuller *et al.*, 2007). In this light, injuries can be classified as: slight (1 to 3 days), trivial (4 to 7 days), moderate (8 to 28 days) or major (28 days and above) (Hägglund *et al.*, 2005; Fuller *et al.*, 2007). A review of literature indicates that injuries may result from the combination of multiple risk factors, some of which include: sex, structure of body, age, physical wellness and skills level. These are referred to as internal risk factors. External risk factors, some of which involve the application of the biomechanics of play include: opponents, officiating, rule violation, protective equipment and sports hardware, as well as natural variables such as playing surface and climate conditions which cannot be controlled (Valderrabano, Barg and Paul, 2014). Furthermore, risk factors can be split into modifiable factors (i.e. factors that can be changed and reformed such as the application of force during play and mechanism of execution through specific training programmes) and non-modifiable factors (i.e. factors that cannot be changed or reformed such as previous injury history and gender) (Bahr, 2016). Some of the common injuries associated with the above-mentioned risk factors include hamstring and groin strains, as well as lower leg and knee strains, amongst other injuries (Engebretsen *et al.*, 2008). These injuries are lower extremity injuries.

Research shows that soccer injuries occur mostly in the lower extremities (Witvrouw *et al.*, 2003; Le Gall *et al.*, 2006; Bradley and Portas, 2007). This was reported by Goga and Gongal (2003) who found that lower extremities injuries such as lower limb fractures were common in soccer players. The authors investigated the risk factors for these injuries and identified some factors in amateur South African soccer players to be related to their attitude towards the game. These included aggression during play, poor skills and ability, foul play towards opponents, poor training and fitness. Similarly, in an assessment of amateur female soccer players, Sentsomedi and Puckree (2016) showed that amongst female high school soccer players, defenders and midfielders sustained the most injuries, and 78% of those injuries were located in the lower extremities. These injuries were associated with unskilled contact and aggressive play. The study also pointed out that the prevalence of injuries is mostly in the distal part of the extremities specifically the ankle and knee. Muscle injuries, such as strains were also commonly reported. In terms of age, younger professional South African soccer players were found to sustain fewer injuries and required more time to return to play, while older professional soccer players have issues with recurring injuries (Nematswerani, 2018).

The two main reasons for investigating risk factors are to predict the possibility of injury occurrences and to identify factors that might place a player at risk for sustaining these injuries. In soccer, screening assessments are mostly in the pre-seasonal period, and often goes along with monitoring of players during the season. Assessments may include participation examination (PPE) and periodic health examination (PHE).

Balance, organisation, swiftness, aerobic and anaerobic wellness are vital in soccer (Rosch *et al.*, 2000; Requena *et al.*, 2009) and statistics indicate that players are often injured due to a lack of these components. Van's sequence of prevention model states that by constant assessment of injury, injury mechanisms and risk factors are identified, highlighting that collecting and recording of data is a core approach for preventing injuries (Van Mechelen, Hlobil and Kemper, 1992). Another similar proposal states that assessing epidemiological information on teams with similar characteristics, initiating plans on management, estimating and assessing risk, may help prevent injuries (Fuller *et al.*, 2007; Clarsen, Myklebust and Bahr, 2012). Physiotherapists mainly utilize examination as a tool when assessing for injury risk in sports teams (musculoskeletal screening). Musculoskeletal appraisal instruments, which ordinarily involve measuring flexibility, force, and mobility are often employed (Mottram and Comerford, 2008). Studies suggest that for a therapist to entirely examine an athlete's functional capabilities, there is a strong need for screening in movement patterns or biomechanics which pose a risk to the most common injuries (Rosch *et al.*, 2000; Requena *et al.*, 2009; Schneiders *et al.*, 2011).

Several screening tests are available in usage in the clinical setting; some of which include: the Functional Movement Screening test, Landing Error Scoring System, Y-Balance Test, Star Excursion Balance Test, Drop Jump Screening Test, and the Tuck Jump Analysis (Chimera and Warren, 2016; Lai *et al.*, 2017). These screening techniques only recently received research attention, hence there is a dearth of data regarding their applicability, validity, and reliability (Chimera and Warren, 2016). For instance, the Y-Balance Test (YBT), used alone, was reported by Lai *et al.* (2017) as not being capable of predicting injury to the lower extremities and recommended caution in its use as a lone screening tool for injuries by rehabilitation professionals. However, the YBT is touted as being capable of identifying at-risk soccer players when included into physical examinations (Gonell, Aurelio and Romero, 2015).

Several systematic reviews related to common soccer injuries have been conducted mostly in developed countries. However, none of them addressed the screening tools for common soccer injuries. The focus of the reviews were on the risk factors for hamstring and groin injuries (Foreman *et al.*, 2006; Maffey and Emery, 2007; van Beijsterveldt *et al.*, 2013; Shadle and Cacolice, 2016). The only review that explored the screening tools which can predict injury to the lower extremities was not specific to soccer as it involved a wide range of team sports namely hockey, football, soccer, volleyball and basketball, (Dallinga, Benjaminse and Lemmink, 2012). Therefore, a systematic review to establish the validity and reliability of screening tools in soccer is imperative.

The systematic review of Dallinga, Benjaminse and Lemmink (2012), on screening apparatus for lower limb injuries, made a clinical contribution to recognize tests which may foresee injuries in sport by employing a search technique that comprised articles from the nineties. They followed a set of incorporated criteria and analysed methodological positioning plots. However, investigating screening instruments for common soccer injuries were distinguished in tumbling. Sleeper, Kenyon and Casey`s (2012) study confirmed the use of the gymnastic functional movement tool (GFMT) to examine the speed, power, strength, balance, endurance and overall fitness level, to identify functional and fitness deficit. In dance, Steinberg *et al.* (2006) assessed the range of some important functional movements, namely the hip, knee, ankle, foot and spin. In jogging, Whatman, Hing and Hume (2011) investigated the relationship of five lower extremity functional tests to determine jogging kinematics. There is currently a tendency to incorporate functional tests in numerous sports which are focussed on the kinematics utilized within the sport.

However, one of the common questions asked is whether screening tools effectively predict soccer injuries. Bahr (2016) reported scepticism about the effectiveness of risk factor screening tools in predicting injury to a satisfactory level of accuracy for reducing injury risk. The study highlighted three steps that are required to be in place to validate a screening test and stated that no PHE screening test met the criteria, and also none has been supported by research evidence.
By investigating the validity and reliability (accuracy) aspects of these screening tools this question can be investigated. It should however be done in the context of the epidemiology, risk factors and available screening tools for the game of soccer. Applicability can then be determined by the evaluation of the tests` properties on pertinent populations using the factual statistical tools (Bahr, 2016).

1.2 Problem Statement

Morehead (2014) compiled a test battery to be included in the Functional Movement Screening (FMS™) tool for soccer. “Ten tests were eventually selected to be added in the FMS™ for football, namely: Single-leg Squat, Deep Squat, In-line Lunge, Y-balance Test, Modified Thomas Test, Internal Rotators of the Hip Assessment, Vertical Jump Test External Rotators of the Hip Assessment, Adductor/Groin Flexibility Test and gastrocnemius tests." However, the study posed certain challenges, such as: the selection of an appropriate panel, and 'guessing' certain responses and delay in responses from participants. Tests that were used for the Delphi methods were also selected randomly from the literature and not based on identifying risk factors of the most common soccer injuries.

This study therefore aimed to review screening tools in soccer, and relate it to the most common type of injuries and risks of injuries in soccer. The implementation would eventually be the inclusion of appropriate tests in a screening tool for soccer players.

1.3 Justification

Management of soccer injuries is expensive and is estimated to cost over 30 billion dollars per year worldwide (Dvorak and Junge, 2000). The estimated amount may be higher in Africa owing to factors such as: data insufficiency; low healthcare resources and economic constraints. This conundrum often leads to extended out of play time for injured soccer players in Africa, increased complications and sometimes early retirement from soccer when compared to their counterparts in the developed countries (Nuhu and Kutz, 2017). More time spent on injury management and convalescence of soccer team players translates to more economic deficits recorded by team management or owners and reduction in overall team efficacy and success (Orchard, 2009).

This study provides information on risk factors, common injuries and screening tools that may determine the compilation of valid assessments or tests that can be used in screening tools for soccer players, which in turn could influence effective and economic management.

1.4 Research question

What is the accuracy of screening tools in predicting common soccer injuries?

1.5 Purpose

The purpose of this study is to conduct a systematic review on common injuries, risk factors and the accuracy of available screening tools to predict these injuries in soccer players.

1.6 Research objectives

The following objectives were to:

- ✓ Determine the common injuries in soccer players.
- ✓ Determine the common risk factors for injuries in soccer players.
- ✓ Determine the screening tools for common soccer injuries in soccer players.
- ✓ Determine the accuracy (specificity, sensitivity, validity and reliability) of screening tools in soccer players.

1.7 Type of study

A quantitative systematic review of etiology and risk.

1.8 Outline of Dissertation

Chapter 1: Introduction

The introductory chapter provides a brief description of the epidemiology of soccer and soccer injuries. It also focuses on risk factors, common soccer injuries sustained by soccer players, screening tools and accuracy of screening tools used in soccer for preventing and predicting injuries. The problem statement, aim and objectives of research are also included in this chapter.

Chapter 2: Literature review

Chapter 2 discusses the existing knowledge regarding the epidemiology of soccer injuries, common soccer injuries, injury risk factors in soccer, injury prevention, screening tools, and reliability and validity of screening tools. Several databases were accessed for articles referenced in this section.

Chapter 3: Methodology

Type of study and the design adopted were elaborated in this part. The information about the study setting, study participants, sampling techniques, and research procedures are reported in this section. This chapter also discusses the data measurement tools, tools validation, data collection and management, data analysis, and ethical procedures.

Chapter 4: Results

This presentation of results of the analysis of included studies were the major significance of the results chapter. The analysis entails a forest plot graph and a qualitative analysis. These analyses are sequentially presented. Finally, the chapter ends with a brief summary of the findings.

Chapter 5: Discussion

From the beginning of the discussion part to the end, this area discussed the findings from the meta-analysis and qualitative analysis in relation to the existing literature and the study objectives. Finally, it ended with highlighting the strengths and limitations of the systematic review.

Chapter 6: Conclusion

The study is concluded in Chapter 6 by providing a summary of the study and subsequent recommendations.

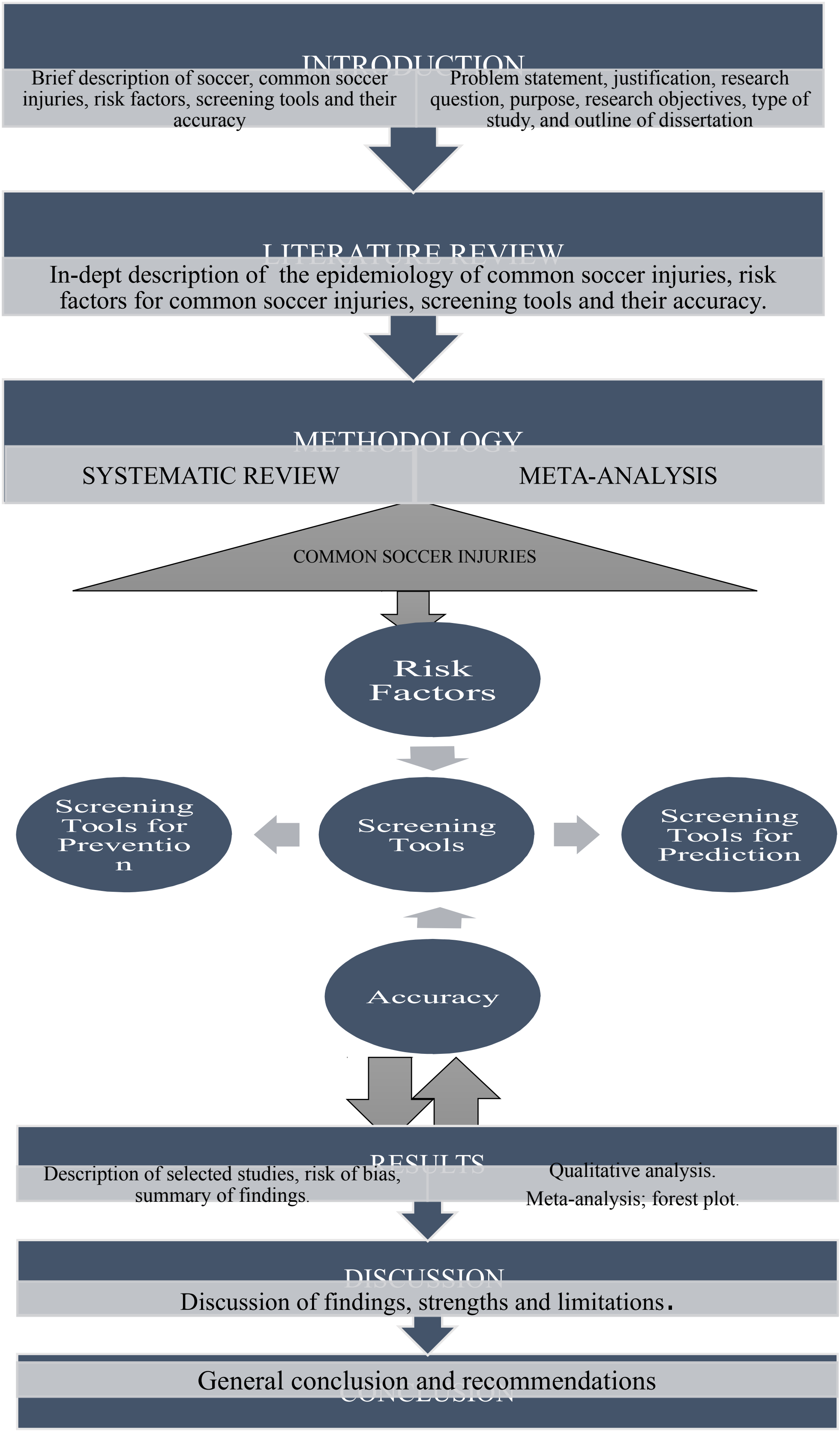

Figure 1.1: Figurative illustration of this study

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter discusses the existing literature regarding the epidemiology of soccer injuries, common soccer injuries, injury risk factors in soccer, injury prevention, screening tools, and reliability and validity of screening tools.

Several databases such as CINAHL, SPORT Discus, Science Direct, and PubMed were accessed to source relevant articles used in this section. Key search terms included: soccer injuries or football injuries, injury screening, screening, screening tool accuracy, risk factors, epidemiology, injury incidence, injury prevalence, injury prediction. Current literature dating back to the year 2000 was accessed and commonly cited and dated articles relevant to this review were also accessed. Only full text articles in English were included.

2.2 Epidemiology of soccer injuries

2.2.1 Epidemiology of soccer injuries

Studies on the epidemiology of soccer injuries have been widely conducted at top international soccer tournaments as well as at club, national and various soccer leagues in different countries of the world (Ekstrand, Hagglund and Walden, 2011; Junge and Dvorak, 2013). Asia, being the largest continent, has the largest amount of soccer players in the world (Eirale *et al.*, 2017). There has therefore been an abundance of epidemiological studies on soccer injuries in the region as it is imperative for effective prevention planning (Ekstrand, 2008; Junge and Dvorak, 2013; Nuhu and Kutz, 2017). Contrary to this, there is still a lack of literature on epidemiology of soccer injuries in Africa (Nuhu and Kutz, 2017).

Variability exists in the types of injuries experienced by soccer players across regions of the world (Arundale *et al.*, 2015; Eirale *et al.*, 2017). Variability also exists between elite soccer players (male and female elite); between different periods (such as start and end of season); as well as the frequency (low and high frequency) of matches. The second phase of the season and high frequency of matches are associated with higher injury incidence (Arundale *et al.*, 2015; Eirale *et al.*, 2017). Furthermore, young and amateur soccer players have also been found to experience variable injury patterns (Al-Hazzaa *et al.*, 2001; Blanch and Gabbett, 2016). Injury rate is also said to be higher during matches than during training sessions, higher among players who are overweight and among players who play in particular positions such as midfield and central attack (Brophy *et al.*, 2009; Arundale *et al.*, 2015; Mithoefer *et al.*, 2015). Goalkeepers have the lowest injury rate compared with other playing positions (Junge, Chomiak and Dvorak, 2000; Kristenson *et al.*, 2013). Culture and religion have also been strongly linked to the cause of variability in injury patterns among soccer players in different areas of the world (Al-Hazzaa *et al.*, 2001; Blanch and Gabbett, 2016). Hence, prediction of soccer injuries cannot be generalised to all populations or circumstances. Prediction of prevalent soccer injuries in a particular region or population needs to take the contextual factors into account for optimal outcome (Al-Hazzaa *et al.*, 2001; Blanch and Gabbett, 2016).

Nuhu and Kutz (2017) determined the epidemiology of injuries among elite soccer players in an African tournament setting. A total of 240 male soccer players and 12 soccer teams were recruited. Injuries were reported by a team of doctors, nurses and physiotherapists. They reported injury incidence per match and per 1000 match hours as the amount of injury among players divided by the amount of match hours, which equals the injury rate or incidence. Their result showed an incidence of 14.4 per 1000 match hours for contact injury; an incidence of 5.58 per 1000 match hours for non-contact injuries and 50.51 as the overall incidence per 1000 match hours. They also reported that the majority of the injuries occurred during the second half of the matches, with 18% and 47% of injuries sustained in the last 15 minutes and 30 minutes of play, respectively.

On the other hand, an epidemiological study by Falese *et al.* (2017) to determine the incidence of soccer injuries sustained in all competitive matches assessed Italian league soccer players across 20 soccer teams over a two-season period. The study showed that age is directly proportional to the incidence of injury among soccer players. The study also showed that injury rate is not dependent on a players' playing position, and that incidence is usually higher during the seventh to tenth month which is the start of the Italian soccer league season. Their study reported incidence rate using a different method: the total sum of soccer injuries divided by the total sum of player-matches. The results reported an overall incidence rate of 15.2 injuries per 1000 player-matches. The authors defined a player-match as "one player's participation in one match regardless of the actual minutes played. This includes matches played in the national league, in the Italian Cup as well as in European competitions".

2.3 Common soccer injuries

2.3.1 Common location of soccer injuries

Soccer injuries occur in every part of the body, but the majority occur in the lower body parts, namely the foot, ankle, leg, knee, thigh, hip, and pelvis. The high involvement of the lower extremities in soccer injuries is consistent among elite and non-elite players, with an abundance of studies reporting between 50% to 80% of lower extremities involvement in all injury occurrence (Chomiak *et al.*, 2000; Giza *et al.*, 2005; Waldén, Hägglund and Ekstrand, 2005; Nuhu and Kutz, 2017). Studies also show that non-contact mechanisms are responsible for a large amount of injuries to lower extremities (Woods *et al.*, 2003; Grooms *et al.*, 2013). The knee is the most commonly involved anatomical part in soccer injuries closely followed by the ankle (Murphy, Connolly and Beynnon, 2003). This site of occurrence also correlates with the discussion on the type of injuries in paragraph 2.3.2 below, where it is mentioned that most strains and sprains occur in the lower extremity. The head, neck, trunk, and upper extremities (hand, forearm, wrist, arm, elbow and forearm) are involved to a lesser degree (Ackerman *et al.*, 2009).

2.3.2 Types of common soccer injuries

Literature shows that the common injuries among soccer players are muscle strain and ligament sprain, ranging from grade one to three. Other forms of injury include: contusions, concussions, lacerations, fractures, tendinitis, patella-femoral pain syndrome and Osgood-Schlatter disease (Nuhu and Kutz, 2017; O'Kane *et al.*, 2017). The majority of time loss injury among non-elite soccer players were similar to those reported for elite players, including strains, sprains, contusions, concussions, and fractures. Only fractures and concussions recorded low rate of incidence among the non-elite players in non-time loss injuries (Randall Dick *et al.*, 2007; Marar *et al.*, 2012; Swenson *et al.*, 2013; Agel, Rockwood and Klossner, 2016; Kerr *et al.*, 2017).

Soccer injuries manifest with varying severity namely, minor (grade 1), moderate (grade 2) and severe (grade 3) (Grooms *et al.*, 2013). Some injuries will require long-term rehabilitation and or surgical management. The more severe the injury sustained by soccer players, the higher their risk of developing secondary injury following return to play (van Mechelen, Hlobil and Kemper, 1992). Severe or traumatic injuries has relatively high incident rate, with re-injuries and chronic injuries constituting a relatively small proportion of reported injuries (Giza *et al.*, 2005; Kristenson *et al.*, 2013; Arundale *et al.*, 2015).

Trauma and overuse are the leading causes of soccer injuries. Quadriceps strains are associated with the soccer player's kicking limb especially before the start of the season. However the pattern is reversed in adductor strains which occur due to overuse, and commonly towards the end of the playing season (Ekstrand, Hagglund and Walden, 2011; Hägglund, Waldén and Ekstrand, 2013). Hamstring strains in United States' elite soccer league often occur earlier in the season compared to the occurrence in the European elite soccer league (Ekstrand, Hagglund and Walden, 2011; Hägglund, Waldén and Ekstrand, 2013). There is paucity of data on this in the African setting.

Muscle strain is the most common soft tissue injury experienced by soccer players irrespective of their level of play (Price *et al.*, 2004; Grooms *et al.*, 2013). Muscle strains are however more common among men than women. The thigh accounts for the largest proportion of muscle strains especially in the hamstrings, followed by injury in the thigh adductors, then the quadriceps, and finally the calf muscles (Ekstrand *et al.*, 2013; Kristenson *et al.*, 2013).

Ligament sprain on the other hand is less common. Ankle sprains constitute the majority of reported incidents; usually above 50% of reported cases of sprains. This is followed by knee sprain which is more debilitating than an ankle sprain. The pattern of sprains is relatively consistent between male and female soccer player populations. The most common form of knee sprain among male soccer players occurs at the medial collateral ligament while that of women is in the anterior cruciate ligament (Ekstrand *et al.*, 2013). O'Kane and colleagues' (2017) study on over-use injury involving 351 female youth soccer players also found a high rate of injuries affecting the lower extremities. Of these injuries, the knee was commonly affected and occurrence was either at the right side or both sides of the body. Patello-femoral pain syndrome, Osgood-Schlatter disease, and tendinitis were the most diagnosed injuries.

The football medical manual report indicates the common soccer injuries during matches, as shown in figure 2.1.

Severity category (number of days' absence)	Men	Women
Minimal (1 to 3 days)	Ankle lateral ligament complex tear and quadriceps contusion	Ankle lateral ligament complex tear and lower leg and quadriceps contusions
Mild (4 to 7 days)	Ankle lateral ligament complex tear	Ankle lateral ligament complex tear and concussion
Moderate (8 to 28 days)	Hamstring muscle and ankle lateral ligament complex tears	Concussion and ankle lateral ligament complex tear
Severe (>28 days)	Hamstring muscle and anterior cruciate ligament tears	Anterior cruciate ligament tear

Figure 2.1: Most common match injuries as a function of severity category (Ackerman et al., 2009).

2.4 Injury risk factors in soccer

Several systematic reviews related to common soccer injuries have been conducted mostly in developed countries. However, none of them addressed the screening tools for common soccer injuries. Most reviews are focussed on the factors of risk for hamstring, ankle, and groin injuries (Thacker *et al.*, 1999; Foreman *et al.*, 2006; Maffey and Emery, 2007; van Beijsterveldt *et al.*, 2013; Shadle and Cacolice, 2016). For example, Thacker *et al.* (1999) presented a review on the prevention of ankle sprains in sports while the prospective review by Foreman *et al.* (2006) involved the causation of hamstring strains related to sport. The review of Maffey and Emery (2007) focused on the risk factors for groin strain injury in sport. Furthermore, the review by van Beijsterveldt *et al.* (2013) focused on risk factors for hamstring injuries in male soccer players, while that of Shadle and Cacolice (2016) was a critical appraisal on the reduction of hamstring strains in elite adult male soccer players due to participation in eccentric exercises.

The review by Dallinga, Benjaminse and Lemmink (2012) was the only review that explored the screening tools which can predict injury to the lower extremities and it was not specific to soccer as it involved a wide range of team sports namely soccer, basketball, volleyball, football, and field hockey. Therefore, a systematic review to establish the validity and reliability of screening tools in soccer is imperative.

Recurrent injury is considered an important risk factor for subsequent injury. Players are likely to sustain injury of same nature repeatedly in the same location (Ackerman *et al.*, 2009). Other factors to consider that can surge the risk of injuries in soccer includes age, low "knee separation distance" and being on more than one soccer team, while factors that reduce the risk of soccer injury occurrence include good strength in the lower limb muscle groups, and involvement in other physical activities (O'Kane *et al.*, 2017).

Past injuries affecting the groin, hamstrings and knee joint predisposes the player to a twice or three times higher risk for recurrence of the injury in the particular lower extremity (Hägglund, Waldén and Ekstrand, 2006). Therefore, poor injury management or untimely return to play after an injury could be strongly linked with early recurrent injury. Nevertheless, time interval does not always matter as some recurrent injuries are solely based on the particular previous injury. This is believed to be caused by enduring deficits in the initial injury which makes the player more susceptible to re-injury (Hägglund, Waldén and Ekstrand, 2006).

Injury risk factors can be further classified to be either intrinsic or extrinsic (Williams, 1971; Bahr and Holme, 2003), with intrinsic factors comprising gender, age, former injury and insufficient treatment, limb preference, body size, limb bulk, flexibility, strength, cardiovascular fitness, stability and balance, body alignment, foot structure, and alertness. The extrinsic factors comprise playing surface, intensity of competition, player's skill set, footwear, and use of ankle brace or strapping (Taimela, Kujala and Osterman, 1990; Murphy, Connolly and Beynnon, 2003).

2.4.1 Intrinsic risk factors

- Gender: Literature is unequivocal on the relationship of age and injury risk, as some studies have reported higher injury risk among female soccer players compared to their male counterparts (Powell and Barber-Foss, 2000; Knapik *et al.*, 2001), while others have found higher injury risks among male players compared to females (Stevenson *et al.*, 2000). A large body of studies have also reported lack of significant difference in risk of injury between both sexes (Beynnon *et al.*, 2001; Beynnon, Murphy and Alosa, 2002; Slauterbeck *et al.*, 2002).

- Age: Although further studies to establish the relationship between injury risks and age using a larger age range is recommended, literature suggests contrasting results on the relationship between age and injury risks. Some studies reported a correlation between high soccer injury risk and incidence with older age (Östenberg and Roos, 2000; Stevenson *et al.*, 2000; Knapik *et al.*, 2001; Orchard, 2001), while a few others correlated high soccer injury risks and occurrence with younger age (Peterson *et al.*, 2000). Other studies reported lack of correlation between age and risk of injury occurrence (Chomiak *et al.*, 2000; Söderman *et al.*, 2001).

- Former injury and insufficient treatment: Literature shows evidence supporting the correlation of past injuries and poorly managed injuries with a high injury risk at a later time; especially at the same anatomical location and the same type of previous injury. This is as a result of muscle weakness and reduced muscle coordination, ligament impairment, lack of sustained attention and visual cues secondary to phobia of injury recurrence, as well as usage of inappropriate muscle recruitment pattern. Many studies support the correlation of past injuries with increased injury recurrence (Milgrom *et al.*, 1991; Chomiak *et al.*, 2000) while very few others showed lack of association between past injury and future injury (Tropp, Ekstrand and Gillquist, 1984; Baumhauer *et al.*, 1995).

- Cardiovascular fitness: Fatigue makes many soccer players use inappropriate muscle recruitment patterns, hence, it sounds plausible for aerobic fitness to be a risk factor for injuries. However, there is no consensus on the relationship between injuries and cardiovascular fitness. The lack of consensus may be due to the variant methodologies used to assess fitness. Some studies showed a relationship between fitness and injury risk and incidence (Chomiak *et al.*, 2000; Knapik *et al.*, 2001), while a few others reported a lack of relationship between fitness and injury risk (Milgrom *et al.*, 1991; Östenberg and Roos, 2000).

- Size of body: Although size of the human body has been investigated as possible risk for injuries, studies have found divergent results. Many studies reported lack of correlation between injury risks and size of body (Östenberg and Roos, 2000; Knapik *et al.*, 2001) while a few reported a relationship between body size and injury risk (Milgrom *et al.*, 1991; Orchard, 2001). Body size was assessed in various ways in these studies, including by means of Body Mass Index, body weight, body height, lean muscle mass, and body type, making it difficult for comparison of results.
- Limb dominance: The dominant limb is assumed to be more at risk for soccer injuries due to high usage frequency, but literature shows two contrasting findings. A group of studies found a relationship between leg dominance and injury incidence at different anatomical locations on the dominant limb (Baumhauer *et al.*, 1995; Chomiak *et al.*, 2000; Orchard, 2001), while another group found a lack of relationship between leg dominance and injury risk (Surve *et al.*, 1994; Beynnon *et al.*, 2001).

- Flexibility: This aspect refers to an interplay between the relationship of articular surfaces and laxity of the soft tissues (Krivickas and Feinberg, 1996). The quantification of flexibility through overall and specific joint laxity, range of motion, and muscle tightness on injury incidence is divisive despite the general belief that increased flexibility has a corresponding relationship with decreased injury risk and incidence. Some studies found a relationship between joint range of motion and injury risk (Beynnon *et al.*, 2001; Söderman *et al.*, 2001) while others found no relationship between range of motion and injury incidence and risk (Milgrom *et al.*, 1991; Twellaar *et al.*, 1997).

- Reaction time, muscle force, and imbalance: It is widely accepted that the muscle-contraction generated forces (reaction time, muscle force, and imbalance) are imperative for ambulation; hence, it is not clear if the contraction of muscle generated forces are risk factors for soccer injuries. Some studies have reported the forces as risk factors for lower limb injuries (Baumhauer *et al.*, 1995; Söderman *et al.*, 2001; Butler *et al.*, 2012) while others found the forces not to be a risk factor for soccer injuries (Östenberg and Roos, 2000; Beynnon *et al.*, 2001).

- Limb circumference: The amount of force a muscle is capable of generating is proportional to its cross-sectional area; thus, limb circumference is considered a factor of risk (Murphy, Connolly and Beynnon, 2003). Although studies described the relationship between soccer injury and limb girth, their methods for investigating the association vary, thereby reducing the potential for interpreting their results and comparison among these studies (Murphy, Connolly and Beynnon, 2003).

- Postural stability: Postural stability among soccer players has been seen as a possible risk factor for lower extremity injuries as there is an association between high disparity in postural stability and a partial neuromuscular system, inter-segmental joint force increase, and elevated force development in the soft tissue structures (Murphy, Connolly and Beynnon, 2003). However, the relationship between soccer injury and reduced postural stability is not established as there are divergent results reported by studies on the concept. Some studies have reported an association (McGuine *et al.*, 2000; Söderman *et al.*, 2001) while others reported lack of relationship concerning the risk of injury and postural stability (Beynnon *et al.*, 2001; Butler *et al.*, 2012).

- Body position: The forces around the joints and their corresponding resisting soft tissue structures are connected through the joints and skeletal system anatomical alignment. This is why anatomical alignment is considered a likely risk factor for lower extremities soccer injuries (Murphy, Connolly and Beynnon, 2003). Although several studies have investigated this potential risk factor among several sports with disparate results, some reported association between injury and anomalous alignment, while others reported a lack of association (Milgrom *et al.*, 1991; Twellaar *et al.*, 1997; Beynnon *et al.*, 2001; Söderman *et al.*, 2001). There is still a lack of studies among soccer players to investigate the association between anatomical alignment and risk factors for soccer injury.

- Foot morphology: Foot morphology has a profound consequence between axes of rotation of the lower extremities and the ground reaction force and the, lower extremities joints, and the subsequent forces generated on these structures. The medial longitudinal arch has been investigated for this reason as a possible risk factor for lower limb injuries (Murphy, Connolly and Beynnon, 2003). The number of low- or high-arch quantification methods employed by the various studies results in highly divergent findings, hence it is difficult to reach a consensus on the association between foot morphology and lower extremity injury risk (Dahle *et al.*, 1991; Twellaar *et al.*, 1997; Beynnon *et al.*, 2001).

2.4.2 Extrinsic risk factors

- Competition level: Through consensus, researchers have come to understand that, incidence of injury is lesser during training sessions than during the competition (Murphy, Connolly and Beynnon, 2003; Anderson, 2005). Compared to the training environment, players are more susceptible to high incident rate of injury during competitive matches due to high determination of winning (Murphy, Connolly and Beynnon, 2003). The more injuries sustained in a previous match season, the greater the risk of sustaining injury in the present season. The risk may be three times less if there is no injury in the previous season (Hägglund, Waldén and Ekstrand, 2006).

- Skill level: There have been consistent findings among researchers on the association between skill level and soccer injury risk. Findings show a twofold increase in injury (of various severity) incidence among soccer players with lower skill level compared with soccer players with higher skill level (Chomiak *et al.*, 2000; Peterson *et al.*, 2000).

- Ankle bracing: The use of ankle brace or tape among soccer players is accepted as a means to reduce incidence of ankle injuries (sprains) as it enhances kinaesthetic ankle positioning, ankle joint stability, and limited ankle inversion (Beynnon, Murphy and Alosa, 2002). The study by Surve *et al.* (1994) showed that among soccer players with an injury history, there was a reduction in ankle injury incidence among soccer players who wore an ankle brace compared to the players who did not wear a brace. Conversely, there was no significant difference among the braced and un-braced groups for soccer players without history of previous ankle injury.

- Playing surface: Playing surface could be natural or artificial. Artificial playing surfaces include tartan turf, super turf, and astro turf, all of which have been shown to increase the incidence of soccer injuries in comparison with natural playing surfaces such as grass or gravel (Powell and Barber-Foss, 2000). This is due to the stiffness and elevated shoe-surface frictional force associated with artificial playing surfaces. Adequate frictional force is required for executing several movements in soccer but an elevated frictional force increases the injury risk among players (Murphy, Connolly and Beynnon, 2003). However, Fuller *et al.* (2007) found no significant difference between artificial and natural playing surfaces among soccer players of both sexes.

2.4.3 Other risk factors

Besides the intrinsic-extrinsic form of risk factor classification, risk factors are also classified as either being modifiable or non-modifiable factors. Gender and age are classified as non-modifiable factors while factors such as strength and balance, which could be likely altered through physical conditioning and behavioural techniques, are classified as modifiable factors (R Bahr and Holme, 2003).

A vitae point to note that, mere classification of injury risks is not sufficient. The mechanism underlying the occurrence of injuries must also be known to establish an in-depth understanding of the causative factors. Therefore, dynamic models which describe and account for the interplay between risk factors and other events that contribute to injury incidence is required (Bahr and Holme, 2003). An example of such a model was developed by Meeuwisse (1994) (shown in Figure 2.2), and described the internal risk factors to be predisposing factors which are essential and inherent factors which are not usually enough to cause injury. External risk factors are described to be enabling factors, namely, factors that operate on the already predisposed player externally. The relationship between the predisposing and enabling factors is required to put the player in a state suitable for injury occurrence, at which point, the final aspect, namely the inciting event, which operates at the injury inception, acts on such player to cause injury (Meeuwisse, 1994). Bahr and Holme (2003) proposed expanding the description of inciting factors to provide a holistic view by accommodating other preceding events that contribute to the onset of injury, and by accounting for situations where the inciting factors are distant from the injury incidence such as accumulated effects

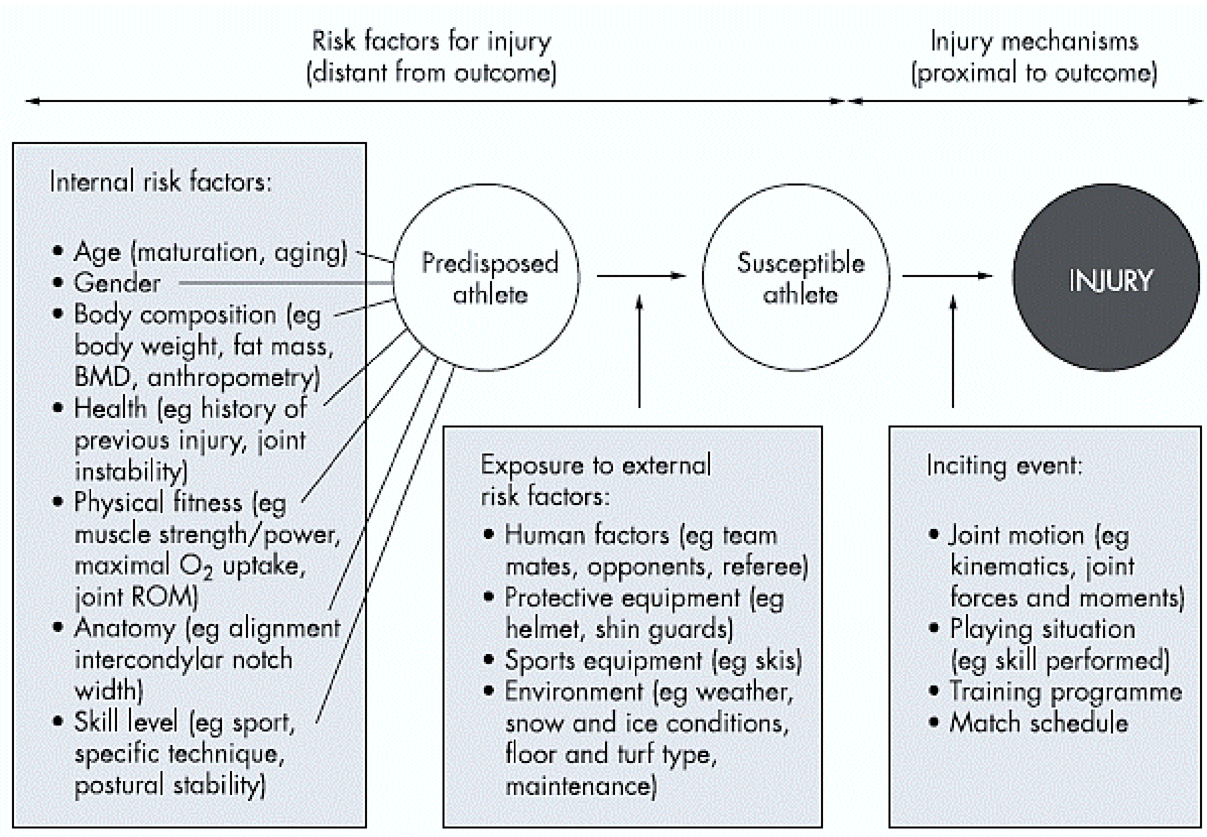

Figure 2.2: An adapted dynamic, multi-factorial model of sports injury etiology (Bahr and Holme, 2003)

In order to ensure more playing time and reduced financial implication associated with soccer injuries, injury prevention strategies have been developed to try and address the above-mentioned risk factors (Ackerman *et al.*, 2009).

2.5 FIFA medical and research council on injury prevention

Strong evidence supports the use of various modes of injury prevention programs to prevent football injuries in general (Fuller *et al.*, 2006). Targeted hamstring and knee injury intervention programs have successfully prevented these injuries (Caraffa *et al.*, 1996; Askling, Karlsson and Thorstensson, 2003). In spite of these reported successes, many injury-preventing training programs are generic and not tailored to a particular sport (Astrid Junge *et al.*, 2002; Engebretsen *et al.*, 2008; Steffen *et al.*, 2008; Emery and Meeuwisse, 2010; Handoll *et al.*, 2011; Longo *et al.*, 2012; Waldén *et al.*, 2012). These programs have largely been effective in reducing injury risks (Astrid Junge *et al.*, 2002; Grindstaff *et al.*, 2006; Soligard *et al.*, 2009; Longo *et al.*, 2012) albeit they are expensive to implement and require a considerable amount of time, unique equipment, and highly trained professionals to achieve effectiveness (Grooms *et al.*, 2013).

As a result, the Federation International de Football Association (FIFA) Medical Assessment and Research Centre (F-MARC) 11+ was developed as a cost- and time-effective alternative to solve the problems associated with the implementation of injury prevention programs. The F-MARC- developed programme reduced the duration of administration, administered low skill level requirement of strength and conditioning personnel for implementation, and required only a soccer ball as equipment. This programme was also an improvement on the previous version of the F-MARC 11 and provided a widely available injury prevention program (Ackerman *et al.*, 2009). The F-MARC 11+ consists of three parts, which are explained below:

"Part I: running exercises at a slow speed combined with active stretching and controlled partner contacts;

Part II: six sets of exercises, focusing on core and leg strength, balance, and plyometric/agility, each with three levels of increasing difficulty; and

Part III: running exercises at moderate/high speed combined with planting/cutting movements.

This exercise programme involves the use of common practice in the course of training which involves concentration regarding a correct body posture, a good body control, a straight leg alignment, a knee-over-toe posture and landing softly (Ackerman *et al.*, 2009).

Grooms *et al.* (2013), in their investigation on the effectiveness of the F-MARC 11+ program in reducing lower extremities injury risk among male collegiate soccer players, reported that the program which had been established to reduce injury risk among female collegiate soccer players had similar results in the male counterparts. It was also reported that the program was more effective at preventing injury compared to the conventional warm-up of equal duration. Furthermore, having an athletic trainer to direct the program enhanced compliance, continuation and delivery for the overall injury risk reduction. The result is in agreement which several other previous studies that reported injury reduction from 21 to 71% among youth soccer players of both sexes (Astrid Junge *et al.*, 2002; Soligard *et al.*, 2009; Longo *et al.*, 2012). However, the ideal situation would be that these prevention programmes be based on evidence regarding the risk factors, and the valid assessment thereof.

The prevention of injury recurrence however lacks similar evidence (Fuller *et al.*, 2006) although bracing and balance board training have been effective in reducing recurrence of previous ankle injuries (Surve *et al.*, 1994). In general, to reduce the high injury incidence and injury recurrence rate in soccer, prevention of secondary recurrence is vital (Hägglund, Waldén and Ekstrand, 2006). Trunk stabilization rehabilitation programs have, for example, showed a decrease in hamstring injury recurrence rates among athletes in other sports, excluding soccer (Sherry and Best, 2004).

2.6 Screening tools in soccer

Effective injury prevention programmes require systemic injury surveillance to be in place (Eirale *et al.*, 2017). There has been an advancement in the areas of injury etiology, identification of at-risk athletes, and screening tools; but the high level of soccer injuries still persists. This is due to the limited adoption of the injury prevention strategies that have been shown to reduce injuries in the lower extremities (Inklaar *et al.*, 1996; Alentorn-Geli *et al.*, 2009).

Performance and medical screening of players such as the Periodic Health Examination (PHE), is a common component of injury prevention strategies in elite sport (Bahr, 2016). During the season and pre-season periods, over 90% of the European elite soccer clubs carry out PHE, which consists of a medical test, performance test, and musculoskeletal screening tools such as sit and reach test, leg raise test, and range of motion (ROM) of the hip (McCall, Dupont and Ekstrand, 2016). The PHE is capable of promoting regular health surveillance and identifying common musculoskeletal or medical conditions that reduce players' performance and inhibit innocuous participation in competitions (Ljungqvist *et al.*, 2009). Furthermore, PHE gives a benchmark for clinicians and scientists to monitor rehabilitation progress and training response, and is also relevant for the development of injury prevention strategies (Jacobsson and Timpka, 2015; Drew, Cook and Finch, 2016). The medical test is not 100% significant to common soccer injuries as it involves mortality and illnesses.

2.6.1 Accuracy (reliability or validity) of screening tools

To measure the validity of a screening tool, it is preferably to use sensitivity and specificity statistics. Sensitivity and specificity helps to evaluate screening tools validity using percentages of the overall effects on the subject or injury screened. Likewise to measure the reliability we focus more on two aspects; inter-rater and intra-rater reliability. Inter-rater reliability can be seen as when different examiners perform a screen while inter-rater reliability is when the same examiner score different ratings on a performed screening (Kazman *et al.,* 2014).

A couple of screening tools have been investigated to determine their validity, reliability and specificity to predict injuries in soccer. These screening tools include the Functional Movement Screening (FMS™), Star Excursion Balance Test/Y Balance Test (SEBT/YBT), Drop Jump Test (DJT), Tuck Jump Assessment (TJA). Reliability studies have been carried out on these screening tools, although some of them lack evidence on validity. The accuracy studies on these screening tools are presented below.

2.6.2 Functional movement screening (FMS™)

FMS™ measures the basic prerequisite movements for athletic performance under seven distinct movement patterns and three clearing tests. Each movement pattern is graded from one to three, with an overall maximum score of 21 (Cook, Burton and Hoogenboom, 2006; Cook *et al.*, 2014). Reliability of a test is necessary to determine its validity (Chimera and

Warren, 2016). The inter-rater and intra-rater reliability of the FMS™ have been investigated by several studies (Smith, Chimera, Wright, 2013; Kraus *et al.*, 2014). The study by Smith *et al.* (2013) during a two hour training session reported a good inter-rater reliability for the first (ICC = 0.89; 95% CI: 0.80-0.95) and second (ICC = 0.87; 95% CI: 0.76-0.94) training sessions. The FMS™ was developed by athletic trainers and physical therapists, hence it has a good face validity (Cook, Burton and Hoogenboom, 2006; Cook *et al.*, 2014).

The capacity of an instrument to precisely identify a change after it has happened (responsiveness), as well as the validity, are both important in informing an instrument's accuracy (Beaton *et al.*, 2001; Chimera and Warren, 2016). Kazman *et al.* (2014)'s study to evaluate the construct validity of FMS™ using factor analysis reported a lack of unitary construct. Also, Cronbach's alpha indicated a small internal consistency. Several studies which reported the validity of FMS™ in predicting musculoskeletal injury using the single summed score (lesser or greater than 14) showed low sensitivity (Kiesel, Plisky and Voight, 2007; O'Connor *et al.*, 2011; McGill *et al.*, 2015; Warren, Smith and Chimera, 2015).

2.6.3 Star excursion balance test/Y balance test (SEBT/YBT)

The SEBT has been widely used and reported in research on dynamic balance assessment on diverse populations (Kinzey and Armstrong, 1998). To perform the SEBT, a grid pattern of tape strips is arranged on the floor, the participant then balances on one limb in the centre of the grid, while reaching out to the furthest distance as possible in a single direction with the other lower limb. The investigator then measures the reach distance at the point where the reaching limb touches down slightly, balance is maintained on the stance limb while returning the reach limb back to stance/initial position (Hertel *et al.*, 2006). The YBT is a version of the three reach SEBT and is intended to enhance test reliability (Plisky *et al.*, 2009). YBT utilizes a PVC piping device with a centre area and a reach indicator along the PVC piping tube. The participant balances on one limb in the centre area of the device and uses the other limb to push the reach indicator to the furthest distance the participant is capable of achieving (Chimera and Warren, 2016).

The modified SEBT and YBT are similar in that their scoring involves measuring the furthest reach distance in the three reach directions – posteromedial, anterior, and postero-lateral, and calculating a composite score for the reach (Chimera and Warren, 2016). Intra-rater reliability is similar between the modified SEBT (ICC range = 0.84-0.92; 95%CI: not reported) (Munro and Herrington, 2010) and YBT normalized reach distances (ICC range = 0.85-0.91 (95%CI: 0.64-0.95) (Plisky *et al.*, 2009). A comparison of the composite score between the modified SEBT and YBT cannot be made as a high intra-rater reliability of 0.91 (95%CI: 0.69-0.96) was reported by Plisky *et al.* (2009) while no value was reported for SEBT by Munro and Herrington (2010). Although inter-rater reliability is very good between the SEBT and YBT, inter-rater reliability of SEBT 0.89-0.94 (95%CI: 0.80-0.95) is slightly less than the YBT ICC 0.99-1.00 (95%CI: 0.92-1.0) for the normalized reach distances (Plisky *et al.*, 2009). Also on the composite score reliability, the SEBT 0.92 (95%CI: 0.85-0.96) is slightly less than the YBT with an ICC range of 0.97-0.99 (95%CI: 0.92-0.99) (Gribble and Hertel, 2003; Plisky *et al.*, 2009). The validity of the SEBT or YBT has not been reported in literature despite the high reliability rates reported for both (Chimera and Warren, 2016).

2.6.4 Drop jump test (DJT)

The DJT is used for clinical evaluation of landing patterns either with the Drop jump scoring test (DJST) or the Landing Error Scoring System (LESS).

2.6.4.1 DJST

To perform the test, the participant jumps thrice with “reflective” markers placed on his two lateral malleoli, centre of patella’s, and on the greater trochanters to assess the discrepancies between ankle, knee, and hip joints` separation during the three-phased (pre-landing, landing, and take-off) drop jump. The researcher analyse only the greatest representative jumps among the three (Noyes *et al.*, 2005). Studies on the reliability of the DJST have largely been conducted by a single research group (Chimera and Warren, 2016), with a high reliability reported. The ICCs of the three phases of the test were found being greater or equal to 0.90; however, the validity of the DJST has not been established (Noyes *et al.*, 2005).

2.6.4.2 LESS

The procedure for DJST and LESS is similar and the basic difference between them is that video recording in the frontal and sagittal planes during the participant’s jump landing is done in LESS. Also, the LESS requires the participant to jump from a 30cm-high box and land on the floor at half his height's distance from the box and instantly jump vertically as high as possible (Chimera and Warren, 2016).

The LESS is reliable and valid. The gold standard of 3-dimentionsal kinetic and kinematic analysis was used to determine the validity of LESS in a large study. The construct validity was established as lower scores on LESS correlated with decreased hip and knee flexion angle, high internal rotation moment, high hip abduction and knee valgus, and high anterior tibia shear force. The inter-rater reliability and intra-rater reliability of LESS were given as (ICC = 0.84) and (ICC = 0.91) respectively (Padua *et al.*, 2009, 2011). The reliability of LESS is very high irrespective of the skill level of the rater, with 80% to 100% agreement on kappa statistics for landing errors/individual items; and an overall ICC score of 0.84 (novice: Kappa = 0.583, Agreement = 85%, $P = 0.004$; expert: Kappa = 0.500, Agreement = 75%, $P = 0.01$) (Cortes and Onate, 2013).

Phi-correlation-coefficient analysis of the LESS yielded inconsistent validity depending on the landing error/individual item being evaluated (Onate *et al.*, 2010). Landing Error Scoring System-Real Time (LESS-RT) was developed to improve the usefulness of the LESS - its composite score had a good inter-rater reliability of ICC = 0.81 (Padua *et al.*, 2011). The quick version of LESS named "iLESS", which was developed as a time efficient clinical assessment also reported high agreement level between high skilled and novice raters (iLESS: Kappa = 0.692, Agreement = 90%, $P = 0.001$; LESS: Kappa = 0.600, Agreement = 80%, $P = 0.001$) (Cortes and Onate, 2013).

2.6.5 Tuck jump assessment (TJA)

The TJA is a time efficient (two minutes administration and 10 minutes scoring) clinical test to determine the lower limb landing technique flaws during a plyometric activity (Myer, Ford and Hewett, 2008; Myer *et al.*, 2011). The tests involves sagittal and frontal plane video recording of recurring tuck jumps which is then subsequently scored by repeated viewing of the slow motion recording (Chimera and Warren, 2016).

TJA has very good face validity as it was developed by movement experts (Hewett *et al.*, 2005; Boden *et al.*, 2010), but the validity has not been formally determined (Chimera and

Warren, 2016). The studies on the reliability of TJA reported diverging results (Myer *et al.*, 2011; Herrington, Myer and Munro, 2013), thereby necessitating further research to determine the reliability (Chimera and Warren, 2016). For example, Myer *et al.* (2011) reported an excellent inter-rater reliability of 93% and 0.88 Kappa agreement and excellent intra-rater reliability of 100% and 96% for the two involved assessors; however, a reliability study involving five raters with diverse level of expertise and education reported low inter-rater reliability (ICC = 0.47; 95% CI: 0.33-0.62). Intra-rater reliability ranged from 0.44 (0.22-0.68) to 0.72 (0.55-0.84) (Myer *et al.*, 2011; Dudley *et al.*, 2013).

2.7 Summary

It has been established in literature that high rates of injuries are common among soccer players compared to players in other occupations or sporting activities. This high rate of soccer injuries engendered a plethora of epidemiological studies on soccer injuries especially in developed countries, with very few of these studies emanating from Africa. These studies are imperative for an effective prevention planning.

A lot of injury-preventing training programs have been developed for soccer and for other sports. However, the ideal situation would be that these prevention programmes be based on evidence regarding the risk factors and the accurate identification of these factors, as well as the valid assessment thereof. The capacity of an instrument to precisely identify a change after it has happened (responsiveness), as well as the validity, are both important in informing an instrument's accuracy. However, the available screening tools to determine risk factors in soccer have not been comprehensively tested for their accuracy in the African population.

Although several systematic reviews related to common soccer injuries have been conducted in developed countries, none of them have addressed the screening tools for common soccer injuries. A systematic review is needed to supply the highest level of evidence to discuss the accuracy of the screening tools for soccer injuries, and will be outlined in the following chapter.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Chapter 3 describes the type of study and the design adopted. The information about the study setting, study participants, sampling techniques, and research procedure are provided. The study procedure was followed by discussing the data measurement tools, validation of the tools used for the systematic review, data collection and management, data analysis, and ethical procedures.

3.2 Study Design

A systematic review (quantitative and qualitative) was performed. A systematic review is a method of research that helps to respond to a specific question asked, by giving a better summary of the question asked. It follows a unique process of literature search (systematic search), critically appraising studies, and data synthesis which is important for combining separately conducted studies with conflicting or non-conflicting findings (Koretz, 2017).

Meta-analysis is used in quantitative systematic reviews and involves the combination of results of multiple studies to produce one effect with the use of statistical methods. Meta-analysis increases precision, responds to questions not asked in the study, and resolves controversies. Thus, this process was adopted for this study to increase analytical precision which involves using a forest plot (Needleman, 2002).

A forest plot is a method of data synthesis that reviews extracted data using a tabular summary to determine heterogeneity or homogeneity. Heterogeneity, or a lack of similarity in the extracted information, can be quantified statistically and is called statistical heterogeneity (Verhagen and Ferreira, 2014). Homogeneity among results, refers to similarity in studies (Koretz, 2017). In this case, pooling of results can be done. In the case of heterogeneity, the analysis will be adapted to a summary of aggregate data known also as interpretation. Interpretative qualitative analysis of data often leads to new understanding that can also fill a gap in the literature (Seers, 2015).

3.3 Procedure

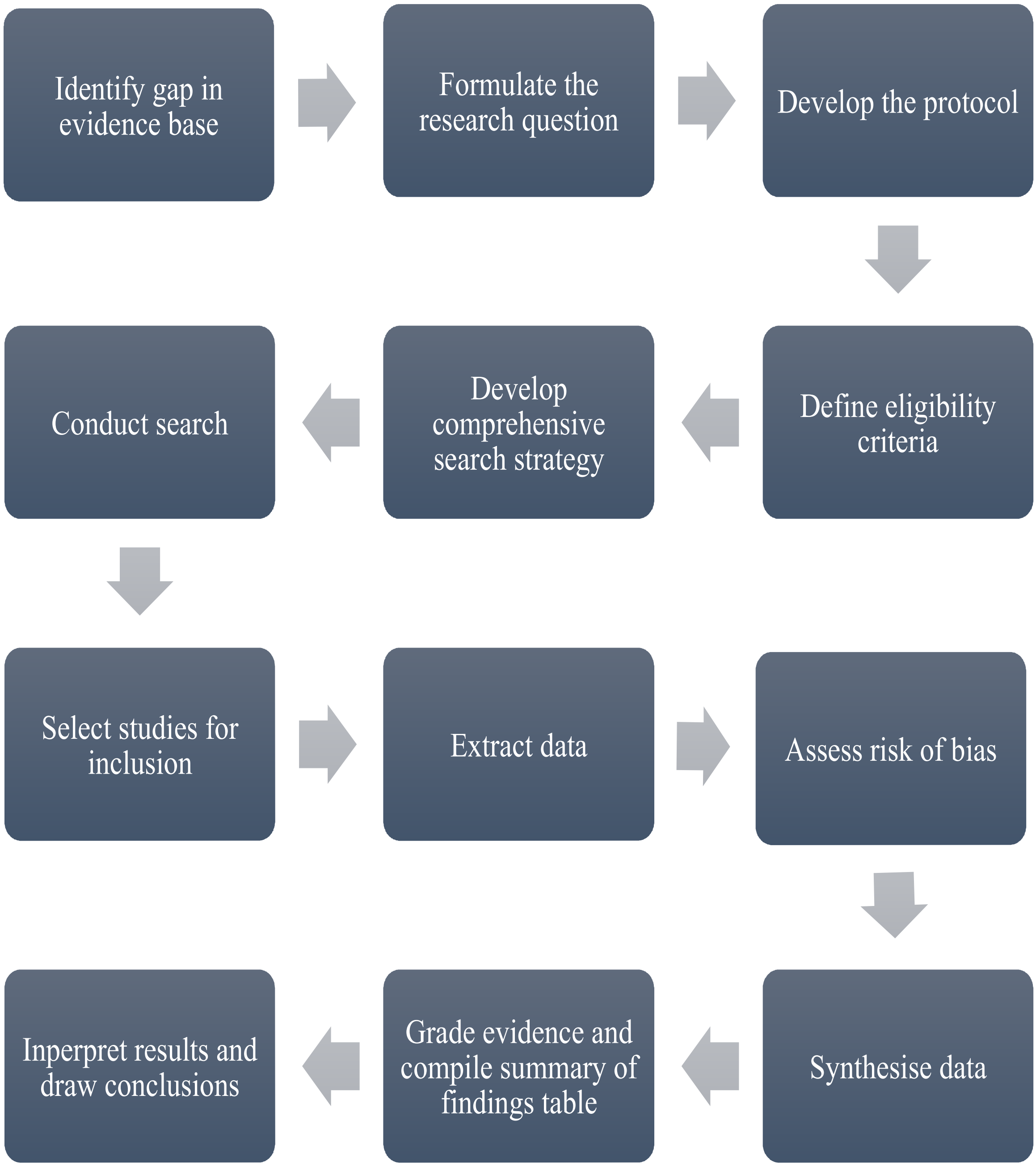

Figure 3.1: Steps for systematic review

Procedures followed in this systematic study include: defining the research question, determining the inclusion and exclusion criteria of studies examined, and critically appraising studies, systematic pooling of data for methodological quality, synthesising and analysing a forest plot graph and summary, and a qualitative review (Figure 3.1). The study also described conclusions on data synopses, examined and reported the known (results and strengths of this study) and unknown (missing information and limitations of the this study), (Cipriani and

Barbui, 2006). The review described each included study, relating it to the PICO format to ensure applicability of results. PICO is defined be in Table 3.1:

Table 3.1: Description of included studies using the PICO format

Population	• **They are the types of participants.** • **Soccer players.** • **Male and/or female.** • **Professional, elite and social.**
Intervention	• They are the manipulative effect of the population for an expected outcome. • Common injuries on soccer players and their risk factors. • They are the effects of screening tools (preventive/predictive) for common soccer injuries on soccer players and their accuracy.
Control	• They are the comparison of the effects of intervention. Not applicable to this study
Outcome	• They are the expected results. • Identification of common soccer injuries. • Identification of risk factors for common soccer injuries. • Identification of screening tools for common soccer injuries. • Identification of accuracy for common soccer injuries.

Analysis of a forest plot indicated studies that could be used for meta-analysis in this study, and helped to determine the specific outcome of heterogeneity, and the overall effects size (Wilson, 1999). The individual results of this study were expressed in a standard way, namely: odds ratios. Results were traditionally displayed in the figure of the forest plot.

The accuracy of the gauge is given by 95% confidential intervals. Synopsis esteems are determined for each study independently and combined with other studies, with a weighting dependent on the exactness of each study`s results. Data is exhibited as a summary value, 95% confidence interval, and P-value for the impact. Data heterogeneity was displayed as a I^2 -square value and the level of significance by a related P-value (Needleman, 2002).

This study design was adopted to respond to the research question. The process of adoption was conducted through the collaborative efforts of researcher Raphael Christopher (RC) and the research supervisor Corlia Brandt (CB), by carefully discussing the best research method that can be used to respond to the objectives and purpose of this study, and to minimize bias. Qualitative discussion of data also added to trustworthiness in improving reliability and accuracy of findings and conclusions (Needleman, 2002).

3.4 Search strategy

In order to access the relevant literature for this review, the following search strategy was utilized. Databases such as SPORT Discus, Cinahl, Medline, Science Direct, PubMed and grey literature were accessed. Manual search for grey literature was conducted subsequent to the electronic database search. Key terms included: soccer injuries or football injuries, injury screening, screening, screening tool accuracy, risk factors, epidemiology, injury incidence, injury prevalence, injury prediction, accuracy, validity, specificity, reliability, and sensitivity. Literature dating back to the year 2000 was accessed and only full text articles in English were included. Observational, such as prospective and retrospective cohort studies, case-control studies, cross-sectional studies, and case series and case reports, as well as clinical studies such as randomised clinical trials and other comparative studies were included in this review. This however led to an increase in the chance of heterogeneity of results. After pertinent studies were sourced through these databases, the reference lists of these articles were scrutinized to recognize further references related to the study objectives, and these were then sourced through the important databases. This procedure was completed until no further articles were identified for inclusion.

The search procedure was accomplished by three distinct steps;

Step 1: this step involved the selection of keywords from the abstract and title of this study such as, soccer injuries or football injuries, injury screening, screening, screening tool accuracy, risk factors, epidemiology, injury incidence, injury prevalence, injury prediction, accuracy, validity, specificity, reliability, sensitivity. This step also identified databases to be searched such as SPORT Discus, Cinahl, Medline, Science Direct, PubMed and grey literature, using the keywords to give a random knowledge of the selection process.

Step 2: step 2 involved a comprehensive search strategy, the use of specific keywords to provide relevant index terms amenable to the included databases. that described the necessary articles based on the objectives of this study such as:

("Risk factors") AND ((("elite soccer players" OR "elite football players") AND ("epidemiology" OR "injury incidence" OR "injury prevalence"))). This search was for the epidemiology for common soccer injuries and risk factors for common soccer injuries.

Screening OR "functional screening" OR "functional movement screening" OR "FMS™" OR "injury screening"))) AND (("elite soccer players" OR "elite football players")). (("soccer injuries" OR "football injuries"))). AND Grey literature. These keywords were used for screening tools for common soccer injuries.

(Accuracy OR validity OR reliability OR sensitivity OR specificity) AND (soccer OR football) AND (screening tools). For the accuracy of screening tools for common soccer injuries, these keywords were used.

Step 3: this last step involved selection of relevant studies found, based on their abstracts, titles, limitation by date, 2000s to date and limitation by language which was only studies done in English.

3.5 Inclusion criteria

The objectives, inclusion criteria and methods of analysis for this review were specified in advance and documented in the protocol in line with the Joanna Briggs Institute (2014) guidelines. The criteria can be explained under the following headings:

Condition: The variables under review included the most common soccer injuries, risk factors for common soccer injuries, accuracy of screening tools, and screening tests that determined risk of injury.

Context: Worldwide

Population: This review included studies involving male and female professional, elite, and social soccer players.

3.6 Exclusion criteria

Excluded studies, such as non-English studies, studies published before the year 2000, and animal studies, were excluded.

3.7 Assessment of methodological quality

Methodological quality of papers that were included in this review was determined by the criteria outlined in the JBI critical appraisal tool and included studies (Appendix A). The 38 studies appraised were cohort studies, thus only one appraisal tool was needed to rate the 38 studies. Description of rating is shown in Table 3.2 below.

Table 3.2: Description of JBI appraisal tool

Description of appraisal tool	Explanation
Study	Title of study for each study.
Author	Names of authors in each study.
Sample type	This is the representation of the population of each study, which is professional, elite and social soccer players.
Method of recruiting participants	This is the pattern soccer players were recruited for each study with inclusion of ethical approval.
Sample size	This is the number of soccer players recruited for each study.
Settings	This is the country and place where study took place for each study.
Analysis	This is the appropriate method of data analysis for each sample size used in each study
Outcome measurement	This is the outcome of measurements, based on the objective of each study.
Measurement validity	This consider the dependability of the measurement tool used.
statistical analysis	This defines the procedure of statistical analysis used for each study
Important differences	This defines the differences statistics analysis for different

accounted for	sample size mentioned for each study.
Subpopulation objective criteria	This defines grouping of populations for each study based on their objectives.
Include	This is the rating for the criteria mentioned above, if studies meet the inclusion criteria, then they move to data extraction processing.
Exclude	If studies do not meet the inclusion criteria mentioned above, then they will be excluded.
Seek further information	If details are unclear, then the researcher and research assistance would seek clarity from a third party, with more experience.

A blind review involving critical appraisal of the included articles was conducted by the researcher and a research assistant independent of each other. Inconsistencies in the data reviewed by both reviewers was resolved through discussion. Subsequently, the unresolved inconsistencies were resolved by the third reviewer (CB). The data was then finally captured in a Microsoft Excel spreadsheet.

3.8 Data extraction

A standardized data extraction tool (Appendix B), which permitted the extraction of similar information from the studies under review, was utilized to extract the significant data from the included articles. The data extracted included social, demographic, seasonal and other risk factors, zone, dates of survey or intervention, definitions of conditions and populations, inclusion and exclusion criteria, mean age, sex, sample size, statistical methods used to analyse data in the identified studies and estimates of prevalence and incidence.

A modified JBI data extraction form was created to accommodate data extraction for screening tools (Appendix C), and screening tools accuracy (Appendix D). The modification was done to suit the research objectives of this study. An additional element - screening tools identified- was added for the screening tools form. Likewise for the screening tools accuracy, an additional element - identification of screening tools accuracy - was added to the form.

The purpose of the extracted data would reflect areas of discrepancy/diverse uniqueness (heterogeneity) among studies that would influence the interpretation of the findings and data synthesis. The extent of heterogeneity amongst the studies under review would determine if and how data synthesis could be done.

3.9 Risk of bias

The risk of bias (ROB) was accessed by two researchers (RC) and Jejelaye Anthony, and it follows the guidelines stated by Bilandzic *et al* (2016) in the risk of bias of Non-Randomised Studies (ACROBAT-NRSI (version 1.0.0)**.** The ROB assessment for each study has seven domains. Each domain of risk of bias and its judgements is presented in table 3.3 below.

Table 3.3: Description of risk of bias and judgments

Risk of bias domain	Each domain judgement	Overall domain judgement
Bias due to confounding	Low ROB: considered a well performed with complete 7 ROB domains	Low ROB: low ROB for the 7 domains
Selection bias of participation	Moderate ROB: considered moderate with at least 6 well performed ROB	Moderate ROB: considered moderate with at least 6 low risk/1 moderate of the 7 domains
Bias in measurement of interventions	Serious ROB: considered serious when a vitae issue is recognized in any of the 7 domain	Serious ROB: considered serious with at least 1 serious ROB/0 critical ROB in any domain.
Bias due to departures from intended interventions	Critical ROB: considered problematic when there is issues with the effects of intervention	Critical ROB: considered critical with at least 1 critical ROB in one domain.
Missing data bias		
Outcome measurement bias		
Selective reporting bias		

3.10 Data synthesis

The reviewers synthesized data extracted from the studies under review using a descriptive format in a narrative and tabular summary. Inconsistencies in the data extracted by both reviewers was resolved through discussion. Subsequently, the unresolved inconsistencies were resolved by a third reviewer (CB). The data was then finally captured in a Microsoft Excel spreadsheet.

There was considerable heterogeneity across the studies examined in the result chapter (Chapter 4), after combining data in the forest plot. Therefore, statistical sources of heterogeneity were discussed using a statistical summary. The I^2 statistics was used to quantify the heterogeneity from 1 to 100% (Verhagen and Ferreira, 2014)

3.11 Data analysis

The forest plot area summarizes the results of test for heterogeneity performed. Data were analysed in Stata statistical software, version 15.1. The initial literature search on CINAHL, SPORT Discus, Science Direct, and PubMed, returned more than 26 citations. Plot data analysis was done using Stata statistical software, version 15.1. Incidence rates and odds ratios, and sensitivity and specificity were analysed with their respective 95% confidence intervals. I^2 statistic was used to determine the proportion of variation across studies.

3.12 Class of evidence

The class of evidence for this systematic review observed 10 recommended key items (Mueller *et al.*, 2018). They are listed and elaborated below in Table 3.4.

Table 3.4: Class of evidence recommendations

Protocol development	**This is often written in the initial stage of research. It gives a brief introduction of the research and methodology to be used for the research.**
Research question	This is the guideline for the research to be done, it set a sight for the research.
Search strategy	It is the pattern the search for studies in the database would be conducted and the databases and keywords to use.

Study eligibility	This includes the inclusion and exclusion criteria.
Data extraction	It gives idea of the method at which data would be extracted.
Study designs	This shows the different studies to be included.
Risk of bias assessment	ROB pave way for clarity of studies biases to be considered, it gives understanding of factors that may affect data synthesis.
Publication bias	Publication bias is as much of importance as it shows the study publication index
Heterogeneity	Heterogeneity is differences or lack of similarities in pooled data and the reason why.
Statistics analysis	This is the combination of variables to produce one effect.

3.13 Summary of findings

The finding of this study is to determine common soccer injuries, the risk factors for these injuries, the screening tools used for measurements of risk factors and the accuracy of these tools. The findings were compared between systematic results findings and that of the literature review. The results emanating from the methodology above, are presented in the following chapter according to the identified research objectives and aims.

3.14 Ethical Consideration

Ethical waiver for this study was obtained from the Human Research Ethics Committee of the University of the Witwatersrand, Johannesburg, South Africa (Appendix E). The researcher also complied with requirements by submitting a Turnitin report to state that no plagiarism was committed (Appendix F).

CHAPTER 4: RESULTS

4.1 Introduction

The chapter includes description of studies (included and excluded studies), followed by tables presenting the excluded articles with reasons for exclusion, ROB of included studies, forest plots depicting the heterogeneity/homogeneity of studies and overall effects, and conclusive summary of findings tables.

4.2 Identification and selection of studies

Through relevant searches using specific keywords, and databases that suited the purpose of the study, the search procedure involved three separate literature searches in tandem with each objective. The results will be presented according to the following objectives of the study:

- Objective 1 and 2: common injuries and risk factors for injuries in soccer players.

- Objective 3: screening tools for common soccer injuries.
- Objective 4: accuracy of screening tools for common soccer injuries.

Tables 4.1, 4.2 and 4.3 below, show a tabular representation of keywords used, databases searched, and the numbers of studies found. Figures of databases searched are attached as (Appendix G)

Table 4.1: Search results for objective 1 and 2

Keywords	Database	Number of studies found
("Risk factors") AND ((("elite soccer players" OR "elite football players") AND ("epidemiology" OR "injury incidence" OR "injury prevalence"))).	PUDMED SCIENCE DIRECT SPORT Discus CINAHL AND MEDLINE	19 23 2 18

For objectives 1 and 2, database searches returned a total of 62 related studies. Of these 62 studies, 10 studies were removed for being duplicates, while 21 studies were retrieved from databases by downloading, based on the PICO format. The remaining 31 studies were excluded for reasons stated below:

- Fifteen studies discussed injury incidences in football, not soccer.
- One study discussed the Benin paroxysmal positioning vertigo in sport.
- One study described the prevalence of hip abnormality in sport.
- One study focussed on upper extremities injuries in soccer.
- Two studies were in a different language other than English.
- Seven studies focussed on concussion in sports.
- Four studies had no relationship with soccer or soccer injuries.

Table 4.2: Search results for objective 3

Keywords	Search engines	Number of studies found
screening OR "functional screening" OR "functional movement screening" OR "FMS™" OR "injury screening"))) AND (("elite soccer players" OR "elite football players")). (("soccer injuries" OR "football injuries"))). AND Grey literature.	PUDMED SCIENCE DIRECT SPORT Discus CINAHL AND MEDLINE	2 18 4 1

For objective 3, database searches identified 25 studies. Of these 25 studies, four studies were identified as duplicates, seven studies were retrieved from databases by downloading based on the PICO format, and seven studies were excluded due to the following reasons:

- Two studies were identified to be systematic review studies.
- One study is about serum paediatric treatments.
- Two studies focussed on football and not soccer.
- One study focused on screening tools for rugby.
- One study discussed intervention for concussion injuries.

Table 4.3: Search results for objective 4

Keywords	Search engines	Number of studies found
(accuracy OR validity OR reliability OR sensitivity OR specificity) AND (soccer OR football) AND (screening tools)	PUDMED SCIENCE DIRECT SPORT Discus CINAHL AND MEDLINE	24 2 16 28

Out of a total of 70 studies, 50 studies were left after duplicates were removed, 34 of these studies were excluded due to the following reasons:

- Seventeen studies focussed on football screening tools and not on soccer.
- Nine studies focused on rugby and cricket sports
- Five described the impacts on head injuries.
- Three studies were not concentrating on soccer nor soccer screening tools

The flow diagram in figure 4.1 below gives an illustration of how studies were selected, included, excluded and appraised.

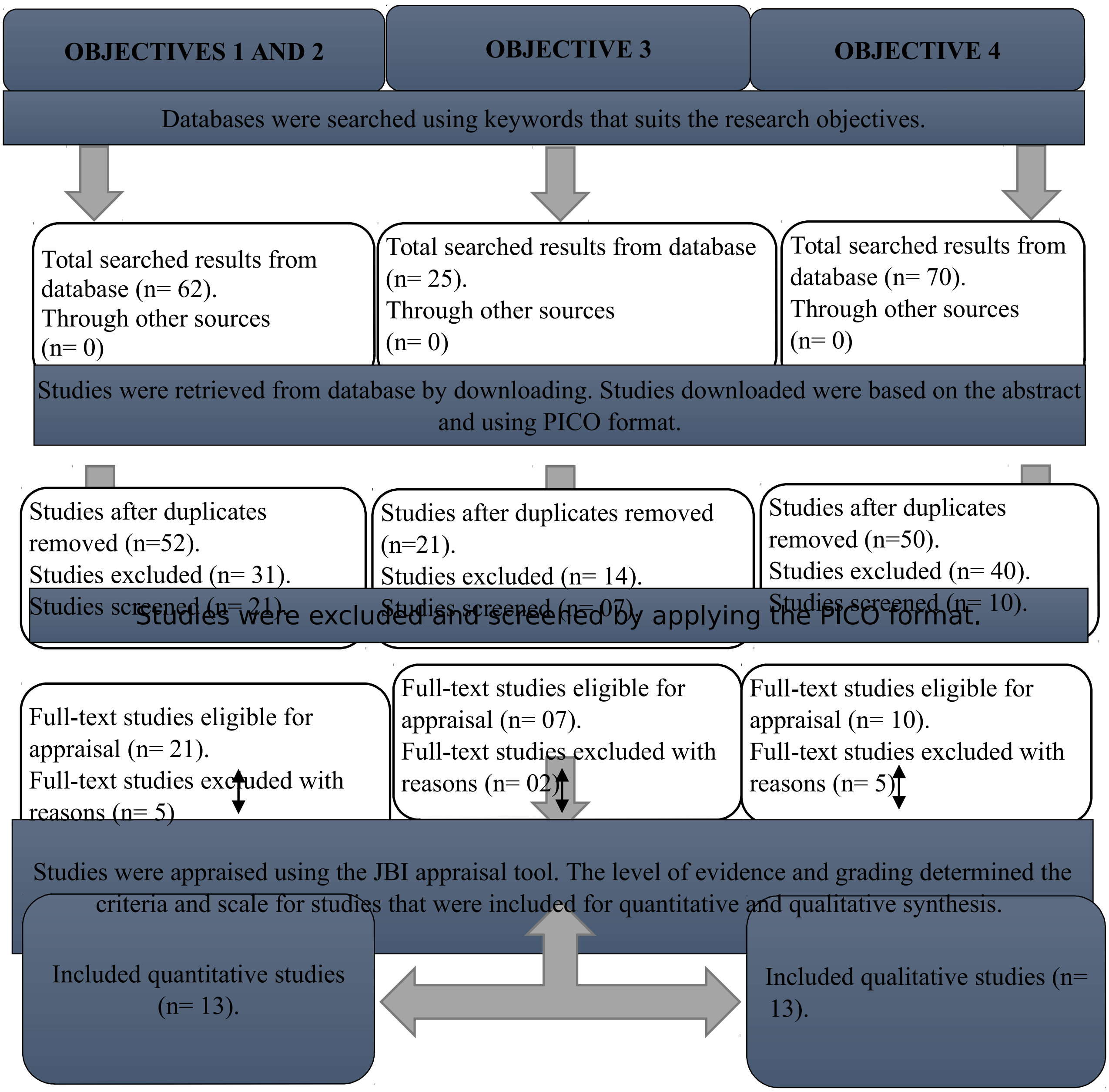

Figure 4.1: Flow diagram for studies retrieved for the four objectives

4.3 Methodological quality of studies

Studies included for the methodological quality were 38 full texts studies, all of which were observational studies (appendix A). The rating of the methodological quality of included studies was done using a 9 point scale system, each point rating each quality assessment. A total of 9 assessment quality. A study is excluded if they have less than 7 point mark and automatically disqualified if they do not have the right sample type. Table 4.4 below shows the rating of methodological quality of studies.

Table 4.4: Rating of methodological quality of included studies

Included studies	Rating of methodological quality of studies								
Objective 1	**Sample type**	**Sample size**	**Aim**	**Follow up duration**	**Dependant variable**	**outcome**	**Outcome measurement**	**Data analysis**	**Identification of objective**	**Total**
Smith *et al.*	No	No	No	No	No	No	No	No	No	0
Carling *et al.*, 2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Schiffner *et al.*, 2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Lee *et al.*, 2014	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Merron *et al* 2006	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Ekstrand *et al* 2013	Yes	Yes	No	Yes	No	No	No	Yes	No	4
Coso *et al.*, 2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Mughogho 2012	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Konopinski *et al.*, 2016	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Objective 2	**Sample type**	**Sample size**	**Aim**	**Follow up duration**	**Dependant variable**	**outcome**	**Outcome measurement**	**Data analysis**	**Identification of objective**	**Results**
Brink *et al.*, 2010	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Timmins *et al.*, 2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Arnason *et al.*, 2014 <u>***Continue.***</u>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Dupont *et al.*, 2010	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Ivarsson and Johnson2010	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Lee *et al.*, 2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9

Hides and Stanton 2017	No	No	No	No	No	No	No	No	No	0
Malone *et al.*, 2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Malone *et al.*, 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Reed	Yes	Yes	No	No	No	No	No	Yes	No	3
Rogalski *et al.*, 2013	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Gabbe, Bennell and Finch 2006	No	No	No	No	No	No	No	No	No	0
Objective 3	**Sample type**	**Sample size**	**Aim**	**Follow up duration**	**Dependant variable**	**outcome**	**Outcome measurement**	**Data analysis**	**Identification of objective**	**Results**
Amin 2013	Yes	No	Yes	No	Yes	Yes	No	No	Yes	5
Hartley 2016	Yes	No	Yes	No	Yes	Yes	No	No	Yes	5
Silver *et al.*, 2017	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	8
Lehance *et al.*, 2009	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Hammes *et al.*, 2016	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Frohm *et al.*, 2012	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Objective 4	**Sample type**	**Sample size**	**Aim**	**Follow up duration**	**Dependant variable**	**outcome**	**Outcome measurement**	**Data analysis**	**Identification of objective**	**Results**
Padua *et al.*, 2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Chorba *et al.*, 2010	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Myre *et al* 2010	No	No	No	No	No	No	No	No	No	0
Reed 2016	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
Gabbe *et al.*, 2004	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Grygorowicz *et al.*, 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9
McCunn *et al.*, 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9

Armstrong and Greig 2008	No	No	No	No	No	No	No	No	No	0
Chalmers *et al* 2017	No	No	No	No	No	No	No	No	No	0
Smith *et al* 2017	No	No	No	No	No	No	No	No	No	0
Lichtenstein *et al* 2014	No	No	No	No	No	No	No	No	No	0

4.4 Excluded studies

Of the 157 studies initially found, 38 articles were assessed for eligibility, and 26 studies met the inclusion criteria for the four objectives. The 13 full texts studies excluded with reasons are described in table 4.4.

Table 4.5: Characteristics of excluded studies

Objective 1	**reasons for exclusion**
Smith 2016	Not specific to the intervention
Ekstrand 2013	Not specific to the intervention
Objective 2	**reasons for exclusion**
Reed 2018	Aim not specific to the risk factors of common soccer injuries.
Gabbe 2006	Not specific to the population
Hides 2017	Not specific to the population
Objective 3	**reasons for exclusion**
Hartley 2016	Not specific to the population, intervention, control, and outcomes.
Amin 2013	Not specific to the population and intervention
Objective 4	**reasons for exclusion**
lintenstein 2014 ac	Not specific to the Intervention

Myre 2010 ac	Not specific to soccer alone, involves other sports.
Chalmers 2017ac	Not specific to soccer alone, involves other sports.
Smith 2017ac	Not specific to soccer alone, involves other sports.
Armstrong 2018ac	Not specific to the population

4.5 Included studies

The characteristics of included studies were reviewed using the PICO format (Davies, 2011). Only 38 studies met the methodological quality required for this review and out of the 38, 12 studies were excluded with reasons stated in Table 4.4 above. The characteristics of included studies are stated in table 4.5, showing the population, intervention, outcome, location, setting and design, categorized by the objectives of this review.

Table 4.6: Summary of the characteristics of included studies

Objective 1	Population	Intervention	Outcome	Location	Setting	Design
Carling *et al.*, 2016	Male professional football players, first-team squad of a French League 1 Club (2009–2015).	Common soccer injuries	Strains: hamstring, quadriceps, groin and calf injuries. Sprains: ankle, knee and contusions.	Soccer field	France	observational study
Schiffner *et al.*, 2018	First division soccer players German Bundesliga	Common Soccer injuries	Anterior cruciate ligament rupture ACLR	Soccer field	Germany	cohort study
<u>Continue.</u> **Lee *et al.*, 2014**	152 players from 10 professional	Common soccer injuries	Ligaments sprains: ankle and knee sprain,	Soccer field	Hong Kong	cohort study

	teams, in the in the Hong Kong football Association first division league consisting. 2010-2011		Muscles strains: thigh strain, hamstring strains, and quadriceps strains. Contusion.			
Merron *et al.*, 2016	197, senior and youth first team squad of the English football association youth cup	Common soccer injuries	Ligaments sprains: ankle and knee sprain, Muscles strains: calf, groin, thigh strain, hamstring strains, and quadriceps strains. Tendinitis and Contusion.	Soccer field	England	cohort study
Del coso *et al.*, 2018 ***<u>Continue.</u>***	25,397 adults and under-18 female soccer players of the Royal Spanish Football Federation (RSFF). 2010-	Common soccer injuries	Ligaments sprains: ankle and knee sprain, Muscles strains: calf, groin, thigh strain, hamstring strains, and quadriceps strains.	Soccer field	Spain	cohort study

	2011		Tendinitis and Contusion.			
Mughogho 2012	200 football players, from 12 of the 15 Malawi league teams. 2010-2011.	Common soccer injuries	Lower limb. Ligaments sprains: ankle sprain,	Soccer field	Malawi	Concurrent Mixed method
Konopinski *et al.*, 2016	80 male participants of 3 clubs participating English Championship 2012-2013 season	Common soccer injuries	Thigh, knee, ankle and groin.	Soccer field	England	cohort study
Objective 2	**Population**	**Intervention**	**Outcome**	**Setting**	**Location**	**Design**
Continue. **Brink *et al.*, 2010**	53 elite Dutch male soccer players. 2006-2008	Risk factors for common soccer injuries	Physical stress and Psychological stress. Risk factors for: Traumatic and overuse injuries of the lower limb	Soccer field	Netherland	Cohort study
Timmins *et al.*, 2016	152 outfield elite soccer players in eight professional	Risk factors for common soccer injuries	Eccentric Knee flexor strength and Short biceps femoris fascicles (BFlh	Soccer field	Australia	Cohort study

	Australian Football teams. 2014-2015		fascicles) Risk factors for: Hamstring strains injuries			
Arnason *et al.*, 2004 ***Continue.***	306 male football players from the two highest divisions in Iceland, 1999.	Risk factors for common soccer injuries	Age, previous injuries: hamstrings. Groin: previous groin and decrease in ROM of hip adductor. Previous injuries for knee and ankle sprains. Risk factors for: Hamstrings strains, groin strains and, knee ankle sprains	Soccer field	Iceland	Cohort study
Dupont *et al.*, 2010	32 professional outfield soccer players playing for the same top-level team. 2007-2009.	Risk factors for common soccer injuries	Hamstrings strains, groin strains and, knee ankle sprains, contusions. Risk factors for: Stress: two matches per	Soccer field	Scotland	Cohort study

			week. Recovery time			
Ivarsson and Johnson 2010	48 male soccer players. Sweden. 2009.	Risk factors for common soccer injuries	Psychological factors, personality trait predictors, and daily hassles. Risk factors for: Not mentioned. Just generalized using injuries	Soccer field	Sweden	Prospective study
Lee *et al.*, 2018. ***Continue.***	146 professional Football Chinese national football league. 2017.	Risk factors for common soccer injuries	Lower isokinetic hamstring strength, lower hamstring-to-quadriceps strength ratio, and previous injury of HIS. Risk factors for: Hamstring strain injury	Soccer field	China	cohort study
Malone *et al.*, 2018	37 players. 2015-2016.	Risk factors for common soccer injuries	Large weekly changes of high speed running and speed running. Risk factors for: Lower limbs	Soccer field	Portugal	Observational prospective cohort study

Malone *et al.*, 2017	Forty-eight professional soccer players from two elite European teams. One season	Risk factors for common soccer injuries	Work load. Risk factors for: Lower limb with high rate of muscles injuries.	Soccer field	Europe	Observational cohort study
Rogalski *et al.*, 2013	46 elites Australian footballers. 2010.	Risk factors for common soccer injuries	Work load. Risk factors for:	Soccer field	Australia	Cohort study
Objective 3	**Population**	**Intervention**	**Outcome**	**Setting**	**Location**	**Design**
Continue. **Silver *et al.*, 2017**	Twenty-two under 16 national competitive soccer players. 2 days.	Screening tools for common soccer injuries.	Anthropometrics. FMS™: the deep squat, hurdle step, in-line lunge Shoulder Mobility, active straight leg raise, trunk stability push-up, and rotary stability and three clearing examinations. Jump performance, instep kick speed (shot speed) and anaerobic performance.	Melgaço School of Sports and Leisure biomechanics laboratory.	Portugal	Observational Study

			Screening tools for: Physical performance,			
Lehance ***et al.*****, 2019** ***Continue.***	Fifty-seven elite and junior elite male soccer players from a Belgian First Division team	Screening tools for common soccer injuries.	Functional performance: squat jump and 10m sprint. Screening tools for: the risk of Imbalance and implement antagonist strengthening in lower limb. Acute muscles injuries	Soccer field	Belgium	Observational study
Hammes ***et al.*****, 2016**	238 veteran footballers of 18 teams. 9 months.	Screening tools for common soccer injuries.	FMS™ score Screening tools for: musculoskeletal injuries	Soccer field	Norway	Prospective study
Frohm ***et al.*****, 2012**	18 male elite soccer players of two elite soccer teams. One month.	Screening tools for common soccer injuries.	Functional movement screen: One legged squat, two legged squat, and straight leg raise test, and seated rotation test. In line lunge test, and active hip flexor test.	Test room	Sweden	Reliability study

			Screening tools for: Stability and mobility of the lower limb, Overuse and acute injuries			
Objective 4	**Population**	**Intervention**	**Outcome**	**Setting**	**Location**	**Design**
Padua *et al.*, 2015	829 elite-youth soccer athletes, boys and girls from North Carolina and from Maryland. 2006-2009.	Screening tools for common soccer injuries and its accuracy	Less score Screening tools for: Anterior Cruciate Ligaments	Field-based functional movement screening performed at soccer	USA	Cohort study
Chorba *et al.*, 2010	Thirty-eight female student-athletes.	Screening tools for common soccer injuries and its accuracy	FMS™ score Screening tools for: Anterior Cruciate Ligaments	Field	USA (Ohio)	Cohort study
Read *et al.*, 2016	25 youth soccer players from the academy of a professional English Championship soccer club.	Screening tools for common soccer injuries and its accuracy	Tuck jump Screening tools for: Neuromuscular control Ankle and knee sprain. Anterior Cruciate Ligaments	Soccer field	England.	Re-test study

Gabbe *et al.*, 2004 ***<u>Continue.</u>***	Fifteen participants (nine female and six male) volunteered For this study. All participants were staff or postgraduate students of the School of Physiotherapy at the University of Melbourne who reported the absence of a current musculoskeletal injury of the lumbar spine or lower limb	Screening tools for common soccer injuries and its accuracy	Musculoskeletal screening tests: Sit and reach test – risk for hamstring Lumbar spine extension-ROM- risk of knee injury. Active hip internal ROM. Active hip external ROM. Passive straight leg raise. Active knee extension test. Active slump test.	Field	Australia	Cohort study
Grykorowics *et al.*, 2017	66 professional soccer players of the Polish Premier League.	Screening tools for common soccer injuries and its accuracy	Cut off values for conventional hamstrings-to-quadriceps ratio.	Field	Poland	Retrospective study

<u>***Continue.***</u>	2010-2016		Screening tools for: risk of hamstring, Muscle strain or ligament rupture.			
McCunn *et al.*, 2017	25 healthy, recreationally active university students.	Screening tools for common soccer injuries and its accuracy	Soccer injury movement screen: the anterior reach, single-leg deadlift, in-line lunge, single-leg hop for distance and tuck jump.	Field	Germany	Test-retest design

4.6 Risk of bias of included studies

This study used **ACROBAT-NRSI (version 1.0.0)** to asses study risk. The risk of bias assessments tool has seven domains for each study and these domains were judged using the low, moderate, serious and critical scale as described in table 3.2 in the methodological chapter of this study.

Table 4.7: Risk of Bias Summary Table.

Included studies		**Risk of bias domains**						**Overall ROB Judgement**
Objective 1	**Bias due to confounding**	**Selection bias of participation**	**Bias in measurement of interventions**	**Bias due to departures from intended interventions**	**Missing data bias**	**Outcome measurement bias**	**Selective reporting bias**	
Carling *et al.*, 2015	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Schiffner *et al.*, 2018	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Lee *et al.*, 2014	Low	Low	Low	Low	Low	Low	Low	Low
Merron 2006	Low	Low	Low	Low	Low	Low	Low	Low
Continue.	Low	Low	Low	Low	Low	Low	Low	Low

Coso *et al.*, 2018								
Mughogho 2012	Low	Low	Low	Low	Low	Low	Low	Low
Konopinski *et al.*, 2016	Low	Low	Low	Low	Low	Low	Low	Low
Objective 2	**Bias due to confounding**	**Selection bias of participation**	**Bias in measurement of interventions**	**Bias due to departures from intended intervention s**	**Missing data bias**	**Outcome measurement bias**	**Selective reporting bias**	
Brink *et al.*, 2010	Low	Low	Low	Low	Low	Low	Low	Low
Timmins *et al.*, 2015	Low	Low	Low	Low	Low	Low	Low	Low
Arnason *et al.*, 2014	Low	Low	Low	Low	Low	Low	Low	Low
Dupont *et al.*, 2010	Low	Low	Low	Low	Low	Low	Low	Low
Ivarsson and *Continue.* Johnson2010	Low	Low	Low	Low	Low	Low	Low	Low
Lee *et al.*,	Low	Low	Low	Low	Low	Low	Low	Moderate

2018								
Malone *et al.*, 2018	Low	Low	Low	Low	Low	Low	Low	Low
Malone *et al.*, 2017	Low	Low	Low	Low	Low	Low	Low	Low
Rogalski *et al.*, 2013	Low	Low	Low	Low	Low	Low	Low	Low
Objective 3	**Bias due to confounding**	**Selection bias of participation**	**Bias in measurement of interventions**	**Bias due to departures from intended interventions**	**Missing data bias**	**Outcome measurement bias**	**Selective reporting bias**	
Silver *et al.*, 2017	moderate	Low	Low	Low	Low	Low	Low	Moderate
Lehance *et al.*, 2009	Low	Low	Low	Low	Low	Low	moderate	Moderate
Hammes *et al.*, 2016	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Continue. **Frohm *et al.*, 2012**	Low	Low	Low	Low	Low	Low	Low	Low
Objective 4	**Bias due to confounding**	**Selection bias of participation**	**Bias in measurement of interventions**	**Bias due to departures from intended**	**Missing data bias**	**Outcome measurement bias**	**Selective reporting bias**	

				intervention s				
Padua *et al.*, 2015	Low	Low	Low	Low	Low	Low	Low	Low
Chorba *et al.*, 2010	Low	Low	Low	Low	Low	Low	Low	Low
Reed 2016	Low	Low	Low	Low	Low	Low	Low	Low
Gabbe *et al.*, 2004	Low	Low	Low	Low	Low	Low	Low	Low
Grygorowicz *et al.*, 2017	Low	Low	Low	Low	Low	Low	Low	Low
McCunn *et al.*, 2017	Low	Low	Low	Low	Low	Low	Low	Low

The overall judgements shows that out of 26 studies, 20 studies (77%) were graded low risk and six studies (23%) were graded moderate risk.

- One study, (Silver *et al.,* 2017) showed a bias in confounding, which is as a result of a new variable in the final results.
- Three studies, (Carling *et al.,* 2015; Hammes *et al.,* 2016; Schiffner *et al.,* 2018) showed selection bias in participation, which is due to missing information of the exact numbers of included participants in the study.
- Source of funding was not reported by any study.

4.7 Tests for heterogeneity

Heterogeneity is the lack of similarity in the extracted data from included studies. A forest plot is a method of data synthesis that reviews extracted data using a tabular summary in determining the heterogeneity or homogeneity. Studies to be assessed at this stage need to have complete information on estimates like incidence rates, odd ratios or risk ratios with their confidence intervals, and address questions similar or direct to the study objectives. Thus, Table 4.7 shows groups/subgroups of included studies and their estimates.

Table 4.8: Statistics used for included studies

Study	**Estimates**	
Objective 1	Group incidence rate	Sub-group odd ratio
Lee *et al.*, 2014	Incidence of 0.040 per 1000 h	
Konopinski *et al.*, 2016	Incidence of 5.2 [0.9-2.7] injuries/1000h	
Brink *et al.*, 2010	Incidence of 37.55 per 1000 match hours	
Arnarson *et al.*, 2004	Incidence 24.6 injuries per 1000 player hours	
Dupont *et al.*, 2010	Incidence 48.7 injuries per 1000 hours	
Malone *et al.*, 2018	Incidence Match injury= (90% CI: 8.87–14.92), training injury = (90% CI: 3.95–	
Malone *et al.*, 2017	Incidence 4.9/1000 h, (95% CI: 4.11–5.12). 6.9/1000 h, (95% CI: 6.15–7.33).	
Rogalski, *et al.*, 2013	Incidence (x^2 = 9.37, df = 1, p = 0.002) 32.8 per 1000 h	
Objective 2	Group incidence rate	Sub-group odd ratio
Merron *et al.*, 2016	Incidence 7.59 injuries per player per 1000 hours	
Timmins *et al.*, 2016		(OR=0.261; 95% CI 0.10 to 0.57; p=0.002
Arnarson *et al.*, 2004		Odds ratio [OR] = 1.1 per year, P = 0.05).
Malone *et al.*, 2018		OR: 0.12, 90%CI: 0.08–0.94)

		OR: 0.54, 90%CI: 0.41–0.85)
Malone *et al.*, 2017		OR = 4.52, p = 0.011). (OR = 4.52, p = 0.011).
Objective 3 and 4	Group sensitivity	Sub-group specificity
Chorba *et al.*, 2010	sensitivity of 0.579 (CI95= 0.335 to 0.798)	specificity of 0.737 (CI95=0.488 to 0.909)
Padua *et al.*, 2015	sensitivity of 86%. 18.3, 95% CI 14.9–21.7) = 0.17).	A specificity of 64%. 18.3, 95% CI 14.9– 21.7) = 0.17).
Grygorowics *et al.*, 2017	(specificity of 46.9% vs. 24.1%, respectively; t = 229.0, p<0.0001)	(specificity of 46.9% vs. 94.5%, respectively; t = 153.0,p<0.0001)

4.8 Forest plot

Approximately seven studies reported incidence rates with respective 95% confidence intervals. These studies are summarized in Table 4.8. There was considerable heterogeneity across the studies (98%). The heterogeneity was statistically significant (χ^2-p value <0.001), examined below in Figure 4.5. A portion of the heterogeneity was due to different injuries and locations. The incidence of injuries for this study sample is 6.83 per 1000 hours of play.

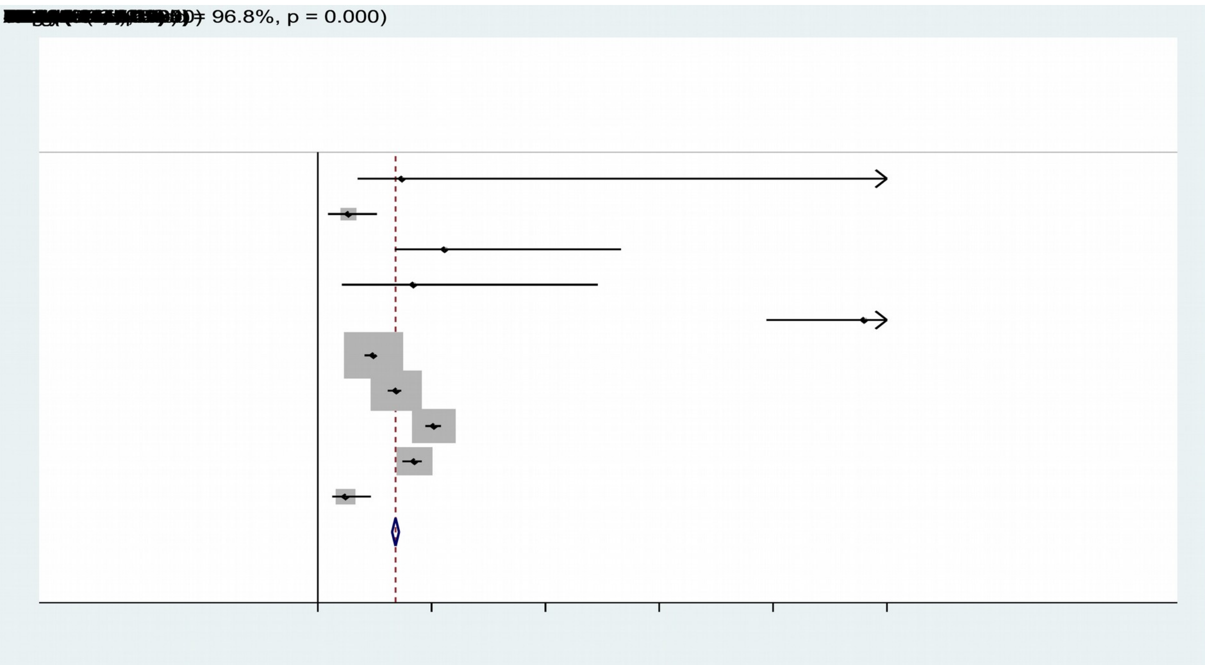

Figure 4.2: Forest plot graph for objective 1

Table 4.9: Incidence of injuries for objective 1

Study	Incidence per 1000 h	Lower 95% CI limit	Upper 95% CI limit
Lee 2014	7.4	3.5	61.1
Konopinski 2016	2.7	0.9	5.2
Brink 2010	11.14	6.74	26.65
Arnason 2004	8.4	2.1	24.6
Dupont 2010	48	39.4	58
Malone 2018	4.9	4.11	5.12
Malone 2018	6.9	6.15	7.33
Malone 2017	10.2	9.45	10.84
Malone 2017	8.5	7.44	9.15
Rogalski 2013	2.44	1.28	4.66

For objective 2, approximately five studies reported odd ratios with respective 95% confidence intervals. These studies are summarized below in table 4.9. There was considerable heterogeneity across the studies examined for studies assessing the risk of injuries using odd ratios, we observed considerable heterogeneity (98%). The heterogeneity was statistically significant (χ^2-p value <0.001), indicated below in Figure 4.6. Furthermore, the results shows there is a higher likelihood for injuries to most common injuries and this was statistically significant (OR=1.12 95% CI 1.07; 1.17).

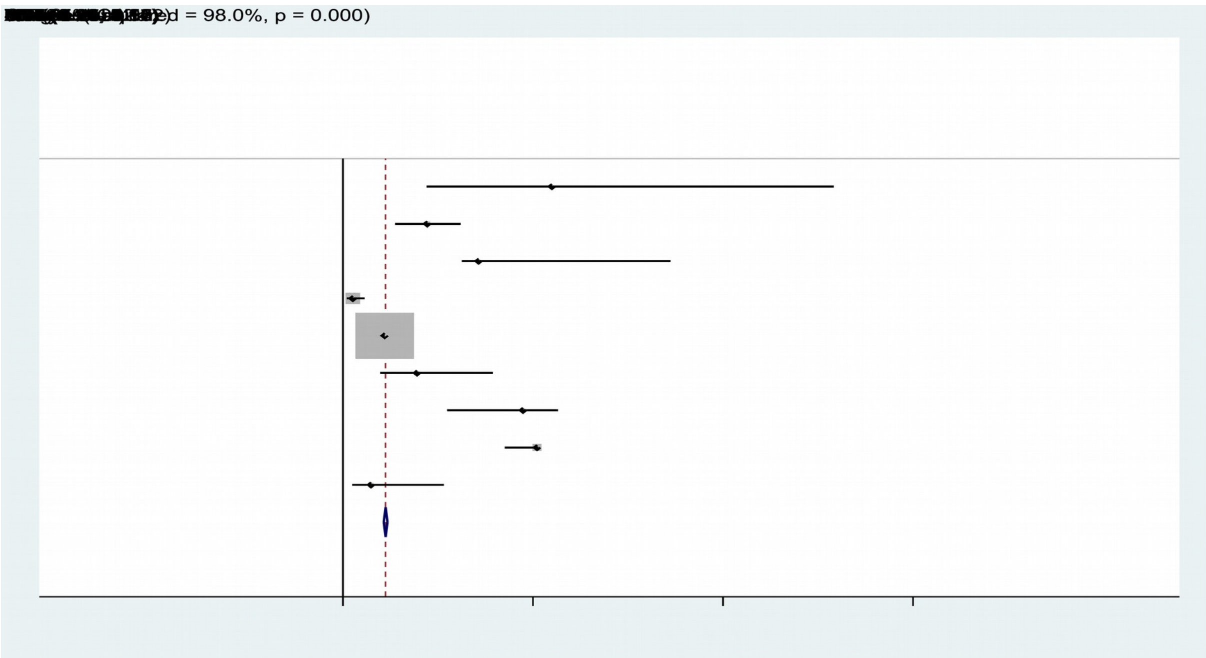

Figure 4.3: Forest plot graph for objective 2

Table 4.10: Risk of injuries for objective 2

Study	Odd Ratio	Lower 95% CI limit	Upper 95% CI limit
Merron 2016	5.5	2.2	12.92
Merron 2016	2.22	1.37	3.1
Merron 2016	3.57	3.13	8.62
Timmins 2016	0.261	0.1	0.57
Arnason 2004	1.1	1	1.1
Malone 2018	1.95	0.98	3.95
Malone 2018	4.74	2.74	5.66
Malone 2017	5.11	4.26	5.14
Malone 2017	0.74	0.24	2.66

For objective 4 and 5 (sensitivity and specificity), only 3 studies reported the estimates with the 95% confidence intervals. These studies are summarized in Table 4.10. There was considerably high sensitivity and specificity ICC (0.68, 95% CI: 52-0.84 and 0.64, 95% CI: 0.61-0.66, respectively), regarding screening tools accuracy.

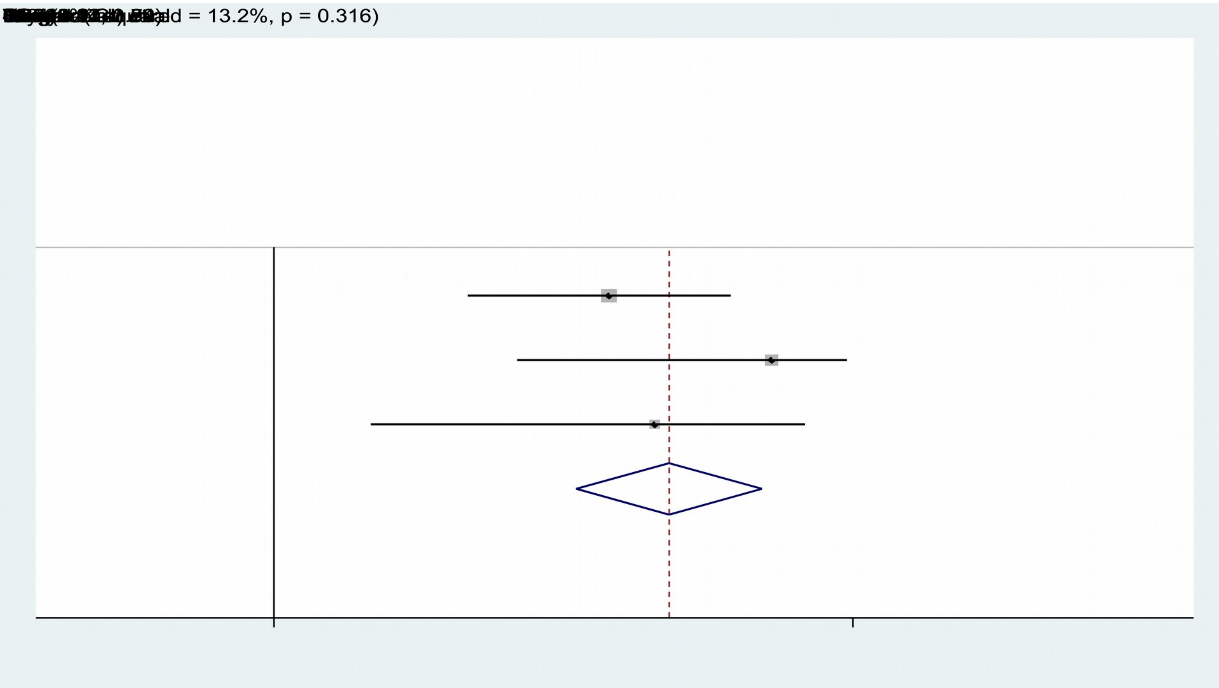

Figure 4.4: Forest plot graph for objective 3 and 4 (sensitivity)

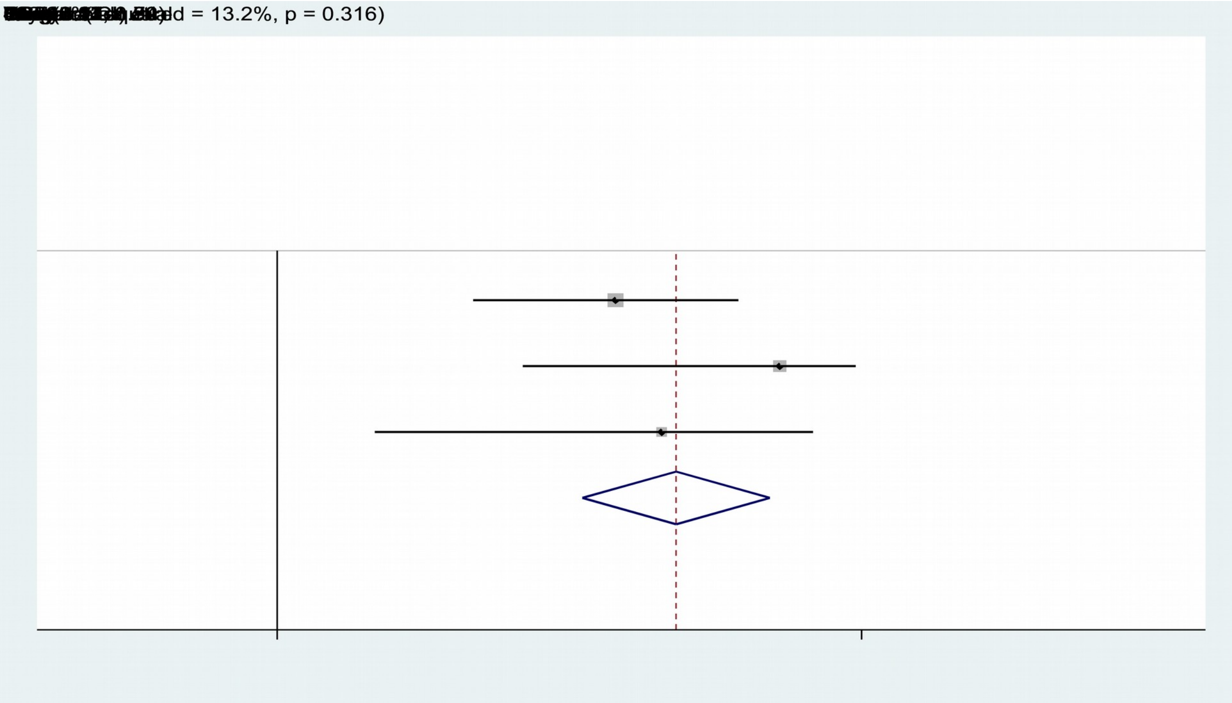

Figure 4.5: Forest Plot graph for objective 3 and 4 (specificity)

Table 4.11: Sensitivity and specificity by study.

	Sensitivity	**Lower 95% CI limit**	**Upper 95% CI limit**
Study			
Chorba 2010	0.579	0.335	0.789
Padua 2015	0.86	0.42	0.99
Grygorowicz 2017	0.658	0.167	0.917
	Specificity	**Lower 95% CI limit**	**Upper 95% CI limit**
Study			
Chorba 2010	0.737	0.488	0.909
Padua 2015	0.64	0.62	0.67
Grygorowicz 2017	0.47	0.469	0.948

The horizontal axis on the forest plot represents the statistics that the studies being profiled used. This study considered incidence rate, sensitivity, specificity and odds ratio. Weights represent the individual influence of each study on the overall meta-analysis. Studies with wider confidence intervals are assigned the least weights. The vertical line, i.e. “line of null effect” is placed to suggest no association, effect or significance of the statistic under consideration. The diamond represents overall estimate and confidence intervals when considering all the individual studies (Reid, 2006). When the confidence interval of the overall effect cuts this line, it was interpreted that the result is not statistically significant. To determine the proportion of variation across this study, I^2 statistic was used to quantify the heterogeneity from 1 to 100%. The heterogeneity was statistically significant (χ^2-p value <0.001).

4.9 Results

4.9.1 Results of objective 1

The studies included in the forest plot showed high incidence rate of common soccer injuries, with an incidence rate of 6.83 per 1000 hours of play. Objective 1 of this study was to identify the most common soccer injuries, thus Table 4.11 presents findings for common soccer injuries based on their identification in the studies included.

Table 4.12: Tabular presentation of objective 1 findings

Objective 1	Number of participants	Common soccer injuries identified
Carling *et al.*, 2016	No specification of number of soccer players	Strains: hamstring -35% of injuries. Sprains: ankle -20% of injuries. Contusions 30% of injuries. Others:- 15% A total of 34 injuries recorded.
Schiffner *et al.*, 2018	No specification of number of soccer players	Anterior cruciate ligament rupture ACLR. 72 ACLR injuries was noted in 66 different players. 9.6 ACLRs per season and 0.53 per team and season with an incidence of incidence of 0.040 per 1000 h of exposure
Lee *et al.*, 2014	152 soccer players	7.4 injuries/1000 player hours and 296 injuries. Ankle sprain:- 52% of the total sprains (highest) Hamstring strains:- 82% of the total strains(highest)
Merron *et al.*, 2016	196 soccer players	Ankle sprain:- 19% of 427 injuries Knee sprain:- 43% of 427 injuries Calf: 5 out of 427 injuries Thigh: 22% of 427 injuries Hamstring strain: 40 out of 427 injuries Tendinitis : 6 out 427 injuries Contusion: 6 contusion of 427 injuries

Del coso *et al.,* 2018	25,397 soccer players	Lower limb:- 1559 of 2108 injuries Ankle sprain:- 34% of 2108 injuries knee sprain:- 40% of 2108 injuries Thigh: hamstring/quadriceps- 171 of 2108 injuries
Mughogho 2012	200 soccer players	Prevalence of injury was 68.9% Lower limb:- 84% of 68.9% Ankle sprain:- 33.3% most affected of sprains
Konopinski *et al.,* 2016	80 soccer players	Total injuries:- 117 of 63 players affected Thigh strain:- 40% Knee sprain:- 15% Ankle:- 16% Groin:-10% Others:- 19%

The tabular presentation show high occurrences of ankle sprain, knee sprain, hamstring strain and quadriceps sprain as was also seen in the literature review in chapter 2 to be the common soccer injuries.

Carling *et al.* (2016), did not give records of numbers of participants who were recruited for the study but gave the total numbers of injuries sustained to be 34 injuries in match played outside congestion circles while 13-19 injuries were sustained in the final matches in two-match and three-match congestion cycles. The incidence was recorded as 66 injuries per 1000 hours of play. The study also mentioned injuries sustained as: hamstring, quadriceps and groin strains, ankle and knee sprain, and contusion. Schiffner *et al.* (2018), reported incidence rate of 72 anterior cruciate ligament rupture from 66 different participants, with a rate of 0.040 per 1000 hours of play, 95% confidence interval of 0.009-0.12 from eighteen teams. The study did not specify the total numbers of participants. Coso, Herrero and Salinero, (2018) recorded ankle and knee sprain, hamstring, quadriceps, and calf strains, and contusion as common soccer injuries in female soccer players with an incident rate of 0.094 per 1000 hours of play from 397 females soccer players. Mughogho (2012) found that 84% of 200 male participant's sustained lower limb injuries, 57% of injuries sustained were re-occurring injuries, 33.3%

accounts of ankle injuries, ligament sprain account for 36%. Thirty six percent of injuries were recorded to be severe.

4.9.2 Results of objective 2

The studies added to the forest plot showed higher likelihood for injuries to occur with a significant statistic of OR=1.12, 95% CI 1.07; 1.17. Included studies for objective 2 provides evidence of risk factors and the injuries resulting from these risks factors. Table 4.12 presents finding for common risk factors and the injuries at risk based on their identification in the studies included.

Brink *et al.* (2010) showed that physical and traumatic stress which is as a result of high work load (training and match load) increases the risk of traumatic injuries, overuse injuries and illnesses in soccer players. Timmins *et al.* (2016) identifies eccentric knee flexor strength, and short biceps femoris fascicles (Bfih) to be factors that can increases the risk of hamstring strain injury (HSI). The study by Malone *et al.* (2018) explains how large weekly changes of high speed running and speed running can increase the risk of lower limb injuries while Arnason *et al.* (2004) significantly mentioned that players age, range of motion (ROM) of hip adductors, previous hamstring and groin strain, knee and ankle sprain are certainly risk of hamstring sprain, groin, knee strain, and ankle strain. Ivarsson and Johnson. (2010) mentioned psychological factors, personality traits predictors and daily hassles as risk factors for soccer injuries, but did not specifically mention the injuries facing risk of injury. Hamstring strain injury have higher risk of low hamstring-to-quadriceps strength ratio and another risk factor can be as a result of previous hamstring injury (Lee *et al*., 2018).

Table 4.13: Tabular presentation of objective 2 findings

Objective 2	Numbers of participants	Risk factors identified	Types of injuries that there is a risk for
Brink *et al.*, 2010	53 soccer players	Physical stress and Psychological stress.	Risk factors for: Traumatic, overuse injuries and illnesses
Timmins *et al.*, 2016	152 soccer players	Eccentric Knee flexor strength and Short biceps femoris fascicles (BFlh fascicles)	Risk factors for: Hamstring strains injuries

Arnason *et al.*, 2004	306 soccer players	Age, previous injuries: hamstrings. Groin: previous groin and decrease in ROM of hip adductor. Previous injuries for knee and ankle sprains.	Risk factors for: Hamstrings strains, groin strains, knee and ankle sprains
Dupont *et al.*, 2010	32 soccer players	Stress: two matches per week. Recovery time	Risk factors for: Hamstrings strains, groin strains and, knee ankle sprains. Contusions.
Ivarsson and Johnson, 2010	48 soccer players	Psychological factors, personality trait predictors, and daily hassles.	Risk factors for: Not mentioned. Just generalized using injuries
Lee *et al.*, 2018	146 soccer players	Lower isokinetic hamstring strength, lower hamstring-to-quadriceps strength ratio, and previous injury of HIS.	Risk factors for: Hamstring strain injury
Malone *et al.*, 2018	37 soccer players	Large weekly changes of high speed running and speed running.	Risk factors for: Lower limbs
Malone *et al.*, 2017	48 soccer players	Work load.	Risk factors for: Lower limb with high rate of muscles injuries.
Rogalski *et al.*, 2013	46 soccer players	Work load.	Risk factors for:

4.9.3 Results of objective 3

Studies included for objective 3 focused on identifying screening tools for common soccer injuries. Table 4.13 presents findings of screening tools and the risk of injury/biomechanics/performance deficit they are associated with.

Table 4.14: Tabular presentation of objective 3 finding

Objective 3	Number of participants	Screening tools identified	Risk of injury/biomechanics/performance variable associated
Silver *et al.*, 2017	22 soccer players	Anthropometrics. FMS ™: the deep squat, hurdle step, in-line lunge Shoulder Mobility, active straight leg raise, trunk stability push-up, and rotary stability and three clearing examinations. Jump performance, instep kick speed (shot speed) and anaerobic performance.	Screening tools for: Physical performance
Lehance *et al.*, 2019	57 soccer players	Functional performance: squat jump and 10m sprint.	Screening tools for: the risk of Imbalance and implement antagonist strengthening in lower limb. Acute muscles injuries
Hammes *et al.*, 2016	238 soccer players	FMS™ score	Screening tools for: musculoskeletal injuries
Frohm *et al.*, 2012	18 soccer players	Functional movement screen: One legged squat, two legged squat, and straight leg raise test, and seated rotation test. In line lunge test, and active hip flexor test.	Screening tools for: Stability and mobility of the lower limb, Overuse and acute injuries

The four studies discussed functional movement screening scores and tests as a potential tool for predicting/preventing common soccer injuries, but each has its own dimension of application and variables. Silva *et al.* (2017) used physical performance, anthropometrics, FMS™, jump performance instep kick speed and anaerobic performance to analyse the association between FMS™ individual score and overall FMS™ score, as well as physical performance variables of lower extremities such as power jumps, repeated sprint ability, and shot speed. The FMS™ tools used by Silva *et al.* (2017) includes the deep squat, hurdle step, in-line lunge shoulder mobility, active straight-leg raise, trunk stability push-up, rotary stability, three clearing examinations, jump performance, instep kick speed (shot speed), and anaerobic performance.

Furthermore, the results suggest that FMS™ is suitable to determine the physical performance of soccer players and not for downsizing their functional performance. This is because individual FMS™ scores may be a better determinant of performance than the FMS™ total score. In addition, the authors established minimal association between FMS™ scores and physical variables. Lehance *et al.* (2009) compared pre-season muscular strength and power profiles in professional and junior elite soccer players, using functional performance, squat jump and 10m sprints to implement antagonist strengthening aimed at injury prevention. The results showed that there was no significant difference in isokinetic muscle strength performance between the three groups in the study when considering normalized body mass parameters. Individual isokinetic profiles enabled the identification of 32 out of 57 (56%) subjects presenting lower limb muscular imbalance. Thirty six out of 57 players were identified as having sustained a previous major lower limb injury. Of these 36 players, 23 still showed significant muscular imbalance (64%).

Hammes *et al.* (2016) proved that screening tools such has FMS™ is limited to predict common soccer injuries in veteran football. The results showed that the potential risk factor for injuries in veteran football is age, lower body mass, and a longer career. To evaluate the inter- and intra-rater reliability of the test battery on a group of male elite soccer players, Frohm *et al.* (2012), used functional movement screening of which are one legged squat, two legged squat, and straight leg raise test, and seated rotation test, in-line lunge test, and active hip flexor test. The test battery was used to predict injuries that is caused by stability and mobility of the lower limb. The results of this test showed good inter-rater and intra-rater reliability and a strong need for future validation.

4.9.4 Results of objective 4

The studies added to the forest plot showed that there was considerably high sensitivity and specificity (0.68 95% CI: 52-0.84 and 0.64 95% CI: 0.61-0.66, respectively). These studies show the accuracy of screening tools for preventing and predicting injuries. Table 4.14 below presents findings of screening tools for common soccer injuries and the risk factor of injuries associated.

Table 4.15: Tabular presentation of objective 4

Objective 4	**Number of participants**	**Screening tools**	**Risk factors associated**
Padua *et al.*, 2015	829 soccer players	Less score	Screening tools for: Anterior Cruciate Ligaments
Chorba *et al.*, 2010	38 soccer players	FMS™ score	Screening tools for: Anterior Cruciate Ligaments
Read *et al.*, 2016	25 soccer players	Tuck jump	Screening tools for: Neuromuscular control Ankle and knee sprain. Anterior Cruciate Ligaments
Gabbe *et al.*, 2004	15 soccer players	Musculoskeletal screening tests: Sit and reach test Lumbar spine extension- ROM- risk of knee injury. Active hip internal ROM. Active hip external ROM. Passive straight leg raise. Active knee extension test. Active slump test.	Sit and reach test – risk for hamstring Lumbar spine extension- ROM- risk of knee injury.
Grykorowics *et al.*, 2017	66 soccer players	Cut off values for conventional hamstrings-to-quadriceps ratio.	Screening tools for: risk of hamstring, muscle strain or ligament rupture.
McCunn *et al., 2017*	25 soccer players	Soccer injury movement screen: the anterior reach, Y- balance	Anterior reach-ankle sprain Y-balance- limb asymmetric

		single-leg deadlift, in-line lunge, and single-leg hop for distance and tuck jump.	Tuck jump- ACL Single-leg deadlift- hamstring strain in-line lunge-stress single-leg hop for distance- non contact hamstring injury

Padua *et al.* (2015) showed that landing error scoring system (LESS) can be used to predict and prevent anterior cruciate ligament injuries while Chorba *et al.* (2010) showed that anterior cruciate ligament rapture injuries can be predicted using the functional movement screening (FMS™) tools. Grygorowicz *et al.* (2017) tried to use conventional hamstring to quadriceps ratio to predict and prevent hamstring injuries. It proved to be significant; however, due to the different threshold values, it was also proven to be highly biased.

Gabbe *et al.* (2004) discussed musculoskeletal tests in his study which demonstrated an excellent reliability (intra-class correlation coefficient, (ICC 0.88-0.97). Intra- reliability was also shown to be good for these tests (ICC 0.63-0.99). The results showed that the sit and reach test, lumbar spine extension ROM, active hip internal ROM, active hip external ROM, passive straight leg raise, active knee extension test and active slump test are reliable to use as pre-participation screening tools for sport participants. The study reliability is important and suggestion for future studies focused on soccer players is needed.

To analyse the within-subject variation of the tuck jump screening assessment in elite male youth soccer players, Reed *et al.* (2016), used tuck jump assessment tool, which proved to be reliable in the assessment. The assessments included elite male soccer players and the results also showed caution should be applied when interpreting solely the composite score due to the high within-subject variation in a number of the individual criteria. McCunn *et al.* (2017), assessed the intra- and inter-rater reliability of the SIMS using five sub-tests: the anterior reach (AR), single-leg deadlift (SLDL), in-line lunge (ILL), single-leg hop for distance (SLHD) and tuck jump (TJ). The action of the movement was filmed using IPhone 4s device to get the scores, which were compared individually as participants were blinded. The five sub-tests shows to have acceptable landmarks with a 95% CI**,** sensitivity, specificity, odds ratios and likelihood ratio. Confidence intervals was set at CI 95% with an odd ratio of 3.850 (CI 95% = 0.980 to 15.130).

4.10 Summary of findings

The finding of this study is to determine the common soccer injuries, the risk factors for these injuries, what are the screening tools used for measurements of factors of risk and the accuracy of these tools. The findings were compared between systematic results findings and that of the literature review.

Table 4.16: Literature review summary of findings

Most common injuries	Risk factors	Screening tools	Components of the tools	Accuracy of the tools	Do the screening tool measure common risk factors according to evidence?
Ligaments sprain: **Ankle and knee sprain.**	Knee separation distance Past injuries Age, gender, fitness, stability, balance, skills, foot wares. Recurrent injuries	**Bracing and balanced board** **F-MARC 11+.** **FMS:** **Start excursion balance test** **Y balance test.** **Tuck jump test:** *TJST* *LESS*	**F-MARC 11+:** *Running with slow speed* *Six sets of exercise focusing on core, leg strength, and balance/agility.* *Running with moderate speed.* **FMS:** *Deep squat.* *Hurdle step,* *In-line lunge* *Active straight leg raise.*	**SEBT** Has reliability of (ICC 0.92; (95%CI: 0.85-0.96) **YBT** Has reliability of (ICC 0.92; (95%CI: 0.85-0.96). **FMS** Has reliability of ICC 0.89; (95%CI: 0.80-0.95). SEBT has reliability of (ICC 0.92; (95%CI: 0.85-0.96) **YBT**	Not specific ***<u>Continue below.</u>***

		PHE		Has reliability of (ICC 0.92; (95%CI: 0.85-0.96). **TJST** ICC greater than 0.90. **LESS** ICC = 0.91 with 85% agreement mark **TJS** Has reliability of (ICC 0.47' (95%CI: 0.33-0.63). **FMS** Has reliability of ICC 0.89; (95%CI: 0.80-0.95).	
Muscles strains: **Hamstring and quadriceps strains.**	Past injuries Age, gender, fitness, stability, balance, skills, foot wares. Recurrent injuries Poor injury managements	**F-MARC 11+** **FMS:** **Start excursion balance test** **Y balance test.** **Tuck jump assessment** **PHE**	**SEBT:** *A grid pattern of tape strips is arranged on the floor, the participant then balances on one limb in the centre of the grid, while reaching out to the furthest distance as possible in a single direction with the other lower limb* **YBT:** *The YBT is a version of the three reach SEBT. The participant balances on one limb in the centre area of PVC pipe and uses the other limb to push the reach indicator to the furthest distance the participant is capable of achieving* **TJT:**		Not specific ***<u>Continue below.</u>***

			TJST: *the participant jumps thrice with "reflective" markers placed on his two lateral malleoli, centre of patella's, and on the greater trochanters to assess the discrepancies between ankle, knee, and hip joints` separation during the three-phased (pre-landing, landing, and take-off) drop jump.* **LESS:** *The procedure for DJST and LESS is similar and the basic difference between them is that video recording in the frontal and sagittal planes during the participant's jump landing is done in LESS.*		***Continue below.***

			TJS: *The TJA is a time efficient (two minutes administration and 10 minutes scoring) clinical test to determine the lower limb landing technique flaws during a plyometric activity.* **PHE:** *Musculoskeletal test*		***<u>Continue below.</u>***

Table 4.17: Systematic review summary of findings

Most common injuries	Risk factors	Screening tools	Components of the tools	Accuracy of the tools	Do the screening tool measure risk factors
Ligaments sprain: **Ankle sprain**	Previous injuries ankle sprain. Stress Psychological factors, personality trait predictors, and daily hassles. Large weekly changes of high speed running and speed running. Work load.	Musculoskeletal screening tests. **Soccer injury movement screen:** *Tuck jump* *Anterior reach* *In-line lunge.* **FMS™:** **Functional performance:**	**Musculoskeletal screening tests:** *Sit and reach test* *Lumbar spine extension-ROM* *Active hip internal ROM.* *Active hip external ROM.* *Passive straight leg raise.* *Active knee extension test.* *Active slump test.* **Soccer injury movement screen:** *Anterior reach.* *Y- Balance single-leg deadlift.*	**Soccer injury movement screen:** Intra-class/ inter-rater correlation coefficient (ICC) score to be 0.66-0.72 and 0.79-0.86 with CI: 95=0.980 **Cut off values for conventional hamstrings-to-quadriceps ratio.** Specificity of 46.9% vs. 94.5%, respectively; t = 153.0,p<0.0001. Sensitivity of 16.7% vs. 91.7%, respectively; t =	Yes ***<u>Continue below</u>.***

Knee sprain.	Previous injuries for knee sprain. Stress Psychological factors, personality trait predictors, and daily hassles. Large weekly changes of high speed running and speed running. Work load.	**Musculoskeletal screening tests:** *Lumbar spine extension-ROM-* **Soccer injury movement screen:** *Tuck jump* *In-line lunge.* **FMS™:** **Functional performance:**	*In-line lunge.* *Single-leg hop for distance* *Tuck jump.* **FMS™:** *Deep squat.* *Hurdle step,* *In-line lunge* *Active straight leg raise.* **Functional performance:** *Squat jump and* *10m sprint.*	6.125,p = 0.0133). **Musculoskeletal screening tests.** Intra-rater/ inter-rater class correlation coefficient, ICC 0.88–0.97 with a 95% CI. **FMS™ score.** Specificity of 0.737 (CI95=0.488 to 0.909). Sensitivity of 0.579 (CI95= 0.335 to 0.798). **Landing error scoring system** Specificity: A specificity of 64%. Sensitivity: A sensitivity of 86%.	***<u>Continue below.</u>***
Anterior cruciate ligaments	Previous injuries for ACL. Stress Psychological factors, personality trait predictors, and daily hassles.	Less score **FMS™ score** **Musculoskeletal screening tests:** *Tuck jump* **FMS™:** **Functional performance:** **Soccer injury movement**			

	Large weekly changes of high speed running and speed running. Work load.	**screen:** *In-line lunge.*			
Muscles strains: **Hamstring strain**	Eccentric Knee flexor strength and Short biceps femoris fascicles (BFlh fascicles). Age. Previous injury: hamstrings. Stress Psychological factors, personality trait predictors, and daily hassles.	Cut off values for conventional hamstrings-to-quadriceps ratio. **Musculoskeletal screening tests:** *Sit and reach test.* *Single-leg hop for distance.* **Soccer injury movement screen:** *In-line lunge.* **FMS™:** **Functional performance:**			***<u>Continue below.</u>***

	Lower isokinetic hamstring strength, lower hamstring-to-quadriceps strength ratio, and previous injury of HIS. Large weekly changes of high speed running and speed running. Work load.				
Quadriceps strains.	Psychological factors, personality trait predictors, and daily hassles. Large weekly changes of high speed running and speed running. Work load.	Cut off values for conventional hamstrings-to-quadriceps ratio. **Musculoskeletal screening tests:** **Soccer injury movement screen:** *In-line lunge.* **FMS™:**			***Continue below.***

		Functional performance:			

The results from the literature review shows 100% similarity with the most common soccer injuries identified in the systematic review. Compared to the risk factors for injuries, the literature review identified risk factors to be intrinsic and extrinsic factors while the systematic review gave specification of which injuries are due to certain risk factors. Due to the lack of direction of risk factors for the literature review, it was difficult to specify which screening tools can predict or prevent a certain risk of injury. The systematic review screening tools were able to identify risk factors for common soccer injuries with high acceptance rate.

4.11 Class of evidence of systematic review

Ten key recommendations were observed for the class of evidence for the review.

- Protocol development- Protocol was developed at the initial stage of this research.
- Research question- What is the accuracy of screening tools in predicting common soccer injuries? The research question set a map for this research
- Search strategy- A pattern of search was initially written in the protocol, database to be searched and keywords to use.
- Study eligibility- The inclusion and exclusion criteria was stated in the protocol and the review followed the same guideline.
- Data extraction- The method of data extraction was performed by two researchers, blinded.
- Study designs- There was an initial specification of included study designs.
- Risk of bias assessment- The risk of bias was observed.
- Publication bias- Studies raged from 2000-2018.
- Heterogeneity- Was observed
- Statistical analysis- Was done.

4.12 Summary

In summary, this chapters was able to respond to the four objectives, the aim, and the research question stated in this study. The results have shown the existence of common soccer injuries and their risk factors which reflect on the results of injuries and their locations. Screening tools that predict these risk factors and prevent their injuries were also found to have high specificity and sensitivity rate. The forest plot proved to have considerable heterogeneity that shows the lack of similarities among studies. The narrative qualitative description informed the quantitative results on the incidence of injury, risk factors for this injuries, and screening tools for prevention and prediction.

CHAPTER 5: DISCUSSION

5.1 Introduction

This systematic review determined the common injuries among soccer players, the common risk factors for injuries in soccer players, the screening tools for common soccer injuries in soccer players, and the accuracy (specificity, sensitivity, validity and reliability) of screening tools for common soccer injuries. These constructs were determined in order to establish the common injuries, risk factors, and the accuracy of available screening tools to predict these risk factors in soccer players. This is the first study, to our knowledge, which seeks to provide pooled evidence for screening tools to predict common risk factors for soccer injuries in relation to the accuracy of screening tools and the most common injuries. This systematic review used a qualitative approach based on the level of heterogeneity of the included studies. The discussion of each objective covers the aggregated findings from the qualitative sections. Finally, the grading, strengths and limitations of the study are presented.

5.2 Most common soccer injuries

Although a number of epidemiological studies related to soccer injuries exist in literature (Ekstrand, Hägglund and Waldén, 2011; Junge and Dvorak, 2013; Falese *et al.*, 2017; Nuhu and Kutz, 2017), many of the retrieved search results failed to meet the inclusion criteria of this review. Therefore, all studies included for objective one were added to the qualitative discussion for epidemiology of common soccer injuries. Considerable heterogeneity exists among the included studies and thus, it was appropriate to report findings from the forest plot and qualitative discussion. The heterogeneity may be a result of the variability which exists in the types of injuries experienced by soccer players across regions of the world (Arundale *et al.*, 2015; Eirale *et al.*, 2017). The variability involved differences in populations and settings, such as amateur and elite soccer players, male and female soccer players, various regions within a country or continent; and differences in outcome measurement, such as start and end of season, low and high frequency of matches, match and training sessions, and different playing positions (Al-Hazzaa *et al.*, 2001; A Junge *et al.*, 2002; Brophy *et al.*, 2009; Kristenson *et al.*, 2013; Arundale *et al.*, 2015; Mithoefer *et al.*, 2015; Blanch and Gabbett, 2016).

The pooled result from this review showed that there is high incidence of common soccer injuries. This common soccer injuries incidence rate for the studies included in the meta-analysis is 6.83 per 1000 hours of play. This rate is lower than the individual rates reported by most studies especially for contact injuries. For example, Nuhu and Kutz (2017) in determining the epidemiology of injuries among elite soccer players in an African Tournament, recruited 240 male soccer players and 12 soccer teams for a fortnight. They reported an incidence of 14.4 per 1000 match hours for contact injury; an incidence of 5.58 per 1000 match hours for non-contact injuries; and 50.51 as the overall incidence per 1000 match hours. Similarly, Falese *et al.* (2017), in determining the incidence of soccer injuries sustained in all competitive matches . The competition discussed by Falese *et al.* (2017), involved professional Italian league soccer players across the 20 soccer teams over a two-season period. There was 12 out of 13 and 13 out 14 reported injuries and 15.2 injuries per 1000 player-matches as an overall incidence rate.
In contrast with the forest plot presentation for incidence of common soccer injuries, the studies included reported divergent incidence scores and showed low incidence rates except the study by Carling *et al.* (2016). For instance, Carling *et al.* (2016), in determining the impact of short periods of match congestion on injury risk and patterns in an elite football club reported an incidence of 66 injuries per 1000 match hours. However, an incidence rate lower than that of this review was reported by Schiffner *et al.* (2018), with a rate of 0.040 per 1000 match hours, in their study on anterior cruciate ligament ruptures in German elite soccer players. Also, Del Coso, Herrero and Salinero (2018), reported an incidence rate of 0.094 per 1000 match hours.

This review found the common types of soccer injuries to be largely associated with the lower extremities, in addition to contusion, the finding is consistent among the included studies (Merron *et al.*, 2006; Mughogho, 2012; J. W. Lee *et al.*, 2014; Carling *et al.*, 2016; Konopinski *et al.*, 2016; Del Coso, Herrero and Salinero, 2018). The high involvement of the lower extremities in soccer injury compared to other parts of the body such as the head/neck, trunk, and upper extremities (shoulder, arm, elbow, forearm, wrist, and hand) is in tandem with literature (Chomiak *et al.*, 2000; Giza *et al.*, 2005; Ackerman *et al.*, 2009; Nuhu and Kutz, 2017). These common soccer injuries include ankle sprain, knee sprain, thigh strain, hamstring strain, quadriceps strain, hip strain, groin strain, calf strain, and contusion. Mughogho (2012) particularly reported 57% of injuries sustained were reoccurring injuries,

33.3% accounts of ankle injuries, ligament sprain account for 36%, and for severity 36.5% was recorded to be severe.
The types of common soccer injuries found by this review supports the soccer injuries pattern reported in existing literature as muscle strain and ligament sprain of varying severity. Ekstrand *et al.* (2013) showed that muscle strain are the most common soft tissue injuries especially in the hamstrings, the thigh adductors, the quadriceps, and the calf muscles This review however did not focus on the severity of soccer injuries which could be minor (grade 1), moderate (grade 2), and severe (grade 3) (Grooms et al., 2013). Similarly, ligament sprains were reported to be common involving the ankle and knee. Nonetheless, other types of injuries have been reported in literature such as concussions, lacerations, fractures, tendinitis, patella-femoral pain syndrome, and Osgood-Schlatter disease (Marar *et al.*, 2012; Swenson *et al.*, 2013; Agel, Rockwood and Klossner, 2016; Kerr *et al.*, 2017; Nuhu and Kutz, 2017; O'Kane *et al.*, 2017).

5.3 Risk factors of common soccer injuries

Similar to epidemiology of common soccer injuries, there is a vast amount of literature on the risk factors for soccer injuries especially in developed countries. In comparison with the epidemiology of common soccer injuries, more of the retrieved search results for risk factors of common soccer injuries met the inclusion criteria of this review. Therefore, in total, nine studies met the inclusion criteria for the systematic review. Seven of the studies were added to the meta-analysis while the two other studies were added to the qualitative discussion for risk factors of common soccer injuries. The participants of the included studies were all male (n=868).

The pooled result from this review showed evidence of risk factors and subsequent injury as a highly likelihood (OR=1.12 95% CI 1.07; 1.17). The risk factors of common soccer injuries that emerged from this systematic review include physical stress and traumatic stress following high work load (training and match load), eccentric knee flexor strength, short biceps femoris fascicles, large weekly changes of high-speed running, age of players, range of motion (ROM) of hip adductors, previous hamstring and groin strain, previous knee and ankle sprain, psychological factors, personality traits predictors, daily hassles, low hamstring-to-quadriceps strength ratio, and previous injury (Arnason *et al.*, 2004; Dupont *et al.*, 2010;

Ivarsson and Johnson, 2010; Rogalski *et al.*, 2013; Timmins *et al.*, 2016; Malone *et al.*, 2017, 2018; Lee *et al.*, 2018). These risk factors are consistent with the existing literature on risk factors of common soccer injuries (Murphy, Connolly and Beynnon, 2003). For instance, it was reported that the most important risk factor for a subsequent injury is a past injury in the same body area (Hägglund, Waldén and Ekstrand, 2006; Ackerman *et al.*, 2009). Literature classifies risk factors of soccer injuries as either intrinsic or extrinsic (Beynnon *et al.*, 2001; Murphy, Connolly and Beynnon, 2003; Bahr and Holme, 2003; Butler *et al.*, 2012); however, the risk factors that emerged from this systematic review are predominantly intrinsic risk factors. The risk factors increase the risk of traumatic and overuse injuries of the lower extremities such as; hamstrings and groin strains, knee and ankle sprains, and contusion. Of the lower extremity injuries, hamstring strain injuries (HSI) are reported to be more likely to occur by the enumerated risk factors of common soccer injuries.

Physical stress, traumatic stress following high work load (training and match load) and large weekly changes of high-speed running are also factors of risk (Murphy, Connolly and Beynnon, 2003; Anderson, 2005). These risk factors for injuries are consistent with literature as there are consensus in literature that shows incidence of injury is closely linked with the workload of the soccer players (Murphy, Connolly and Beynnon, 2003; Anderson, 2005). Similarly, the emergence of previous hamstring and groin strain, previous knee and ankle sprain as risk factors for common soccer injuries is similar to the existing literature which states that former injury and insufficient treatment are associated with a high injury risk at a later time (Milgrom *et al.*, 1991; Chomiak *et al.*, 2000).

Although literature on muscle contraction generated forces from muscle strength indicates divergent findings on its link with predisposing soccer players to common soccer injuries. The findings on muscle contractions from this systematic review shows the eccentric knee flexor strength, short biceps femoris fascicles, and low hamstring-to-quadriceps strength ratio are risk factors for common soccer injuries. Despite the contrasting results by previous studies on the relationship between joint range of motion and injury risk (Twellaar et al., 1997; Söderman et al., 2001), range of motion of hip adductors emerged as a risk factor for common soccer injuries in this systematic review. Similarly, age of players emerged in this systematic review as a risk factor for common soccer injuries although there is no consensus in literature about the particular age group (i.e. young or old) that is highly correlated with injury occurrence (Peterson et al., 2000; Knapik et al., 2001). Finally, the other risk factors that emerged from this systematic review include psychological factors, personality traits predictors, and daily hassles. For these identified risk factors of common soccer injuries to be adequately prevented or predicted, surveillance programs involving screening tools specific to soccer must be in place.

5.4 Screening tools for common soccer injuries soccer

In contrast to the epidemiology and risk factors of common soccer injuries, meta-analysis could not be done for the studies that met the inclusion criteria for screening tools in soccer for this systematic review. Although the four studies that were added for the qualitative discussion of screening tools for soccer discussed functional screening scores and test (FMS™) as a potential tool for predicting and preventing common soccer injuries, each has its own dimension of application. Hence, a quantitative discussion was used to synthesize findings from the included studies. The soccer players who participated in these four studies were 335 in total. Other screening tools/tests identified in literature such as the Star Excursion Balance Test/Y Balance Test, Drop Jump Test (DJST and LESS), Tuck Jump Assessment, and Periodic Health Examination (Padua *et al.*, 2011; Cortes and Onate, 2013; Herrington, Myer and Munro, 2013; Chimera and Warren, 2016) were not used in the included studies of this systematic review.

Authors such as Bahr (2016) and McCall, Dupont and Ekstrand (2016) have posited that performance and medical screening of soccer players such as the Periodic Health Examination is a common component of injury prevention strategy in elite sport especially among European elite soccer clubs. Despite their findings, PHE did not emerge in the findings of the studies in this systematic review unlike the FMS™ which dominated the findings of the included studies. This dominance of FMS™ may be because PHE involves medical test (risk of cardiac arrest, mortality and risk of illness), performance test, and musculoskeletal test. Thus, PHE is not 100% significant to common soccer injuries as lower extremities injuries are not substantially related to cardiac arrest, mortality and illnesses. PHE are rather more closely related with contact and congested fixed matches.

Lehance et al. (2009) in determining the muscular strength, functional performances and injury risk in professional and junior elite soccer players, likewise compared pre-season muscular strength and power profiles in professional and junior elite soccer players, using functional performance: squat jump and 10m sprint to implement antagonist strengthening aimed at injury prevention. They found no significant difference in the isokinetic muscle strength performance among the three groups involving junior elite and professional elite soccer players with regards to normalized body mass parameters. Also, the test was able to identify soccer players with muscular imbalance and previous lower extremity injuries which is one of the major risk factors for future soccer injury. This finding supports a systemic injury surveillance strategy for injury prevention which further strengthens the place of the FMS™ as a competent screening tool for preventing common soccer injuries.

Literature shows that the FMS™ has good reliability especially among American elite soccer players (Smith *et al.*, 2013; Chimera and Warren, 2016). One of the included studies by Frohm *et al.* (2012) on reliability for a nine-test screening battery for male elite soccer players. The study used functional movement screening comprising of one-legged squat, two-legged squat, straight leg raise test, seated rotation test, in line lunge test, and active hip flexor test to predict injuries that is caused by stability and mobility of the lower limb. The study results showed good inter-rater and intra-rater reliability and a strong need for future validation. This finding will be subsequently discussed under section 5.5.

The good reliability of the FMS™ could be the reason for its dominance among the included studies in this section of the systematic review. To analyse the association between either the FMS™ individual score and FMS™ overall score and the physical performance variables of lower-extremity power (jumps), repeated sprint ability and shot speed, Silva *et al.* (2017) used functional movement screen scores and physical performance measurements such as physical performance, anthropometrics, FMS™, jump performance, in-step kick speed, and anaerobic performance among youth elite soccer players. The FMS™ tools used included the deep squat, hurdle step, in-line lunge shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability, three clearing examinations, jump performance, in-step kick speed (shot speed), and anaerobic performance. The results from the study by Silva *et al.* (2017) therefore suggest that FMS™ is suitable to determine the physical performance of soccer players for injury prediction and prevention. The study further suggested that FMS™ on the other hand is not suitable for determining the weakness in the functional performance of soccer players as identified by individual FMS™ scores. Finally, the auhors posited that the individual FMS™ score may be better determinant of performance than the overall

FMS™ score as minimal association between FMS™ scores and physical variables was established.

Furthermore, Hammes *et al.* (2016), in determining the injury prediction in veteran football players using the FMS™, further strengthened the conclusion by Silva *et al.* (2017) that a screening tool like the FMS™ is limited to predict common soccer injuries among soccer players especially among veteran soccer players. The most related systematic review to predict injury to the lower extremeties in team sports conducted by Dallinga, Benjaminse and Lemmink (2012) was not specific to soccer therefore the comparision of this systematic review to previous ones cannot be made.

Conclusively, based on the pooled results from the included studies in this section of the systematic review, it can be agreed that although the FMS™ has a good inter-rater and intra-rater reliability. FMS™ is a screening tool capable of screening for common soccer injuries and individual FMS™ score is a better determinant of performance in comparison with the overall FMS™ score. The next section discusses the accuracy (specificity, sensitivity, validity and reliability) of screening tools in soccer players.

5.5 Accuracy of screening tools for common soccer injuries

Literature on the accuracy of screening tools for common soccer injuries is commonly found (Cortes and Onate, 2013; Cook *et al.*, 2014; Kazman *et al.*, 2014; McGill *et al.*, 2015; Warren, Smith and Chimera, 2015; Chimera and Warren, 2016), many of which emanate from developed countries. Similar to the objective 2, considerable heterogeneity exists among the included studies for objective 4 (accuracy of screening tools); thus, it was appropriate to report findings from the qualitative discussion.

The pooled result from this review showed that there is a considerably high sensitivity (0.68 95% CI: 52-0.84) and high specificity (0.64 95% CI: 0.61-0.66) among the screening tools for preventing and predicting risk of injuries. High sensitivity and specificity in screening tools shows that they are able to predict risk of injuries that places soccer players at risk of common soccer injuries. The screenings tools included the FMS™, Landing Error Scoring System (LESS), and the conventional hamstring to quadriceps ratio. For instance, Chorba *et* *al.* (2010) shows that anterior cruciate ligament rapture injuries can be predicted using the functional movement screening (FMS™) tool.

Literature indicates the FMS™ tool to be highly reliable due to results from several studies that investigated the inter-rater and intra-rater reliability of the FMS™ (Smith *et al.*, 2013; Kraus *et al.*, 2014). For instance, Smith *et al.* (2013) in determining the inter-rater and intra-rater reliability of the functional movement screen, found a good inter-rater reliability for the first (ICC = 0.89; 95% CI: 0.80-0.95) and second (ICC = 0.87; 95% CI: 0.76-0.94) training sessions. The same cannot be said of the validity of the FMS™ which has been reported to be low. For example, Kazman *et al.* (2014) in determining the factor structure of the FMS™ in marine officer candidates found a lack of unitary construct and low internal consistency on Cronbach's alpha. Similarly, several studies showed low sensitivity for the validity of the FMS™ in predicting musculoskeletal soccer injuries (O'Connor *et al.*, 2011; McGill *et al.*, 2015; Warren, Smith and Chimera, 2015). Therefore, the high sensitivity of FMS™ which emerged from this systematic review needs to be interpreted with caution as the high sensitivity of the FMS™ is in conjunction with other tools especially the LESS.

The Landing Error Scoring System which is a kind of Drop Jump Test (DJT) used for evaluating landing patterns also emerged in this systematic review as a screening tool with high specificity and sensitivity. One of the included studies in this systematic review by Padua *et al.* (2015) in investigating the landing error scoring system as a screening tool for an anterior cruciate ligament injury-prevention program in elite-youth soccer athletes, shows that landing error scoring system (LESS) can be used to predict and prevent anterior cruciate ligament injuries. Literature on the accuracy of LESS posits the tool as a valid and reliable screening tool for predicting and preventing soccer injuries irrespective of the skill sets of the rater. The construct validity of LESS was established and the inter-rater reliability and intra-rater reliability of LESS were given as (ICC = 0.84) and (ICC = 0.91) respectively (Padua *et al.*, 2009, 2011; Onate *et al.*, 2010). Studies related to determining the accuracy of the LESS has largely been carried out by the same group of researchers; however, the emergent result from this systematic review is supportive of the conclusion that the LESS has a high accuracy as a screening tool to predict and prevent common soccer injuries.

On the other hand, the study by Grygorowicz *et al.* (2017) the use of conventional hamstrings to quadriceps ratio to predict and prevent hamstrings injuries among professional male soccer players was significant, the findings were significantly biased due to the different threshold values. Therefore, caution must be taken in utilizing it for the purpose of predicting and preventing common soccer injuries.

Similar to the meta-analysis for the accuracy of screening tools for common soccer injuries, the studies included in the qualitative discussion reported high accuracy of the included screening tools. The two screening tools include the Tuck Jump Test (TJA) and the Soccer Injury Movement Screening (SIMS). Literature shows that the TJA has a very good face validity but with divergent reliability results (Boden *et al.*, 2010; Myer *et al.*, 2011; Herrington, Myer and Munro, 2013) with the intra-rater reliability ranging from 0.44 (0.22-0.68) to 0.72 (0.55-0.84) (Myer *et al.*, 2011; Dudley *et al.*, 2013). Despite the divergence in literature, the included study in this systematic review by Reed et al. (2016) in using TJA analysing the within-subject variation of the tuck jump screening assessment in elite male youth soccer players, concluded that the TJA is reliable in the assessment of common soccer injuries among elite male soccer players. Thus, caution should be used in interpreting the composite score of the TJA due to the high within-subject variation in a number of the individual criteria.

Finally, this systematic review finds SIMS to be an accurate screening tool for predicting and preventing common soccer injuries. This is because the study by McCunn *et al.* (2017) in determining the intra-rater and inter-rater reliability of the soccer injury movement screen shows good intra-rater composite score reliability ranging from 0.66 to 0.72. Also the inter-rater composite score reliability which ranges from 0.79 to 0.86, and the weighted kappa value of each sub-tests ranged from 0.35 to 0.91. However, for the accuracy of the SIMS to be well established, more studies confirming the validity and reliability of the screening tool need to be undertaken.

5.6 Strengths and limitations of the study

The strength in this study lies in the standardized methodology used (quantitative analysis and qualitative discussion), which complimented each other in responding to the objectives of this study. Articles were selected and included according to a rigorous method that reduced the risk of bias, with the use of three reviewers, who were blinded. This was informed by the rating of the review according to the (ACROBAT-NRSI (version 1.0.0). The quality of evidence used was based on ten recommendation, this review met 10/10 of the items listed.

The limitation of this study is based on the separation of key words used in the study, and the use of synonyms such as 'football' for 'soccer'. Most studies with relevant information were excluded based on their lack of specification to soccer.

CHAPTER 6: CONCLUSION

6.1 Conclusion

Due to the negative impact of soccer injuries on players, their clubs, sport rehabilitation professionals, and other stakeholders, there is growing evidence regarding screening tools for the prediction and prevention of common soccer injuries. However, there is no current systematic review which provide the aggregated results from this emerging evidence. Therefore, this study sought to fill this gap in literature by conducting a review on common injuries, risk factors and the accuracy of available screening tools to predict these risk factors among soccer players. In achieving this purpose, this systematic review was conducted in line with the JBI guidelines. Synthesis of findings entailed a meta-analysis and qualitative discussion of the data from included studies. The use of both qualitative and quantitative strategies emanated from the considerable heterogeneity existing among the included studies. Although literature exists on the topic under investigation, very few articles met the inclusion criteria of this study. This systematic review found a high incidence of common soccer injuries which is reported as 6.83 per 1000 hours of play. This incidence rate is lower than those reported by majority of the previous individual studies on the epidemiology of common soccer injuries. Also, this systematic review found that the common types of soccer injuries to be largely associated with the lower extremities, in addition to contusion. The most common injuries include ankle sprain, knee sprain, thigh strain, hamstring strain, quadriceps strain, hip strain, groin strain, and calf strain.

Similarly, the pooled result from this review showed evidence of risk factors associated with certain injuries (OR=1.12 95% CI 1.07; 1.17). The emergent risk factors from this systematic review include physical stress and traumatic stress following high work load (training and match load), eccentric knee flexor strength, short biceps femoris fascicles, large weekly changes of high-speed running, age of players, range of motion (ROM) of hip adductors, previous hamstring and groin strain, previous knee and ankle sprain, psychological factors, personality traits predictors, daily hassles, low hamstring-to-quadriceps strength ratio, and previous injury. It is note-worthy that high workload was the only extrinsic risk factor that emerged while the others were all intrinsic risk factors for common soccer injuries.

The screening tools for common soccer injuries that emerged from this systematic review include the Functional Movement Screening (FMS™), the Landing Error Scoring System (LESS), the Tuck Jump Assessment, the Soccer Injury Movement Screening (SIMS), and the conventional hamstrings to quadriceps ratio. Although meta-analysis could not be done for all the screening tools, this study found a high sensitivity (0.68 95% CI: 52-0.84) and high specificity (0.64 95% CI: 0.61-0.66) among the screening tools for preventing and predicting common soccer injuries.

6.2 Recommendations

Some of the recommendations that could be made from carrying out this systematic review are listed below:
A combination of screening tools is recommended for optimal outcome in predicting and preventing common soccer injuries. From the results from this study, it could be seen that different screening tools can predict certain soccer injuries.

- Majority of the literature on common soccer injuries were carried out in Asia and the Western countries, hence, it is recommended that scholars should carry out research in in the African setting because literature has shown that the pattern of soccer injuries differs from one region of the world to another, even within different regions within the same country. Such knowledge base will strengthen the existing evidence on common soccer injuries in a specific population.

- It was noted that although literature exists on screening tools for injuries, many of the studies were generic and not focused on soccer injuries. The studies also have low methodological quality which prevented many of the studies from meeting the inclusion criteria of this study. Hence, there is need for sport professionals and scholars to focus more on conducting well-designed studies to determine the accuracy of screening tools for common soccer injuries.

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APPENDICES

APPENDIX A: JBI CRITICAL APPRAISAL CHECKLIST FOR STUDIES REPORTING PREVALENCE DATA

Reviewer_______________________________Date_____________________________

Author ______________________Year _____________Record Number_______________

Yes No Unclear N/A

☐ ☐ ☐ ☐

1. Was the sample representative of the target population?

☐ ☐ ☐ ☐

2. Were study participants recruited in an appropriate manner?

3. Was the sample size adequate? ☐ ☐ ☐ ☐

4. Were the study subjects and the setting described in detail? ☐ ☐ ☐ ☐

5. Was the data analysis conducted with sufficient coverage of the identified sample? ☐ ☐ ☐ ☐

6. Were objective, standard criteria used for the measurement of the condition? ☐ ☐ ☐ ☐

7. Was the condition measured reliably? ☐ ☐ ☐ ☐

8. Was there appropriate statistical analysis? ☐ ☐ ☐ ☐

9. Are all important confounding factors/ subgroups/ differences identified and accounted for? ☐ ☐ ☐ ☐

10. Were subpopulation identified using objective criteria? ☐ ☐ ☐ ☐

Overall appraisal Include ☐ Exclude ☐ Seek further info ☐

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STUDY	**Knee osteoarthritis is associated with previous meniscus and anterior cruciate ligament surgery among elite college American football athletes**	**The impact of short periods of match congestion on injury risk and patterns in an elite football club**
AUTHOR	Matthew V. Smith, MD,Jeffrey J. Nepple, MD,Rick W. Wright, MD,Matthew J. Matava, MDand Robert H. Brophy, MD	Chris Carling, Alan McCall, Franck Le Gall, Gregory Dupont
Representative sample	No	Yes
Appropriate Part. Recruitment	No	Yes
adequate sample size	No	Yes
Detail subject and	No	Yes

setting description		
Data analysis covering sample	No	Yes
objective, standard criteria for measurement	No	yes
condition measured reliably	No	yes
appropriate statistical analysis		yes
important differences accounted for	No	yes
subpopulation identified with objective criteria	No	yes
include	No	yes
exclude	Yes	
seek further info		

Anterior cruciate ligament ruptures in German elite soccer players: Epidemiology, mechanisms, and return to play	**A prospective epidemiological study of injury incidence and injury patterns in a Hong Kong male professional football league during the competitive season**
Erik Schiffner, DavidLatza, Jan P. Grassmann, Alberto Schek, Simon Thelen, Joachim Windolf, Johannes Schneppendahl, Pascal Jungbluth	Justin Wai-Yuk Lee, Kam-Ming Mok, Hardaway Chun-Kwan Chan, Patrick Shu-Hang Yung, Kai-Ming Chan
yes	Yes
yes	Yes
yes	Yes
yes	Yes
yes	Yes
yes	Yes
yes	Yes
yes	Yes
yes	Yes
yes	Yes
yes	Yes

Injuries among professional soccer players of different age groups: A prospective four-year study in an English Premier League Football Club	**Upper extremity injuries in male elite football players**	**Injuries in Spanish female soccer players**
Mr Richard Merron MCSP, MSc, 1Professor James Selfe MCSP, PhD, Mr Rob Swire, MCSP, MSc, Professor Christer G Rolf MD, PhD	Jan Ekstrand • Martin Ha¨gglund • Henrik To¨rnqvist • Karolina Kristenson • Ha°kan Bengtsson • Henrik Magnusson • Markus Walde´n	TagedP Juan Del Coso, Helena Herrero, Juan J. Salinero
yes	No	Yes
yes	No	Yes
yes	No	Yes
yes	No	Yes
yes	No	Yes
yes	No	Yes
yes	No	Yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes

Factors associated with football injuries in Malawi: implications for physiotherapy intervention	**The effect of hypermobility on the incidence of injury in professional football: A multi-site cohort study**	**Functional Movement Screen Scores and Physical Performance among Youth Elite Soccer Players**
Anderson Mughogho	Matt Konopinski, Ian Graham, Mark I. Johnson, Gareth Jones	Bruno Silva, Filipe Manuel Clemente, Miguel Camões and Pedro Bezerra
yes	Yes	Yes
yes	Yes	Yes
yes	Yes	Yes
yes	Yes	Yes
yes	Yes	Yes
yes	Yes	Yes
yes	Yes	Yes
yes	Yes	Yes
yes	Yes	yes
yes	Yes	yes
yes	yes	yes

Muscular strength, functional performances and injury risk in professional and junior elite soccer players	**A nine-test screening battery for athletes: a reliability study**	**Functional screening of a semi-professional Footballer**
C. Lehance, J. Binet, T. Bury, J. L. Croisier	A. Frohm, A. Heijne, J. Kowalski, P. Svensson, G. Myklebust	Dan Amin MSc, GSR, QTLS
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
		Yes

Considerations to reduce injury rates in the professional football setting	**Injury prediction in veteran football players using the Functional Movement Screen**	**Monitoring stress and recovery: new insights for the prevention of injuries and illnesses in elite youth soccer players**
David Hartley GSR	Daniel Hammes, Karen aus der Fünten, Mario Bizzini and Tim Meyer	Michel S Brink, Chris Visscher, Suzanne Arends, Johannes Zwerver, Wendy J Post, Koen APM Lemmink
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes

no	yes	Yes
no	yes	Yes
no	yes	Yes
yes		

Short biceps femoris fascicles and eccentric knee flexor weakness increase the risk of hamstring injury in elite football (soccer): a prospective cohort study	**Risk Factors for Injuries in Football**	**Effect of 2 Soccer Matches in a Week on Physical Performance and Injury Rate**
Ryan G Timmins, Matthew N Bourne, Anthony J Shield, Morgan D Williams, Christian Lorenzen, David A Opar	Arni Arnason, MSc, PT, Stefan B. Sigurdsson, PhD, Arni Gudmundsson, Ingar Holme, PhD, Lars Engebretsen, MD, PhD, and Roald Bahr, MD, PhD	Gregory Dupont, PhD, Mathieu Nedelec, MSc, Alan McCall, MSc, Derek McCormack, MD, Serge Berthoin, PhD, and Ulrik Wisløff, PhD
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes
yes	yes	Yes

Psychological factors as predictors of injuries among senior soccer	**Eccentric hamstring strength deficit and poor hamstring-to-quadriceps ratio are risk factors for hamstring strain injury in football: A prospective study of 146 professional players**	**Predicting football injuries using size and ratio of the multifidus and quadratus lumborum muscles**

players. A prospective study		
Andreas Ivarsson and Urban Johnson	Justin W.Y. Lee, Kam-Ming Mok, Hardaway C.K. Chan, Patrick S.H. Yung, Kai-Ming Chan	J. A. Hides, W. R. Stanton
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	no
yes	yes	No
		No

High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk?	**The acute: chronic workload ratio in relation to injury risk in professional soccer**	**The Effects of Maturation on Measures of Asymmetry During Neuromuscular Control Tests in Elite Male Youth Soccer Players**
Shane Malone, Adam Owenb, Bruno Mendesb, Brian Hughesa, Kieran Collins, Tim J. Gabbett	Shane Malone, Adam Owen, Matt Newton, Bruno Mendes, Kieran D. Collins, Tim J. Gabbett	Paul J. Read. Jon L. Oliver. Mark B.A. De Ste Croix. Rhodri S. Lloyd
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
yes	yes	No
		Yes

Training and game loads and injury risk in elite Australian footballers	**Why are older Australian football players at greater risk of hamstring injury?**	**The use of functional movement screening tool to determine injury risk in female collegiate athletes.**
Brent Rogalski, Brian Dawson, Jarryd Heasman, Tim J. Gabbett	Belinda J. Gabbe, Kim L. Bennell, Caroline F. Finch	Rita S. Chorba, PT, MSPT, MAT, ATC, CSCS, David J. Chorba, MSEd, MAT, ATC, ATC, CSCS, Lucinda E. Bouillon,PhD, PTc, Corey A. Overmyer PT, MPT, OCSd, James A. Landis, MD, PhD, CSCSe.
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
yes	No	yes
	Yes	

Development and validation of clinical based prediction tool to identify female athletes at high risk for Anterior Cruciate Ligament Injury	**The landing error scoring System as a Screening Tool for an Anterior Cruciate Ligament Injury–Prevention Program in Elite-Youth Soccer Athletes**	**Reliability of the tuck jump injury risk screening assessment in elite male youth soccer players.**
Gregory D. Myer, MS, CSCS, Kevin R. Ford, PhD, FACSM, Jane Khoury, PhD,	Darin A. Padua, PhD, ATC; Lindsay J. DiStefano, PhD, ATC†; Anthony I. Beutler, MD‡; Sarah J. de la Motte, PhD, MPH, ATC‡; Michael J. DiStefano, MA, ATC*; Steven W. Marshall, PhD*	Paul Read, MSC, ASCC, CSCS*D1, Jon L. Oliver, PhD2, Mark B.A. DE STE Croix, PhD3, Gregory D. Myer, PhD, CSCS*and Rhodris S. LLOYD, PhD, ASCC, CSCS
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes
no	yes	Yes

no	yes	Yes
no	yes	Yes
no	yes	Yes

Reliability of common lower extremity musculoskeletal screening tests	**Discussion about different cut-off values of conventional hamstring-to-quadriceps ratio used in hamstring injury prediction among professional male football players**	**The intra- and inter-rater reliability of the soccer injury movement screen (sims)**
Belinda J. Gabbe, Kim L. Bennellb, Henry Wajswelnerc, Caroline F. Fincha	Monika Grygorowicz, Martyna Michaøowska,Tomasz Walczak, Adam Owen, Jakub Krzysztof Grabski, Andrzej Pyda, Tomasz Piontek, Tomasz Kotwicki	Robert McCunn, Karen aus der Fünten, Andrew Govus, Ross Julian, Jan Schimpchen, Tim Meyer.
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes
yes	yes	yes

The Functional Movement Screen and modified Star Excursion Balance Test as predictors of T-test agility performance in university rugby union and netball players	**Asymmetry during preseason Functional Movement Screen testing is associated with injury during a junior Australian football season.**	**Prospective functional performance testing and relationship to lower extremity injury incidence in adolescent sports participants**	**Validation of the exercise addiction inventory in a Danish**

Ross Armstrong, Matt Greig	Samuel Chalmersa, Joel T. Fullerb, Thomas A. Debenedictisb, Samuel Townsleyb, Matthew Lynaghb, Cara Gleesonb, Andrew Zachariab, Stuart Thomsonb, and Mary Magareyb.	Joseph Smith, MS, ATC, OTC, NREMT1 Nick DePhillipo, MS, ATC, OTC, CSCS1 Iris Kimura, PhD, ATC, PT1 Morgan Kocher, MS, ATC, CSCS1 Ronald Hetzler, PhD, FACSM1	M. B. Lichtenstein1, E. Christiansen2 , N. Bilenberg3, R. K. Støving4
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
no	no	no	no
yes	yes	yes	yes

APPENDIX B: JBI DATA EXTRACTION FORM FOR PREVALENCE AND INCIDENCE STUDIES

Study details

Reviewer –

Study ID/Record Number -

Date –

Study title –

Author –

Year –

Journal –

Aims of the study –

Study Method

Setting –

Study design –

Follow-up or study duration –

Subject characteristics –

Dependent variable -

Outcomes –

Outcome measurements –

Ethical approval –

Method of data analysis -

Results

Prevalence n/N (%)

Proportion and 95% Confidence Intervals

Incidence n/N (%)

Proportion and 95% Confidence Intervals and duration of recruitment or the study

Authors' comments

Review comment

APPENDIX C: DATA EXTRACTION FORM FOR SOCCER SCREENING TOOLS.

Study details

Reviewer –

Study ID/Record Number -

Date –

Study title –

Author –

Year –

Journal –

Aims of the study –

Study Method

Setting –

Study design –

Follow-up or study duration –

Subject characteristics –

Dependent variable -

Outcomes –

Outcome measurements –

Ethical approval –

Method of data analysis –

Screening tools identified

Results

Proportion and 95% Confidence Intervals

Proportion and 95% Confidence Intervals and duration of recruitment or the study

Authors' comments

Review comment

APPENDIX D: DATA EXTRACTION FORM FOR SENSITIVITY, ACCURACY, RELIABILITY, SPECIFIVITY AND VALIDITY OF SOCCER SCREENING TOOLS

Study details

Reviewer –

Study ID/Record Number -

Date –

Study title –

Author –

Year –

Journal –

Aims of the study –

Study Method

Setting –

Study design –

Follow-up or study duration –

Subject characteristics –

Dependent variable -

Outcomes –

Outcome measurements –

Ethical approval –

Method of data analysis -

Results

Proportion and 95% Confidence Intervals

Sensitivity n/N (%)

Reliability n/N (%)
Specificity n/N (%)
Accuracy n/N (%)
Validity n/N (%)

Proportion and 95% Confidence Intervals and duration of recruitment or the study

Authors' comments

Review comment

Study details	Study details (APPENDIX B)
Reviewer	**Raphael**
Study ID/Record Number	**1**
Date	**02/01/2019**
Study title	**The impact of short periods of match congestion on injury risk and patterns in an elite football club**
Author	Chris Carling, Alan McCall, Franck Le Gall, Gregory Dupont
Year	2015
Journal	British Journal of Sport Medicine
Aims of the study	To prospectively investigate the epidemiology of injury during short periods of fixture congestion in a professional football club.
Study Method	**Study method**
Setting	France
Study design	Prospective observational study.
Follow-up or study duration	2009-2015
Subject characteristics	Male professional football players belonging to the first-team squad of a French League 1 Club (2009–2015).
Dependent variable	Risk of injury
Outcomes	A total of 34 injuries were sustained in match-play outside congestion cycles while 19 and 13 injuries were incurred in the final matches in two-match and three-match congestion cycles. In comparison to the incidence values in matches outside the congestion cycles, there was a higher risk of injury, albeit non-significant, in the final match in the two-match congestion cycle (47.0 (95% CI 31 to 63) vs 70.6 (95% CI 39 to 102), IRR: 1.5 (95% CI 0.9 to 2.6), p=0.1553) and a significantly greater risk in the final match in the three-match congestion cycle (47.0 (95% CI 31 to 63) vs 93.6 (95% CI 43 to 144), IRR: 2.0 (95% CI 1.1 to 3.8), p=0.0345).
Outcome measurements	Frequences, means,and Standard deviation.Injury incidences and incidence rate ratios
Ethical approval	Yes, approval for the study from the present club was obtained
Method of data analysis	Standard statistics. Z statistics. t test. A p value of <0.05 was considered statistically significant.
Results	**Results**
Prevalence n/N (%)	N/A

Proportion and 95% Confidence Intervals	N/A
Incidence n/N (%)	incidence of 66 injuries per 1000 h
Proportion and 95% Confidence Intervals	(IRR: 3.1(95% CI 1.1 to 9.3), p=0.0400). (IRR: 2.0 (95% CI 1.1 to 3.8), p=0.0345). (2.6 (1.1 to 6,5), p=0.0386),. (10.4 (95% CI 1.9 to 57.9), p=0.0068). (IRR: 7.8 (1.3 to 46.8), p=0.0243)
duration of recruitment or the study	six seasons period
Authors' comments	Injury rates and patterns were affected in the same elite football players when competing in short congested fixture cycles in comparison to match-play outside the cycles.
Reviewer comments	

Study details	**Study details**
Raphael	**Raphael**
2	**3**
03/01/2019	**03/01/2019**
Anterior cruciate ligament ruptures in German elite soccer players: Epidemiology, mechanisms, and return to play	**A prospective epidemiological study of injury incidence and injury patterns in a Hong Kong male professional football league during the competitive season**
Erik Schiffner, DavidLatza, Jan P. Grassmann, Alberto Schek, Simon Thelen, Joachim Windolf, Johannes Schneppendahl, Pascal Jungbluth	Justin Wai-Yuk Lee, Kam-Ming Mok, Hardaway Chun-Kwan Chan, Patrick Shu-Hang Yung, Kai-Ming Chan
2018	2014
Journal of Sports Science and Medicine	Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology
This study aims to identify the epidemiology and injury-related lay-off after anterior crutial ligament rapture in professional male soccer players from the first division German Bundesliga	The aim of this study was to investigate the match and training injury incidence, injury patterns and severity, and their monthly variation in a Hong Kong male professional football league.
Study method	**Study method**
Germany	Hong Kong
Retrospective cohort study,	Prospective cohort study.
2009-2016	2010-2011
The players included were in any of the 18 teams of the first division German Bundesliga. The mean players' age with an ACLR was 24 (±3.6) years. The youngest soccer player suffering	**Seven teams in the Hong Kong Football Association first division league consisting 152 players from 10 professional teams participated in this study.** The total exposure of the 152 players was 39,768.50 hours (age, 25.0 ± 4.3 years; height, 177.7 ± 4.7 cm; and weight, 72.5 ±

ACLR was 17 years old and the oldest was 34 years old.	5.6 kg).
Epidemiology of ACLR	**Injury incidence**.
A total of 72 total ACLRs were registered in 66 different players with an incidence of 0.040 per 1000 h of exposure (95% CI 0.009–0.12). On average there were 9.6 ACLRs per season and 0.53 per team and season. The number of ACLRs recorded per season fluctuated during the period observed. Goalkeepers are significantly ($P < 0.05$) less prone to suffer an ACLR compared to outfield players.	The overall injury incidence was 7.4injuries/1000 player hours and 296 injuries were recorded. The relative risk of match injury was 17 times greater than the risk of training injury [relative ratio (RR), 17.3; 95% confidence injury (CI), 11.6e25.7; $p < 0.001$]. Ankle sprain was the most common injury type (16.2% of all injuries) and 52% of these injuries were recurrent. Thigh strain was the second most common injury type with 82% of the injuries involving the hamstring muscle and 80% of hamstring strains were noncontact injuries. During the competitive season, the relative risk of injury was highest in October (RR, 6.8; 95% CI, 6.7e6.9; $p < 0.001$) and February (RR, 4.7; 95% CI, 4.3e5.2; $p < 0.001$).
Incidence, means, age cohort and injury mechanism.	**Injury records using a standard exposure form.**
Yes,the study was approved by the local ethics review board and written consent by kicker.de® as well as transfermarkt.de®was obtained.	Yes, all procedures in this study were approved by the University Clinical Research Ethical Review Committee of the Chinese University of Hong Kong (Hong Kong, China) and were conducted in accordance with the ethical standards of the Declaration of Helsinki (Reference number: CRE-2010.412).
chi-squared test. $\chi 2$ test, with significance accepted at $P < 0.05$. Kruskal–Wallis (analysis of variance (ANOVA) on ranks), Mann–Whitney U-test. The SPSS software pack (version 23, IBM, New York, USA). P-values <0.05 were regarded as statistically significant.	SPSS (version 16.0, SPSS Inc., Chicago, IL, USA). Chi-square statistics. **The results are expressed as the mean ± the standard deviation for continuous data and counts, and as percentages for categorical variables.** **A multivariate Poisson regression model was used to estimate the change in injury incidence over the study on a monthly basis.**
Results	**Results**
N/A	N/A
N/A	N/A
Incidence of 0.040 per 1000 h	Incidence of 7.4 injuries/1000 player-**hours**
95% confidence interval (CI), 0.009–0.12)	95% confidence interval (CI), 11.6-25.7; $p < 0.001$].
Seven years period	Nine months period

Understanding ACLR loading mechanisms, knowing risk factors for the injury and mean off time after ACLR are essential information for the coach, the medical staff, the elite soccer players, the insurance and team managers. Our results are in accordance with reports based on information from medical team staff. Therefore, our analysis of ACLR based on media sources may serve as an alternative for injury reports in elite soccer. The information of this study may be helpful for the medical staff taking care of professional soccer players and for orthopedic surgeons performing ACL reconstructions in this patient population.	This highlighted that Hong Kong professional football has a high match injury incidence. The relative risk of injury was highest at the beginning of the competitive season. A prospective multicentre epidemiological study is warranted to examine regional differences in injury risks. Coaches, players, health professionals, and researchers should join their efforts to investigate the effect on injury incidence and injury pattern associated with the duration and content of the preseason period, and the number of friendly matches held during preseason.

Study details	**Study details**
Raphael	**Raphael**
4	**5**
04/01/2019	**05/01/2019**
Injuries among professional soccer players of different age groups: A prospective four-year study in an English Premier League Football Club	**Injuries in Spanish female soccer players**
Richard Merron MCSP, MSc, 1Professor James Selfe MCSP, PhD, Mr Rob Swire, MCSP, MSc, Professor Christer G Rolf MD, PhD	**TagedP Juan Del Coso, Helena Herrero, Juan J. Salinero**
2006	**2018**
International Sport Medicine Journal	**Journal of Sport and Health Science**
The aim of this study was to investigate and compare the incidence and severity of injuries sustained by the senior and youth team soccer players at an English Premiership Football Club over four years.	The aim of this study was to analyze the incidence of injuries in the population of female soccer players in Spain.
Study method	**Study method**
England	Spain
Prospective and descriptive study	Retrospective cohort study

Four years	2010 - 2011
All senior players were over the age of 18, and trained and played with the first team squad. All youth team players were between 16–18-years old and were selected on their eligibility for competing in the English Football Association Youth Cup. In total, 197 players were included in the study (85 senior players and 112 youth team players).	The study sample was composed of 25,397 female soccer players, including 12,857 adults (18years) and 12,540 under 18 years (U18), licensed by the Royal Spanish Football Federation (RSFF) and playing in official domestic leagues. The study sample was obtained from 4 adult categories (2 national and 2 regional) and 6 age group categories (with only 1 regional category).
Severity of injuries and incidence	Epidemiology of injury
There were 191 injuries in the senior team (85 players) and 236 in the youth team (112 players). All senior players sustained at least one recordable injury, compared with 110 injured players out of 112 in the youth team. The injury incidence during games was 23.2 injuries per 1000 hours in the senior team and 25.0 injuries per 1000 hours in the youth team, which was higher than that during training (4.2 injuries per 1000 training hours in senior team, 6.1 injuries per 1000 training hours in the youth team). There was no significant difference in absence per injury between the senior team (average 27.7 days) and the youth team (average 28.7 days). The knee (24%) and thigh (22%) represented the most common locations of injury in the senior team, whilst in the youth team the knee (19%) and ankle (19%) were most frequently injured.	The proportion of injuries derived from contact with another player was higher during matches (33.7%) than during training (11.4%; $p<0.001$). Non contact injuries were classified as severe more frequently than were contact injuries (51.0% vs. 42.6%; $p<0.001$). A higher incidence of injury was found in adult soccer players (18years) vs. their counterparts younger than 18years (0.094 vs. 0. 072 injuries per player per year, respectively; $p<0.001$). There were no differences between age groups in any other injury variable (e.g., type, mechanism ,location ,orseverity; $p>0.05$).
Injury report forms, Xray and MRI.	**A standardized medical questionnaire**
Not mentioned	Yes, The study was revised by the Research Ethics Committee of the Camilo Jose Cela University in accordance with the latest version of the Declaration of

	Helsinki. The Research Ethics Committee indicated that this investigation did not require approval for bio ethics considerations, and it approved the study design and methodology used in this experiment.
Frequencies, descriptive data and means. As the data were not normally distributed, differences between groups were examined by using the non-parametric Mann Whitney test. Mann Whitney test, P values < 0.05 were regarded as statistically significant. The SPSS (Chicago, Illinois, USA). X-ray, MRI scan.	Software Hardware and Programming (Hardware and Programming SA, Madrid, Spain). χ2 test. Excel 2013 for Windows (Microsoft,Redmond,WA,USA). The criterion for statistical significance was set at p<0.05.
Results	**Results**
N/A	N/A
N/A	N/A
The injury incidence senior team was 7.59 injuries per player per 1000 hours (23.2 for games and 4.2 for training). For youth team players, 8.07 injuries per player per 1000 hours (25 for games and 6.1 for training)	Adult soccer players (18years) vs. younger soccer players (18years) = (0.094 vs .0.072 injuries per player per year; p<0.001). Incidence of 0.083 injuries per soccer player per year
95% confidence interval (CI), P< 0.05).	N/A
Four years period	Ten months period
Although there is a slightly different injury pattern between senior and youth team players, the consequences for participation in training and games in the senior and youth team players of this English Premier Football Club are similar.	Most female soccer in juries were located at the knee and ankle; the injury mechanism determined the playing time lost; and the player's age did not affect injury characteristics.

Study details	**Study details**
Raphael	**Raphael**
6	**7**
05/01/2019	**05/01/2019**
Factors associated with football injuries in malawi: implications for physiotherapy intervention	**The effect of hypermobility on the incidence of injury in professional football: A multi-site cohort study**
Anderson Mughogho	Matt Konopinski, Ian Graham, Mark I. Johnson, Gareth Jones
2012	2016

Grey **literature (Thesis)**	Physical Therapy in Sport
The aim of the study was to determine the need for physiotherapy intervention in prevention and management of football injuries.	To compare injury incidence between hypermobile and non-hypermobile elite football players
Study method	**Study method**
Malawi	England
Concurrent Mixed method	A multi-site cohort study
2010 - 2011	2012 - 2013
200 football players, 8 coaches, and 8 team doctors from 12 of the 15 Malawi league teams. The mean age of football players was 21.73 (SD=3.295) years.	**Participants were in three interested clubs among those participating in the English Championship 2012-2013 season**. There were 80 male participants that provided pre-season assessment data (mean ± standard deviation [SD] age, 24.5 ± 4.6 years) including 10 goalkeepers, 30 defenders, 24 midfielders, and 16 attackers. Mean ± SD Beighton score was 1.30 ± 1.47 of a possible score of 9.
Prevalence of injury	injury incidence
A response rate of 67.5% was obtained. The mean age of football players was 21.73 (SD=3.295) years. The injury prevalence was 68.9% with 64% of injuries occurring during matches and 37% during training. The majority (84%) of the injuries were sustained in the lower limbs and 52.7% of the players who reported to have incurred an injury had recurring injuries with the ankle joint (33.3%) being the most affected part. Ligament sprain was the most common type of injury (36%) and most of the injuries (36.5%) reported were severe. No medical professional is available to manage injuries during training while team doctors are always available during matches. Recurrent injury was significantly associated injury prevalence (P=0.000). Use of protective gear was also significantly associated with injury prevalence both at training (P<0.01) and matches iii (P<0.05).	Mean ± standard deviation incidence of injuries was 9.2 ± 10.8 injuries/1000 h. The prevalence of hypermobility was 8.8%. Hypermobiles had a tendency for higher injury incidence (mean [95% confidence interval] difference, 5.2 [0.9e2.7] injuries/1000 h; p ¼ 0.06). Cox regression analyses found training exposure to be highly significant in terms of injury risk (p < 0.001) for all participants. Non hypermobiles had a lower injury risk (p ¼ 0.11), according to the Cox model, which is suggestive but not conclusive that hypermobility predisposes injury risk.
Self-administered questionnaire and in-depth interviews	Beighton scale, goniometer, and standardised injury card.

Yes, Ethical clearance was granted by the University of the Western Cape and relevant authorities in Malawi.	Yes, Ethical approval was obtained from the Faculty of Health and Social Sciences Ethics Committee at Leeds Beckett University
Descriptive statistics, and chi square test of association and Fischer's exact test for studying the factors associated with football injuries against prevalence of injury. SPSS version 20.0. A chi-square test. Fischer's exact test.	Comparisons between hypermobile and non-hypermobile participants were made using t-tests, Poisson tests, and a Cox Regression model. Unpaired t-tests were used to compare demographic, anthropometric, and exposure data between groups. Within-participant comparisons of the number of injuries in training and match play were made using Wilcoxon signed-rank tests on pairwise differences. Analyses were performed using R version 3.0.2 (R Core Team, Vienna, Austria), with statistical significance set at p ≤ 0.05. T-tests. Poisson tests. Cox Regression model. Wilcoxon signed-rank tests. R version 3.0.2 (R Core Team, Vienna, Austria), with statistical significance set at p< 0.05.
Results	**Results**
The injury prevalence was 68.9%. Recurrent injury prevalence (P=0.000). Protective gear prevalence (P<0.01) during training and during matches (P<0.05).	The prevalence of hypermobility was 8.8%.
N/A	N/A
N/A	Mean ± standard deviation incidence of injuries was 9.2 ± 10.8 injuries/1000 h.
N/A	Mean [95% confidence interval] difference, 5.2 [0.9-2.7] injuries/1000 h; p - ¼ 0.06).
1 year	1 year
There is need for physiotherapy intervention in prevention and management of football injuries in Malawi.	Hypermobility showed a trend towards increased risk of injury. Training exposure is a significant injury risk factor in elite football.

OBJECTIVE 2 (APPENDIX B)

Study details	**Study details**
Raphael	**Raphael**
1	**2**
06/01/2019	**06/01/2019**
Monitoring stress and recovery: new insights for the prevention of injuries and illnesses in elite youth soccer players	**Short biceps femoris fascicles and eccentric knee flexor weakness increase the risk of hamstring injury in elite football (soccer): a prospective cohort study**

Michel S Brink, Chris Visscher, Suzanne Arends, Johannes Zwerver, Wendy J Post, Koen APM Lemmink	Ryan G Timmins, Matthew N Bourne, Anthony J Shield, Morgan D Williams,
2010	2015
British Journal of Sports Medicine	Br J Sports Med
The aim of this study is to investigate how measures to monitor stress and recovery, and its analysis, provide useful information for the prevention of injuries and illnesses in elite youth soccer players.	To investigate the role of eccentric knee flexor strength, between-limb imbalance and biceps femoris long head (BFlh) fascicle length on the risk of future hamstring strain injury (HSI).
Study method	**Study method**
Netherlands	Australia
prospective longitudinal cohort	prospective cohort study
2006-2008	2014 - 2015
53 elite dutch male soccer players between 15 and 18years of age participated in this study.	152 outfield elite soccer players in eight professional Australian Football teams. One-hundred and fifty-two athletes were assessed at the beginning of preseason (age 24.8±5.1 years; height 1.80±0.06 m; body mass 76.9±7.5 kg).
Incidence of injury and illness	risk of future hamstring strain injury (HSI)
During the study period, 320 injuries and 82 illnesses occurred. Multinomial regression demonstrated that physical stress was related to both injury and illness (range OR 1.01 to 2.59). Psychosocial stress and recovery were related the occurrence of illness (range OR 0.56 to 2.27).	Twenty seven new HSIs were reported. Eccentric knee flexor strength below 337 N (RR=4.4;95% CI 1.1 to 17.5) and possessing BFlh fascicles shorter than 10.56 cm (RR=4.1; 95% CI 1.9 to 8.7) significantly increased the risk of a HSI. Multivariate logistic regression revealed significant effects when combinations of age, history of HSI, eccentric knee flexor strength and BFlh fascicle length were explored. From these analyses the likelihood of a future HSI in older athletes or those with a HSI history was reduced if high levels of eccentric knee flexor strength and longer BFlh fascicles were present.
Duration of training sessions, rate of perceived exertion (RPE), Dutch version of the Recovery Stress Questionnaire for athletes (RESTQ-Sport), and standardised Fédération Internationale de Football Association registration system.	Injury questionnaire, ultrasound, Nordic hamstring device. Force and power
Yes, The procedures were conducted in accordance with the ethical standards of the Central Committee on Research Involving Human Subjects.	Yes, Ethical approval for the study was granted by the Australian Catholic University Human Research Ethics Committee (approval number: 2014 26V).

Descriptive statistics (mean and SD) were calculated for the measures of stress and recovery (duration and training load/ monotony/strain RESTQ subscales) of injured, ill and healthy players. Data were analysed using multinomial regression in SPSS 16.0 (SPSS, Chicago, Illinois). Rate of perceived exertion (RPE). Descriptive statistics (mean and SD). SPSS 16.0 (SPSS, Chicago, Illinois). Differences with a p value less than 0.05 were considered signifcant.	All statistical analyses were performed using JMP V.11.01 Pro Statistical Discovery Software (SAS Inc., Cary, North Carolina, USA). Where appropriate, data were screened for normal distribution using the Shapiro-Wilk test and homoscedasticity using Levene's test. The mean and SD was determined for all participants. Univariate analyses were performed using two-tailed t-tests with Bonferonni corrections to account for multiple comparisons. Significance was set at a p<0.05.
Results	Results
N/A	N/A
N/A	N/A
37.55 per 1000 match hours (26.65 when analysing only time loss injuries) and 11.14 per 1000 training hours (6.74 when only analysing time-loss injuries).	(OR=0.261; 95% CI 0.10 to 0.57; p=0.002)
Multinomial regression demonstrated that physical stress was related to both injury and illness (range OR 1.01 to 2.59). Psychosocial stress and recovery were related the occurrence of illness (range **OR 0.56 to 2.27).** ORs and 95% CIs were calculated for the independent measures of stress and recovery.	**N/A** (OR=0.261; 95% CI 0.10 to 0.57; p=0.002)
Two seasons	Nine months
Injuries are related to physical stress. Physical stress and psychosocial stress and recovery areimportant in relation to illness. Individual monitoring of stress and recovery may provide useful information to prevent soccer players from injuries and illnesses.	The presence of short BFlh fascicles and low levels of eccentric knee flexor strength in elite soccer players increases the risk of future HSI. The greater risk of a future HSI in older players or those with a previous HSI is reduced when they have longer BFlh fascicles and high levels of eccentric strength.

Study details	**Study details**
Raphael	**Raphael**
3	**4**
06/01/2019	**07/01/2019**
Risk Factors for Injuries in Football	**Effect of 2 Soccer Matches in a Week on Physical Performance and Injury Rate**

Arni Arnason, MSc, PT, Stefan B. Sigurdsson, PhD, Arni Gudmundsson, Ingar Holme, PhD, Lars Engebretsen, MD, PhD, and Roald Bahr, MD, PhD	Gregory Dupont, PhD, Mathieu Nedelec, MSc, Alan McCall, MSc, Derek McCormack, MD, Serge Berthoin, PhD, and Ulrik Wisløff, PhD
2004	2010
The American Journal of Sports Medicine	The American Journal of Sports Medicine
To identify risk factors for football injuries	To analyse the effects of 2 matches per week on physical performance and injury rate in male elite soccer players.
Study method	**Study method**
Iceland.	Scotland
Prospective cohort study.	Cohort study
1999	2007 - 2009
A total of 306 male football players from the two highest divisions in Iceland (mean age, 24; range, 16 to 38 years) were followed.	32 professional outfield soccer players playing for the same top-level team (as of July 1, 2007: age, 25.6 6 3.8 years; height, 182.4 6 6.9 cm; body mass: 81.3 6 8.5 kg).
Injury risk	Physical performance and incidence of injury
Older players were at higher risk of injury in general (odds ratio [OR] = 1.1 per year, P = 0.05). For hamstring strains, the significant risk factors were age (OR = 1.4 [1 year], P < 0.001) and previous hamstring strains (OR = 11.6, P < 0.001). For groin strains, the predictor risk factors were previous groin strains (OR = 7.3, P = 0.001) and decreased range of motion in hip abduction (OR = 0.9 [1°], P = 0.05). Previous injury was also identified as a risk factor for knee (OR = 4.6) and ankle sprains (OR = 5.3).	Physical performance, as characterized by total distance covered, high-intensity distance, sprint distance, and number of sprints, was not significantly affected by the number of matches per week (1 versus 2), whereas the injury rate was significantly higher when players played 2 matches per week versus 1 match per week.
Peak O2 uptake and power/jump testing and questionnaire about previous and recurrent injuries.	Computerized image recognition system based on semiautomatic video match analysis (Amisco Pro 1.0.2, Sport Universal Process, Nice, France).
Not mentioned	Yes, This study was made with the agreement of the Ethical Committee in Biomedical Research of the organization CCPPRB (Lille, France) and the recommendation of the Helsinki Declaration.
SPSS (version 10.0;SPSS Inc., Chicago, Illinois). Z-test. Univariate logistic regression analysis and multivariate logistic regression analysis. P values of ≤0.05 were considered statistically significant.	Means ± standard deviations. Kolmogorov-Smirnov test. Parametric tests. Paired t test. Fisher exact test. One-way analysis of variance test. Inter- and intraindividual CVs. Tukey test. Significance was accepted at P<.05.
Results	**Results**
N/A	N/A

N/A	N/A
The incidence of acute injuries was 24.6 injuries per 1000 player hours during matches and 2.1 injuries per 1000 player hours during training. Incidence of muscle strains was 8.4 injuries per 1000 match hours and 0.8 injuries per 1000 training hours. The total incidence of ligament sprains was 5.5 injuries per 1000 match hours and 0.4 injuries per 1000 training hours. the total incidence of contusions was 5.9 injuries per 1000 match hours and 0.5 injuries per 1000 training hours	Injury rate during match time (48.7 injuries per 1000 hours of exposure; 95% CI, 39.4-58.0). During training (3.7 injuries per 1000 hours of exposure; 95% CI, 2.7-4.6). Twice per week versus once per week = (25.6 versus 4.1 injuries per 1000 hours of exposure; P<.001)
The OR and 95% confidence interval (95%CI)	95% CI, 20.8-30.5
Five months	Two seasons
Age and previous injury were identified as the main risk factors for injury among elite football players from Iceland.	The recovery time between 2 matches, 72 to 96 hours, appears sufficient to maintain the level of physical performance tested but is not long enough to maintain a low injury rate. The present data highlight the need for player rotation and for improved recovery strategies to maintain a low injury rate among athletes during periods with congested match fixtures.

Study details	**Study details**
Raphael	**Raphael**
5	**6**
07/01/2019	**07/01/2019**
Psychological factors as predictors of injuries among senior soccer players. A prospective study	**Eccentric hamstring strength deficit and poor hamstring-to-quadriceps ratio are risk factors for hamstring strain injury in football: A prospective study of 146 professional players**
Andreas Ivarsson and Urban Johnson	Justin W.Y. Lee∗, Kam-Ming Mok, Hardaway C.K. Chan, Patrick S.H. Yung, Kai-Ming Chan
2010	2018
Journal of Sports Science and Medicine	Journal of Sports Science and Medicine
The purpose of this study was to examine the relationship between (a) personality factors, b) coping variables, and © stress and injury risk.	The purpose of this study was to investigate whether preseason isokinetic strength measures were predictive of future HSI among professional football players.
Study method	**Study method**
Sweden	China
Prospective study	Prospective cohort study
2009	2017

Forty eight male soccer players competing on 3 different teams at a competitive level in Sweden (division 4 – 6, middle – low league), who ranged in age from +16 to 36years (M = 22 years) were involved in the study.	A total of 146 professional football players who were from six teams of the top Chinese national football league. (age, 24.2 ± 4.4 years.;height, 177.7 ± 5.9 cm; weight, 72.9 ± 8.65 kg; playing experience,4.53 ± 3.65 years.)
Injury risk.	**hamstring strain injury**
Results suggest injury was significantly predicted by 4 personality trait predictors: somatic trait anxiety, psychic trait anxiety, stress susceptibility,and trait irritability. Collectively, the predictors self-blame and acceptance could explain 14.6% of injury occurrence. More injuries were reported among players who score high in daily hassles.	Forty-one acute HSIs were sustained, and 12% (n = 5) reoccurred within the study period. In the multivariate analysis, we have shown an association between the injury risk and eccentric hamstring peak torque below 2.4 N m kg−1 (OR = 5.59; 95% CI, 2.20–12.92); concentric H/Q ratio below 50.5% (OR = 3.14; 95% CI, 1.37–2.22); players with previous injury of HSI (OR = 3.57; 95% CI, 3.13–8.62). ROC analysis displayed an area under curve (AUC) of 0.77, indicating fair combined sensitivity and specificity of the overall predicting model.
Football Worry Scale, SSP, LESCA, Brief COPE, and Daily Hassles Scale.	Biodex III dynamometer (Biodex Multi-joint System 3, Biodex Medical Sys-tems, USA)
Yes, The research design was authorized and approved by the Lund University ethics committee for human studies.	Yes, study was approved by the university clinical research ethics committee.
Multivariate analysis of variance (MANOVA). univariate analysis of variance (ANOVA). Linear regression analysis.	t-tests, **logistic regression model**. The level of significance was set at p < .05. SPSS (version 20.0, SPSSInc., Chicago, Illinois). Data are presented as mean ± standard deviations (mean ± sd) or 95% CI unless otherwise noted.
Results	**Results**
N/A	N/A
N/A	N/A
14.6% injury occurrences	N/A
N/A	Eccentric hamstring peak torque below 2.4 N m kg−1 (OR = 5.59; 95% CI, 2.20–12.92); concentric H/Q ratio below 50.5% (OR = 3.14; 95% CI, 1.37–2.22); players with previous injury of HSI (OR = 3.57; 95% CI, 3.13–8.62). ROC analysis displayed an area under curve (AUC) of 0.77,
Four months	Ten months
Previous research has shown positive results regarding adult soccer players at risk (Johnson et al., 2005), but not involving a low-risk soccer population. Therefore, a research design including non-risk players will enhance the research area even more.	Professional football players with significant lower isokinetic hamstring strength, lower hamstring-to-quadriceps strength ratio, and a previous injury of HSI were linked to an increased risk of acute HSI.

Study details	**Study details**	**Study details**
Raphael	**Raphael**	**Raphael**
7	**8**	**9**
07/01/2019	**07/01/2019**	**07/01/2019**
High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk?	**The acute: Chronic workload ratio in relation to injury risk in professional soccer**	**Training and game loads and injury risk in elite Australian footballers**
Shane Malone, Adam Owenb, Bruno Mendesb, Brian Hughesa, Kieran Collins, Tim J. Gabbett	Shane Malone, Adam Owen, Matt Newton, Bruno Mendes, Kieran D. Collins, Tim J. Gabbett.	Brent Rogalski, Brian Dawson, Jarryd Heasman, Tim J. Gabbett
2018	2017	2013
Journal of Science and Medicine in Sport	Journal of Science and Medicine in Sport	Journal of Science and Medicine in Sport
This study investigated the association between high-speed running (HSR) and sprint running (SR) and injuries within elite soccer players.	To examine the association between combined Session Rating of Perceived Exertion-Based Estimations (sRPE) measures and injury risk in elite professional soccer.	To examine the relationship between combined training and game loads and injury risk in elite Australian footballers.
Study details	**Study details**	**Study details**
Portugal	Europe	Australia
observational prospective cohort design	Observational cohort studies	Prospective cohort study
2015 - 2016	not mentioned	2010
Data were collected for 37 players (Mean ± SD, age: 25 ± 3 years; height: 183 ± 7 cm; mass: 72 ± 7 kg).	Forty-eight professional soccer players (mean ± SD age of 25.3 ± 3.1 yr) from two elite European teams were involved within a one season study. 48 players (Mean ± SD,age: 25.3 ± 3.1 years; height: 183 ± 7 cm; mass: 72 ± 7 kg) over one season	Elite (n = 46) Australian footballers were involved in this prospective study. Their mean±SD age, stature and body mass were 22.2±2.9 years, 187.7±7.5cmand 85.4±8.9 kg.
High speed running and sprint running	injury risk	injury risk
Players who completed moderate HSR (701–750-m: OR: 0.12, 90%CI: 0.08–0.94) and SR distances (201–350-m: OR:	Players who exerted pre-season 1-weekly loads of ≥1500 to ≤2120 AU were at significantly higher risk of injury compared to the reference group of ≤1500 AU (OR = 1.95, p = 0.006). Players with	Larger 1 weekly (>1750 AU, OR= 2.44–3.38), 2 weekly (>4000 AU, OR= 4.74) and previous to current week changes in load (>1250 AU, OR= 2.58) significantly related

0.54, 90%CI: 0.41–0.85) were at reduced injury risk compared to low HSR (≤674-m) and SR (≤165-m) reference groups. Injury risk was higher for players who experienced large weekly changes in HSR (351–455-m; OR: 3.02; 90%CI: 2.03–5.18) and SR distances (between 75–105-m; OR: 6.12, 90%CI: 4.66–8.29). Players who exerted higher chronic training loads (≥2584 AU) were at significantly reduced risk of injury when they covered 1-weekly HSR distances of 701–750 m compared to the reference group of <674 m (OR = 0.65, 90% CI 0.27–0.89). When intermittent aerobic fitness was considered based on 30–15 VIFT performance, players with poor aerobic fitness had a greater risk of injury than players with better-developed aerobic fitness.	increased intermittent-aerobic capacity were better able to tolerate increased 1-weekly absolute changes in training load than players with lower fitness levels (OR = 4.52, p = 0.011). Players who exerted in-season acute:chronic workload ratios of >1.00 to <1.25 (OR = 0.68, p = 0.006) were at significantly lower risk of injury compared to the reference group (≤0.85).	(p < 0.05) to a larger injury risk throughout the in-season phase. Players with 2–3 and 4–6 years of experience had a significantly lower injury risk compared to 7+ years players (OR = 0.22, OR= 0.28) when the previous to current week change in load was more than 1000 AU. No significant relationships were found between all derived load values and injury risk during the pre-season phase.
GPS devices (STAT Sports Viper, Northern Ireland) and session rating of perceived exertion (sRPE).	Modified Borg CR-10 rate of perceived exertion (RPE) scale, Yo-Yo Intermittent recovery test level 1 (Yo-Yo IR1).	Modified Borg CR-10 RPE scale.
Yes, The study was approved by the local institute's research ethics committee and written informed consent was obtained from each participant.	Yes, The study was approved by the local institute's research ethics committee and written informed consent was obtained from each participant	Yes, Ethics approval was obtained from the Human Research Ethics Committee of The University of Western Australia.

Means ± SD, Poisson distribution, and logistic regression analysis. GPS devices (STAT Sports Viper, Northern Ireland). Bespoke analysis system. SPSS Version 22.0 (IBM Corporation, New York, USA). The level of significance was set at $p \leq 0.05$.	Means ± SD, One-way ANOVA, chi-squared analysis, and logistic regression analysis. Yo-Yo Intermittent recovery test level 1 (Yo-Yo IR1). A chi-squared. One way ANOVA. SPSSVersion 22.0 (IBM Corporation, New York, USA). Modified Borg CR-10 rate of perceived exertion (RPE) scale.	Chi square analysis. One-way ANOVA. Scheffé post hoc test. IBM SPSS Statistics 20.0 and reported as means and 95% CI. Significance was accepted at $p < 0.05$.
Results	**Results**	**Results**
N/A	N/A	N/A
N/A	N/A	N/A
match injury incidence was 10.9/1000 h and training injury incidence was 4.9/1000 h.	Match injury incidence was 4.9/1000 h, (95% CI: 4.11–5.12) and training injury incidence was 6.9/1000 h (95% CI: 6.15–7.33).	Injury incidence increased ($x^2 = 9.37$, df = 1, p = 0.002) from pre-season (21.9 per 1000 h) to in-season (32.8 per 1000 h).
Match injury= (90% CI: 8.87–14.92), training injury = (90% CI: 3.95–5.14). Descriptive statistics for HSR and SR during the season were expressed as means ± SD and 90% confidence intervals.	The incidence proportion player and match injury = (95% CI: 4.11–5.12), training injury = (95% CI: 6.15–7.33) was 1.6 per	**N/A**
48 weeks	One season	five months
Exposing players to large and rapid increases in HSR and SR distances increased the odds of injury. However, higher chronic training loads (≥2584 AU) and better intermittent aerobic fitness off-set lower limb injury risk associated with these running distances in elite soccer players.	These findings demonstrate that an acute: chronic workload of between 1.00 and 1.25 is protective for professional soccer players. A higher intermittent-aerobic capacity appears to offer greater injury protection when players are exposed to rapid changes in workload in elite soccer players. Moderate workloads, coupled with moderate-low to moderate-high acute: chronic workload ratios, appear to be protective for professional soccer players.	In-season, as the amount of 1–2 weekly load or previous to current week increment in load increases, so does the risk of injury in elite Australian footballers. To reduce the risk of injury, derived training and game load values of weekly loads and previous week-to-week load changes should be individually monitored in elite Australian footballers.

OBJECTIVE 3 (APPENDIX C)

Study details	**Study details**
Raphael	**Raphael**

1	3
05/01/2019	**05/01/2019**
Functional Movement Screen Scores and Physical Performance among Youth Elite Soccer Players	**Muscular strength, functional performances and injury risk in professional and junior elite soccer players.**
Bruno Silva, Filipe Manuel Clemente, Miguel Camões and Pedro Bezerra	C. Lehance, J. Binet, T. Bury, J. L. Croisie
2017	2009
Sports	Scandinavian Journal of Medicine and Science in Sport
To analyze the association between FMS individual and overall scores and physical performance variables of lower-limb power (jumps), repeated sprint ability and shot speed.	The purpose of the present study was to provide and compare pre-season muscular strength and power profiles in professional and junior elite soccer players throughout the developmental years of 15–21.
Study method	**Study method**
Melgaço School of Sports and Leisure biomechanics laboratory.	Belgium
Experimental, observational and qualitative study	Observational study
2 days	2 seasons
Twenty-two Under 16 (age = 15.78 0.52 years; height = 175.00 6.05 cm; body mass = 66.86 4.72 kg) and twenty-six Under 19 (age = 17.32 0.48 years; height = 175.08 6.35 cm; body mass = 69.95 5.53 kg)	Fifty-seven elite and junior elite male soccer players from a Belgian First Division team took part in the study, and performed all the tests described below. The subjects were assigned to three groups: professional group (PRO, n519, age: 26.1 3.5 years, weight: 77.9 6.2 kg, height: 178.4 6.1 cm), under-21 years group (U-21, n520, age: 19.5 1.6 years, weight: 73.2 6.7 kg, height: 179.2 5.4 cm) and under- 17 years group (U-17, n518, age: 15.7 0.8 years, weight: 65.6 5.5 kg, height: 176.2 7.8 cm). An injury report form was used to determine each players past history of major injury to the knee joint structures (bone, ligament, muscle, tendon).
Physical performance, Anthropometrics. FMS. Jump performance. Instep kick speed and anaerobic performance.	Muscular strength
There were no significant differences in the individual FMS scores between competitive levels. There were significant negative correlations between hurdle step (right) and Running-based Anaerobic Sprint Test (RAST) power average (p = -0.293; p = 0.043) and RAST fatigue index (RAST Fat Index) (p= -0.340; p = 0.018). The hurdle step (left) had a significant negative correlation to squat jump (SJ) (p = -0.369; p = 0.012). Rotary stability had a significant negative correlation to RAST fatigue index (Right:	The PRO group ran faster and jumped higher than the U-17 group (P<0.05). No significant difference in isokinetic muscle strength performance was observed between the three groups when considering normalized body mass parameters. Individual isokinetic profiles enabled the identification of 32/57 (56%) subjects presenting lower limb muscular imbalance. Thirty-six out of 57 players were identified as having sustained a previous major lower limb injury. Of these 36 players, 23 still showed significant muscular imbalance (64%).

p = -0.311; p = 0.032. Left: p = -0.400; p = 0.005).	
(Mean +- standard deviation (SD)). Physical variables. Effect size (ES). Variance.	variables and prevalence
Yes, Research was approved by the technical–scientific council of the Polytechnic Institute of Viana do Castelo.	Yes, Ethical Committee according to the code of Ethics of the World Medical Association (Declaration of Helsinki, 1975).
Descriptive statistics (mean +- standard deviation (SD)). Analysis of variance (ANOVA). T-independent test. Cohen's d test with scale of 0.41–1.14 (minimum effect); 1.15–2.69 (moderate effect); and >2.70 (strong effect). Mann–Whitney U test. r test with the effect of r (ES): small effect is 0.1; medium effect is 0.3; and large effect is 0.5. Spearman correlation. Statistics Package for Social Sciences (version 23.0; IBM Corporation, New York, NY, USA).	Means and standard deviations. Kruskal–Wallis. Pearson's w2 test. A level of P<0.05 was selected to indicate statistical significance.
Result	**Result**
n/a	na
2 days	2 seasons
The results suggest that individual FMS scores may be better discriminants of performance than FMS total score and established minimal association between FMS scores and physical variables. Based on that, FMS may be suitable for the purposes of determining physical function but not for discriminating physical performance.	New trends in rational training could focus more on the risk of imbalance and implement antagonist strengthening aimed at injury prevention. Such an intervention would benefit not only athletes recovering from injury, but also uninjured players. An interdisciplinary approach involving trainers, a physical coach, and medical staff would be of interest to consider in implementing a prevention programme.

Study details	**Study details**
Raphael	**Raphael**
3	4
06/01/2019	**02/02/2019**

Injury prediction in veteran football players using the Functional Movement Screen	**A nine-test screening battery for athletes: a reliability study**
Daniel Hammes, Karen aus der Fünten, Mario Bizzini and Tim	A. Frohm, A. Heijne, J. Kowalski, P. Svensson, G. Myklebust
2016	2012
Sport Science	Scandivial journal of medicine and science in sport
The purpose of this study was to determine whether the Functional Movement Screen can be used to predict injuries in veteran footballers (aged > 32 years).	The aim was to evaluate the inter- and intra-rater reliability of the test battery on a group of male elite soccer players.
Study method	**Study method**
Norway	Sweden
Prospective study	A realibility study
9 months	2009 february
Eighteen veteran football teams (n = 238) were recruited and prospectively followed for 9 months. The players (44 ± 7 years; 178 ± 7 cm, 84 ± 11 kg) performed the FMS™ at the start of the study period. Players' exposure hours and injuries were recorded.	Healthy male elite soccer players of two elite soccer teams were included through contact with the fitness coach. Twenty-six players from the two teams were available for this study, 18 completed the re-test. Eight participants dropped out due to illness and injuries between the two test occasions. The median age of the players included was 18 (range: 17–28), the mean height was 1.84m [mean and standard deviation (SD) 0.07] and the mean weight was 76.2 kg (SD 8.5).
Injury prevention	screening tests battery
The difference of FMS™ overall score between injured and uninjured players was not significant (11.7 ± 2.9 vs 12.2 ± 2.8 points; Mann-Whitney U-test P = 0.17). Players scoring <10 (score < 1standard deviation [SD]) below the mean) had a significantly higher injury incidence (z-statistics P < 0.05) compared to an intermediate reference group (mean ± 1 SD; scores of 10–14). No lower injury incidence for players with scores of >14 (score > 1 SD above the mean) was found.	Inter-rater reliability No significant difference (P50.31) was found between test occasion 1 (LS means 18.3, 95% CI 14.9– 21.7) and test occasion 2 (18.0, 14.4–21.7) in the mean total score of the test battery. The ICC was 0.80 and 0.81, respectively. A significant difference between physiotherapists with regard to the mean total scores was found at test occasion 1 (P0.001) and was indicated at test occasion 2 (P50.06). Intra-rater reliability The ICC and the ME for intra-rater reliability by physiotherapist are presented in Table 2. The mean ICC for intra-rater reliability within the

	physiotherapists was 0.75. The inter-rater reliability for each exercise ranged between 0.30 and 0.85 at first test occasion.
Variables. incidence of injuries and Risk factors	Intra-intra realibility
Yes, The study was approved by the local ethicscommittee (Ärztekammer of Saarland, Saarbrücken, Germany) and was registered at ClinicalTrials.gov with the identifier NCT01993056.	Yes, The Swedish ethical committee considered the study as a clinical quality study and a full ethics review was therefore not necessary. All players signed an informed consent form before participation.
Data were analysed using SPSS Statistics version 19 (SPSS, Inc., Chicago, Illinois, USA). Excel 2007 (Microsoft, Inc., Redmond, USA). mean and standard deviation (SD). t-tests. z-statistics. For all tests, P < 0.05 was considered significant.	Data for total and individual scores (by item and occasion)have been evaluated using descriptive statistics, SD.Intra and inter-rater reliability was analyzed using intra-class correlation coefficient (ICC), according to Bland and Altman (1986). ANOVA to calculate varience. All tests were two-sided and P0.05 was regarded as statistically significant. Statistica (v 7.0, Statsoft Inc., Tulsa, Oklahoma, USA) was used for statistical calculations.
Result	**Result**
injury incidences (injuries per 1000 h)	
Overall injuries (area under the curve [95% CI]: 0.56 [0.47–0.64], P = 0.17). non-contact injuries (area under the curve [95% CI]: 0.55 [0.46–0.64], P = 0.30)	(LS means 18.3, 95% CI 14.9– 21.7).
9 months	1 Month
Furtheranalyses of potential risk factors suggest higher age, lower body mass and a longer football career to berisk factors for injuries. The findings of this study suggest that the suitability of the FMS™ for injury prediction in veteran footballers is limited.	Assessing quality of movement patterns is challenging and because a precise balance between stability and mobility has been suggested to possibly prevent injuries and enhance sport performance, sensitive tools and appropriate methods is needed. It is important that clinical test batteries, used in clinical settings and aiming to detect mal alignments are reliable as well as validated. This test battery showed good inter- and intra-reliability. In the present study no test for validity was performed. Future studies will address validity and responsiveness of the test battery.

OBJECTIVE 4 (APPENDIX D)

Study details	**Study details**
Raphael	**Raphael**
1	**2**
08/01/2019	**08/01/2019**

The use of functional movement screening tool to determine injury risk in female collegiate athletes	**The Landing Error Scoring System as a Screening Tool for an Anterior Cruciate Ligament Injury–Prevention Program in Elite-Youth Soccer Athletes**
Rita S. Chorba, PT, MSPT, MAT, ATC, CSCS, David J. Chorba, MSEd, MAT, ATC, ATC, CSCS, Lucinda E. Bouillon,PhD, PTc, Corey A. Overmyer PT, MPT, OCSd, James A. Landis, MD, PhD, CSCSe.	Darin A. Padua, PhD, ATC*; Lindsay J. DiStefano, PhD, ATC†; Anthony I. Beutler, MD‡; Sarah J. de la Motte, PhD, MPH, ATC‡; Michael J. DiStefano, MA, ATC*; Steven W. Marshall, PhD*
2010	2015
North American Journal of Sports Physical Therapy	Journal of Athletic Training
This study sought to determine if compensatory movement patterns predispose female collegiate athletes to injury, and if a functional movement screening (FMS™) tool can be used to predict injuries in this population.	To investigate the ability of the LESS to identify individuals at risk for ACL injury in an elite-youth soccer population.
Study method	**Study method**
United states of America (Ohio)	United states of America (north Carolina) soccer practice facilities.
Cohort study.	Cohort study.
2007 – 2008	2006 - 2009
Thirty-eight female student-athletes (mean age 19.24±1.20 years).	A total of 829 elite-youth soccer athletes (348 boys, 481 girls; age ¼ 13.9 6 1.8 years, age range ¼ 11 to 18 years), of whom 25% (n ¼ 207) were less than 13 years of age.
injury risk	Landing error scoring system
The mean FMS™ score and standard deviation for all subjects was 14.3±1.77 (maximum score of 21). Eighteen injuries (17 lower extremity, 1 lower back) were recorded during this study. A score of 14/21 or less was significantly associated with injury (P=0.0496). Sixty-nine percent of athletes scoring 14 or less sustained an injury. Odds ratios were 3.85 with inclusion of all subjects, and4.58 with exclusion of ACLR subjects. Sensitivity and specificity were 0.58 and 0.74 for all subjects, respectively. A significant correlation was found between low-scoring athletes and injury (P=0.0214, r=0.76).	Seven participants sustained ACL injuries during the follow-up period; the mechanism of injury was noncontact or indirect contact for all injuries. Uninjured participants had lower LESS scores (4.43 6 1.71) than injured participants (6.24 6 1.75; t1215 ¼ 2.784, P ¼ .005). The receiver operator characteristic curve analyses suggested that 5 was the optimal cut point for the LESS, generating a sensitivity of 86% and a specificity of 64%.
Reliability. Model 2 intra class correlation coefficients (ICC). Sensitivity and specificity.	Jump-landing. Movement's errors. Test cut point. Specificity and sensitivity. Reliability

Yes, approval for the study was obtained through the University of Findlay's Institutional Review Board.	Yes, All procedures were approved by the Biomedical Institutional Review Board of the University of North Carolina at Chapel Hill.
Digital video recording. Receiver-operator characteristic (ROC) curve. Composite FMS score. A Fisher's exact test with a one-tailed p value of <0.05 was performed. Chi-square test.	LESS computer software (QuickTime; Apple, Inc, Cupertino, CA). Clinical movement-analysis tool. Dichotomous scoring rubric. Standard statistics. SPSS software (version 16.0; SPSS Inc, Chicago, IL) and SAS software (version 9.2; SAS Institute, Cary, NC). Fisher test. The level was set at .05.
Results	**Results**
sensitivity of 0.579 (CI95= 0.335 to 0.798);	Sensitivity of 86% and a specificity of 64%.
	The LESS is a valid and reliable (interrater reliability: intraclass correlation coefficient [2,1] ¼ 0.84, standard error of the mean ¼ 0.71)
specificity of 0.737 (CI95=0.488 to 0.909);	Specificity of 64%.
Sensitivity, specificity, odds ratios and likelihood ratios with confidence intervals set at 95% (CI95) were also calculated. An odd ratio of 3.850 (CI95=0.980 to 15.130).	(95% confidence interval ¼ 0.61, 0.95).
one year	Four years
The screening tool was able to predict injury in female athletes without a history of major musculoskeletal injury such as ACLR.	Despite sample-size limitations, the LESS showed potential as a screening tool to determine ACL injury risk in elite-youth soccer athletes.

Study details	**Study details**
Raphael	**Raphael**
3	**4**
08/01/2019	**08/01/2018**
Reliability of the tuck jump injury risk screening assessment in elite male youth soccer players	**Reliability of common lower extremity musculoskeletal screening tests**
Paul J. Read, Jon L. Oliver, Mark B.A. De Ste Croix, Gregory D. Myer And Rhodri S. Lloyd	Belinda J. Gabbe, Kim L. Bennellb, Henry Wajswelnerc, Caroline F. Fincha
2016	2004
Journal of Strength and Conditioning Research	Physical therapy in Sport
The purpose of this study was to analyze the within-subject variation of the tuck jump screening assessment in elite male youth soccer players.	The purpose of this study was to establish the reliability of eight, musculoskeletal screening tests, commonly used in the screening protocols of elite-level Australian football clubs.
Study method	Study method
England	Australia (Melbourne)
Experimental study	

Twenty five pre-PHV (age 11.93 6 0.43 years; height 151.40 6 4.84 cm; body mass 41.05 6 5.62 kg; maturational offset 22.34 6 0.41 years;) and 25 post-PHV (age 17.26 6 0.69 years, stature 178.22 6 5.47; body mass 72.27 6 6.93 kg; maturity offset 2.91 6 0.81 years) youth soccer players from the academy of a professional English Championship soccer club.	All participants were staff or postgraduate students of the School of Physiotherapy at the University of Melbourne who reported the absence of a current musculoskeletal injury of the lumbar spine or lower limb. The mean (95% CI) age of participants was 31.6 (27.0–36.2) years
Tuck jump assessment tool	Musculoskeletal screening tests
The results of this study suggest that although tuck jump total score may be reliably assessed in elite male youth soccer players, caution should be applied in solely interpreting the composite score due to the high within-subject variation in a number of the individual criteria. Knee valgus may be reliably used to screen elite youth male soccer players for this plyometric technique error and for test-retest comparison.	All tests demonstrated very well to excellent (Intraclass correlation coefficient, ICC 0.88–0.97) inter-rater reliability. Test–retest reliability was also shown to be good for these tests (ICC 0.63–0.99).
Grade technique. Kinematic data. Reliability. Systematic bias. . Pearson correlation coefficients	ROM. Reliability. ICC.
Yes, Ethical approval was granted by the institutional ethics committee in accordance with the declaration of Helsinki. The study conforms to the Code of Ethics of the World Medical Association (approved by the ethics advisory board of Swansea University) and required players to provide informed consent before participation.	YES, Ethics approval for the study was granted by the Human Research Ethics Committee at The University of Melbourne.
2-dimensional video cameras. 50 Hz using 2 high-definition video cameras (Samsung, New Jersey, USA). Microsoft Excel 2010. T-tests were used with a p value <0.05. SPSS (V.21, Chicago, IL, USA).	SPSS for Macintosh (Version 10.1). Paired t-tests. Intraclass correlation coefficients (ICCs). SPSS for Macintosh (Version 10.1). For all statistical tests, the 5% level of significance was used (i.e. P, 0:05). Sit and reach test. Lumbar spine extension range of movement. Active hip internal rotation range of movement. Active hip external rotation range of movement. Passive Straight Leg Raise. Active Knee Extension test. Active slump test.
Results	**Results**
	(ICC 0.63–0.99).
	95% CI (Intraclass correlation coefficient, ICC 0.88–0.97).

Knee valgus was the only measure to demonstrate substantial agreement in both groups and may be reliably used to screen male youth soccer players for this potential injury risk factor and for test-retest comparison, on the provision that the total number of jumps performed is standardized. Thus, it is suggested that the tuck jump could be used to effectively assess jump-landing technique but only the presence of knee valgus should be evaluated. This provides a time-efficient tool for practitioners who screen large groups of athletes as part of regular field-based screening protocols. In addition, lower total scores reported in the post-PHV players on both trials tentatively suggest that performance in the tuck jump assessment may improve as a result of growth and maturation.	The findings suggest that these simple, clinical measures of flexibility and ROM are reliable and support their use as pre participation screening tools for sports participants.

Study details	**Study details**
Raphael	**Raphael**
5	**6**
09/01/2019	**09/01/2019**
Discussion about different cut-off values of conventional hamstring-to-quadriceps ratio used in hamstring injury prediction among professional male football players	**The intra- and inter-rater reliability of the soccer injury movement screen (Sims)**
Monika Grygorowicz, Martyna Michaøowska,Tomasz Walczak, Adam Owen, Jakub Krzysztof Grabski, Andrzej Pyda, Tomasz Piontek	Robert McCunn, Karen aus der Fünten, Andrew Govus, Ross Julian, Jan Schimpchen, Tim Meyer.
2017	2017
Plus one	The International Journal of Sports Physical Therapy
To measure the sensitivity and specificity of differences cut-off values for isokinetic Hcon/ Qcon ratio in order to improve the capacity to evaluate (retrospectively) the injury of hamstring muscles in professional soccer screened with knee isokinetic tests.	The purpose of the present study was to assess the intra- and inter-rater reliability of the SIMS and determine its suitability for use in further research.
Study method	**Study method**
Poland	Germany
Retrospective study.	test-retest design
2010 - 2016	Not mentioned
Medical and biomechanical data of 74 professional male football players (aged 23.42±4.63 years old, height 182.91±5.40 cm, and weight 77.80±6.60 kg) were analysed in this study.	Twenty-five (11 males, 14 females) healthy, recreationally active university students (age 25.5±4.0 years, height 171±9 cm, weight 64.7±12.6 kg).
Cut off values for screening	soccer injury movement screen

340 isokinetic test reports on both limbs of 66 professional soccer players were analysed. Eleven players suffered hamstring injuries during the analysed period. None of these players sustained recurrence of hamstring injury. One player sustained hamstring strain injury on both legs, thus the total number of injuries was 12. Application of different cut-off values for Hcon/Qcon significantly affected the sensitivity and specificity of isokinetic test used as a tool for muscle injury detection. The use of 0.47 of Hcon/Qcon as a discriminate value resulted in significantly lower sensitivity when compared to 0.658 threshold (sensitivity of 16.7% vs. 91.7%, respectively; t = 6.125, p = 0.0133). Calculated values of specificity (when three different cut-off were applied) were also significantly different. Threshold of 0.6 of Hcon/Qcon resulted with significantly lower specificity compared to 0.47 value (specificity of 46.9% vs. 94.5%, respectively; t = 153.0, p<0.0001), and significantly higher specificity when compared to 0.658 (specificity of 46.9% vs. 24.1%, respectively; t = 229.0, p<0.0001).	Intraclass correlation coefficient (ICC) values for intra- and inter-rater composite score reliability ranged from 0.66-0.72 and 0.79-0.86 respectively. Weighted kappa values representing the intra- and inter-rater reliability of the individual sub-tests ranged from 0.35-0.91 indicating fair to almost perfect agreement.
Sensitivity and specificity	inter and intra rater reability
Polish ethical guidelines do not provide defined regulations for observational studies including the analysis of records containing biomedical or other information. There is no obligation to receive positive decisions of Bioethical Committee, however, we decided to notify the Bioethical Committee that we were going to perform a study involving retrospective analysis of biomedical information. The Bioethical Committee analysed the principles and study design of the scientific project, and we received a letter of confirmation that the study did not meet the criteria for an experimental study, and thus it could be conducted without a decision from the Bioethical Committee.	The study was approved by the local ethics committee (ref number: 270/15, Ärztekammer des Saarlandes, Saarbrücken, Germany) and conformed to the Declaration of Helsinki.

Mean, standard deviation and Receiver operating characteristic (ROC) curve analysis. Biodex software. Discriminant-function analysis. McNemar's chi2 test with Yates's correction. We used PQStat software for all statistical analysis, and an alpha level of $p < 0.05$ was used for all statistical comparisons.	Descriptive data are presented as means ± standard deviation. Reliability statistics are accompanied with 95% confidence intervals (CI). Data were analysed using R statistics program (R Core Development Team 2014) and MedCalc for Windows, version 16.4.3 (MedCalc Software, Ostend, Belgium). Comparison of composite and individual sub-test scores between male and female participants was performed using the Mann-Whitney U statistic. Cohen's d effect size (ES) was also calculated to compare male and female participants and was interpreted as follows: ≤0.2,trivial; 0.21-0.60, small; 0.61-1.2, moderate; 1.21-2.0, large; 2.1-4.0, very large.20, 21 Two way mixed model intraclass correlation coefficients (ICC3, 1), weighted kappas (quadratic) and minimal detectable change (MDC) were used to determine the intra- and interrater reliability of the composite score. MDC values were calculated at both a 95% and 80% level of confidence in order to provide applied practitioners with the means to identify 'true' changes in test performance.
The use of 0.47 of Hcon/Qcon as a discriminate value resulted in significantly lower sensitivity when compared to 0.658 threshold (sensitivity of 16.7% vs. 91.7%, respectively; $t = 6.125$, $p = 0.0133$).	
Threshold of 0.6 of Hcon/Qcon resulted with significantly lower specificity compared to 0.47 value (specificity of 46.9% vs. 94.5%, respectively; $t = 153.0$, $p<0.0001$), and significantly higher specificity when compared to 0.658 (specificity of 46.9% vs. 24.1%, respectively; $t = 229.0$, $p<0.0001$).	
The use of different cut-off values for Hcon/Qcon significantly affected the sensitivity and specificity of isokinetic testing. The interpretation of usefulness of isokinetic test as a screening tool in a group of male professional football players to predict hamstring injury occurrence within the next 12 months might be therefore significantly biased due to the different threshold values of Hcon/Qcon. Using one ªnormativeº value as a cut-off (e.g. 0.47 or 0.60, or0.658) to quantify soccer players (or not) to the group with a higher risk of knee injury might result in biased outcomes due to the natural strength asymmetry that is observed within the group of soccer players.	Establishing the reliability of the SIMS is a prerequisite for further research seeking to investigate the relationship between test score and subsequent injury. The present results indicate acceptable reliability for this purpose; however, room for further development of the intra-rater reliability exists for some of the individual sub-tests.

APPENDIX E: HREC WAIVER CLEARANCE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL

Human Research Ethics Committee (Medical)

Research Office Secretariat:
Faculty of Health Sciences, Phillip Tobias Building, 3rd Floor, Office 301/2/4, 29 Princess of Wales Terrace, Parktown, 2193
Tel +27 (0)11-717-1252 /1234/2656/2700
Private Bag 3, Wits 2050
Office email: HREC-Medical.ResearchOffice@wits.ac.za
Website: www.wits.ac.za/research/about-our-research/ethics-and-research-integrity/

Ref: W-CBP-180917-3 17/09/2018

TO WHOM IT MAY CONCERN:

Waiver: This certifies that the following research does not require clearance from the Human Research Ethics Committee (Medical)

Investigator: Mr Raphael Christopher (student no. 1917645)

Supervisor: Dr Corlia Brandt

Department: Therapeutic Sciences, Physiotherapy

Project title: A screening tool for injury prevention in South African Elite Soccer Players.

Reason: Study will be an umbrella review. No human participants will be involved in the study.

Dr CB Penny
Chairperson: Human Research Ethics Committee (Medical)

Copy – HREC (Medical) Secretariat: Zanele Ndlovu, Charmaine Khumalo and Rhulani Mkansi.

APPENDIX F: TURNITIN REPORT

SCREENING TOOLS FOR COMMON SOCCER INJURIES A SYSTEMATIC REVIEW

ORIGINALITY REPORT

15%	10%	12%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.science.gov Internet Source	1%
2	mdpi.com Internet Source	1%
3	www.wjgnet.com Internet Source	1%
4	"Sports Injuries", Springer Nature America, Inc, 2015 Publication	1%
5	www.ncbi.nlm.nih.gov Internet Source	<1%
6	Gabbe, B.J.. "Reliability of common lower extremity musculoskeletal screening tests", Physical Therapy in Sport, 200405 Publication	<1%
7	ffiri.ir Internet Source	<1%
8	tampub.uta.fi Internet Source	<1%
9	onlinelibrary.wiley.com Internet Source	<1%
10	"Return to Play in Football", Springer Nature, 2018 Publication	<1%

APPENDIX G: FIGURES OF DATABASES SEARCHED

Figures 4.1a, 4.1b, 4.1c, 4.1d represents object 1 and 2 searches.

Figures 4.2a, 4.2b, 4.2c, 4.2d represent objective 3 searches.

Figures 4.3a, 4.3b, 4.3c, and 4.3d represent objective 4 searches.

Figure 4.1a: PubMed search on objective 1 and 2

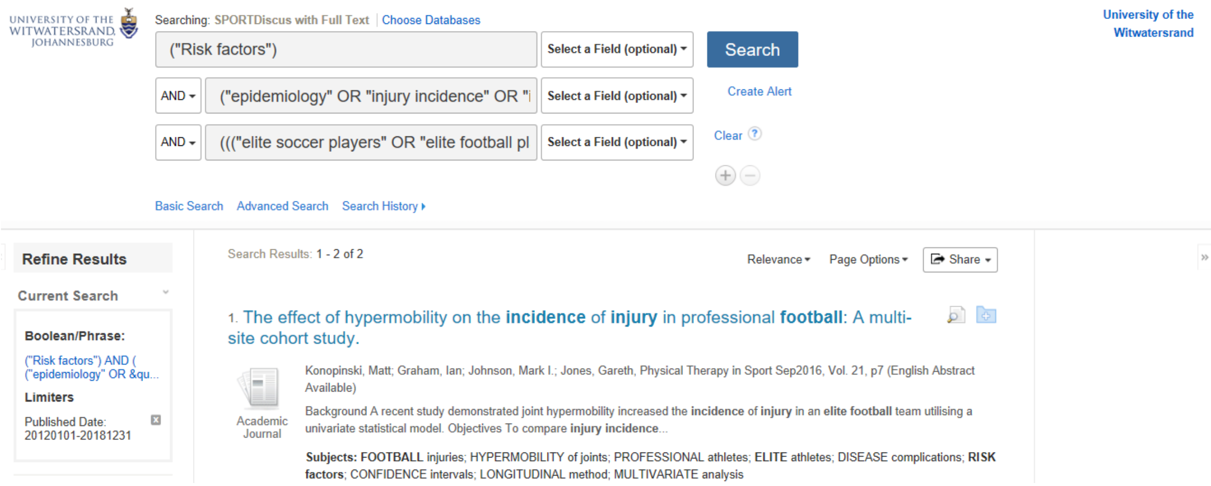

Figure 4.1b: Sport Discus search on objective 1 and 2

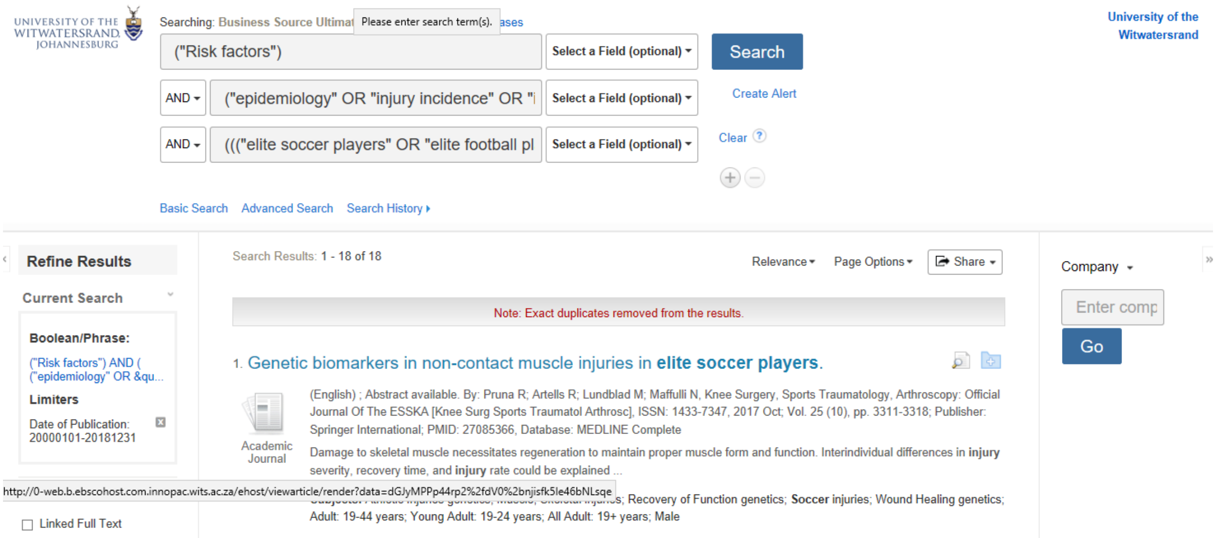

Figure 4.1c: Cinahl and Medline search on objective 1 and 2

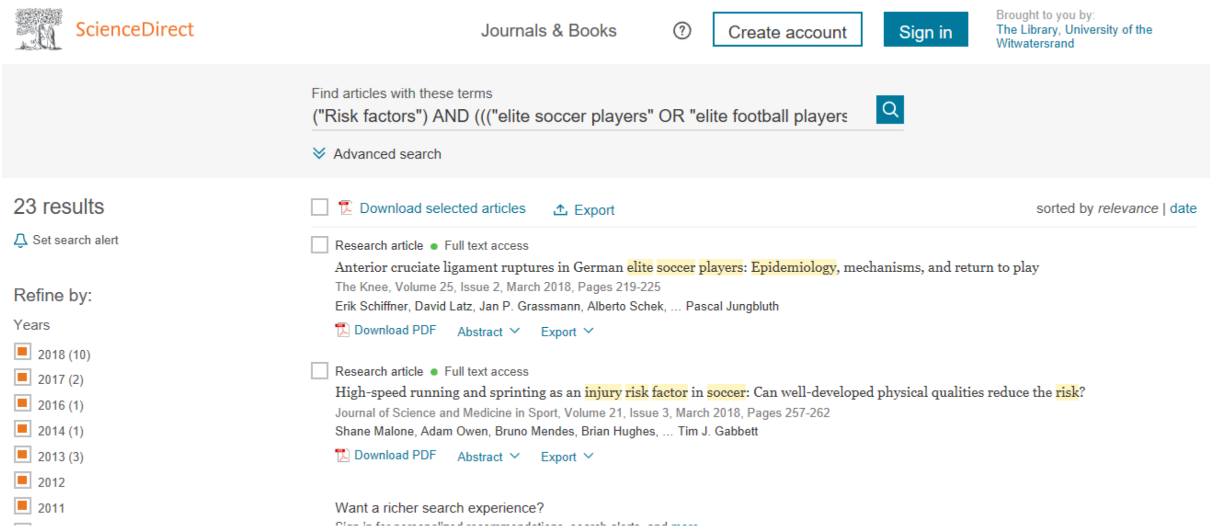

Figure 4.1d: Science Direct search on objective 1 and 2

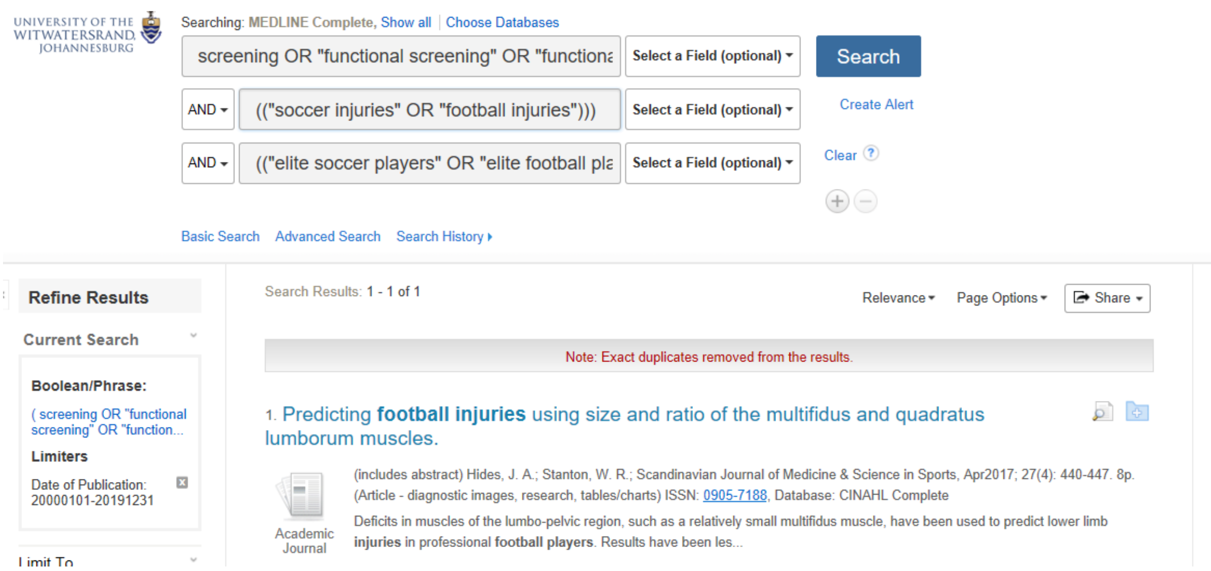

Figure 4.2a: Cinahl and Medline search on objective 3

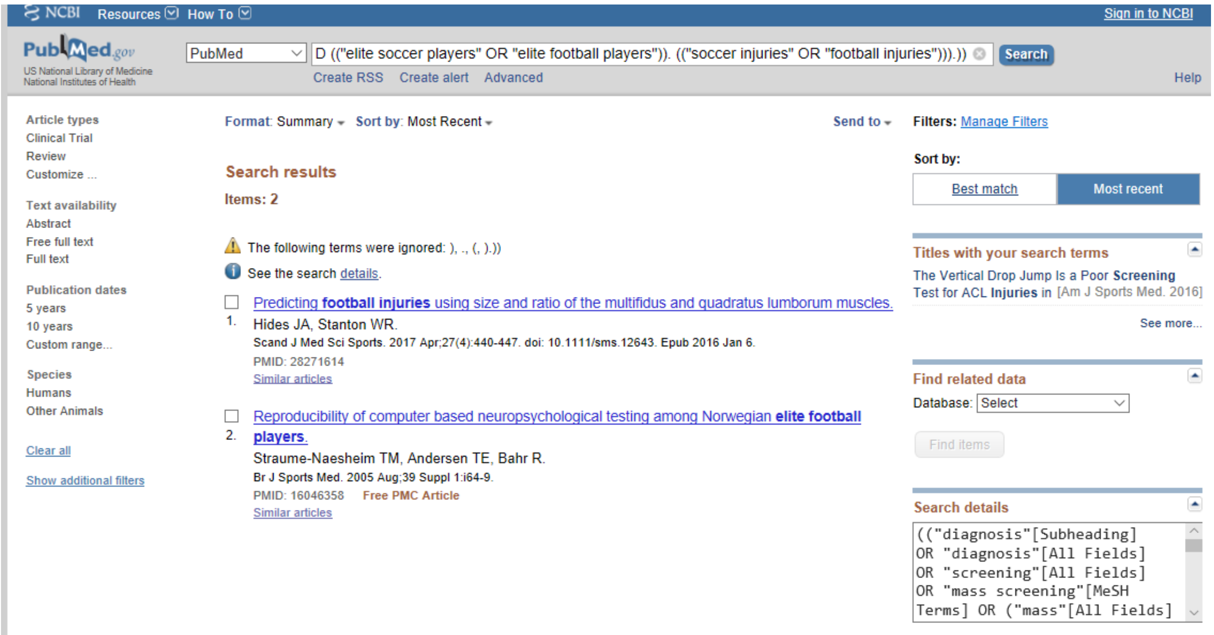

Figure 4.2b: PubMed search on objective 3

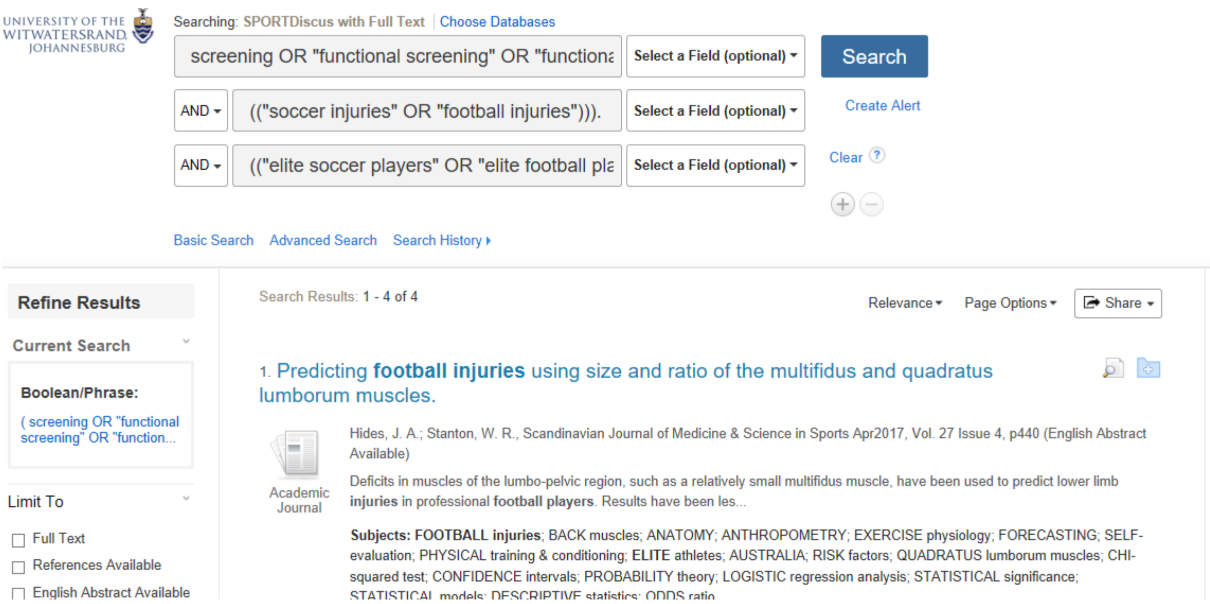

Figure 4.2c: Sport Discus search on objective 3

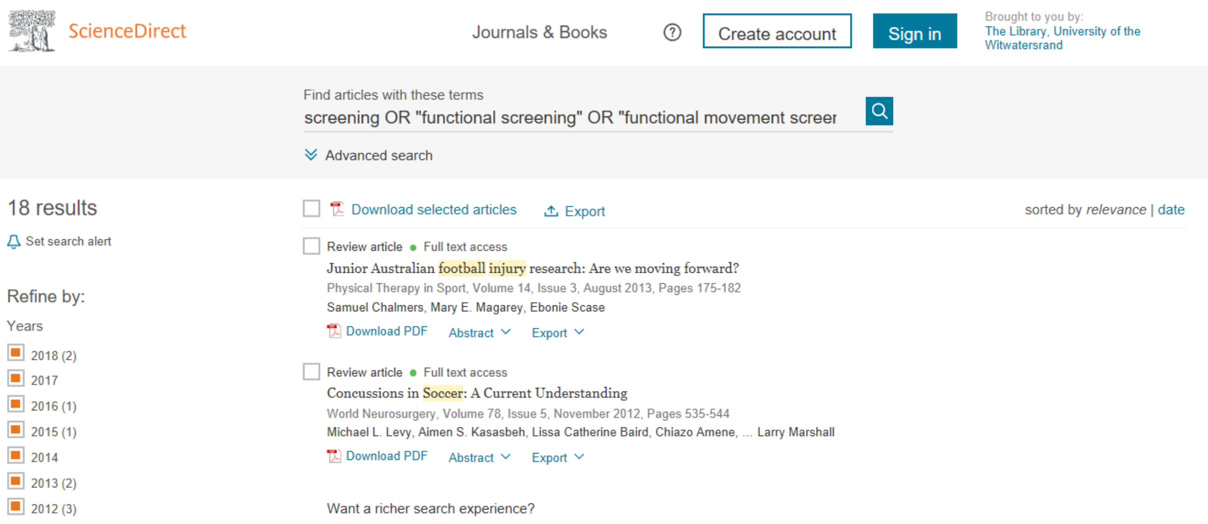

Figure 4.3d: Science Direct search on objective 3

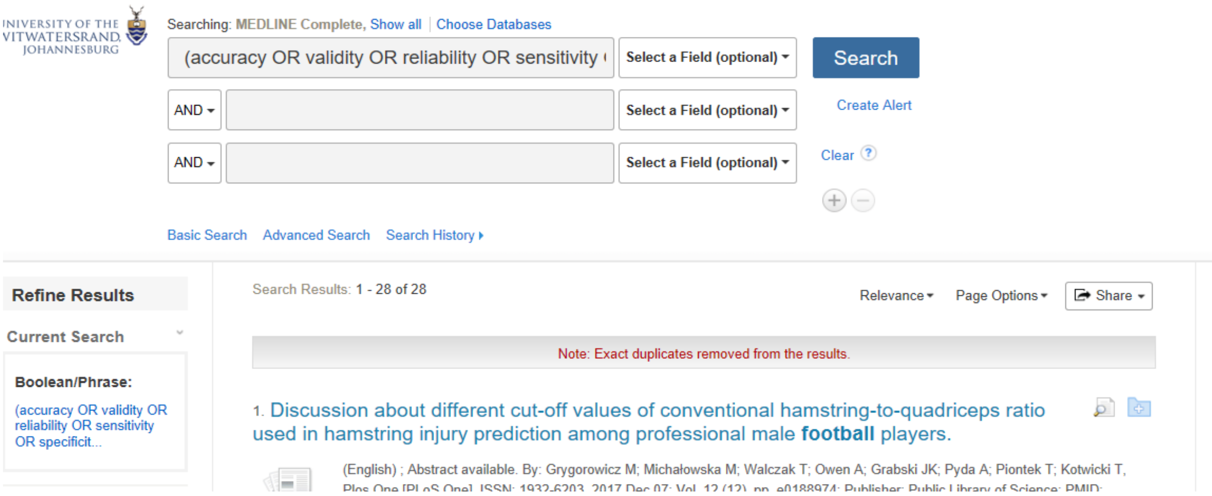

Figure 4.3a: Medline and Cinahl search on objective 4

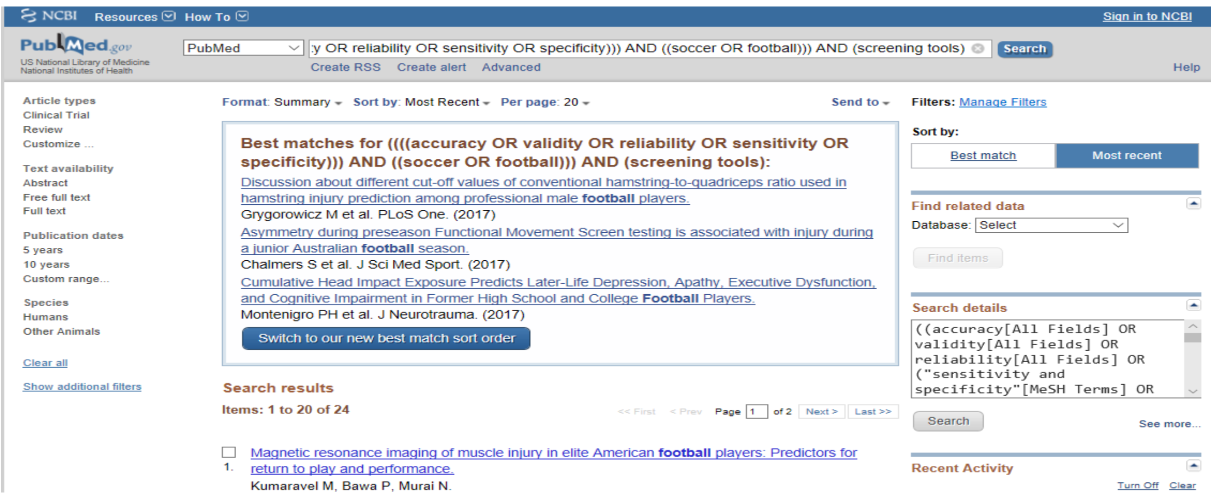

Figure 4.3b: PubMed search on objective 4

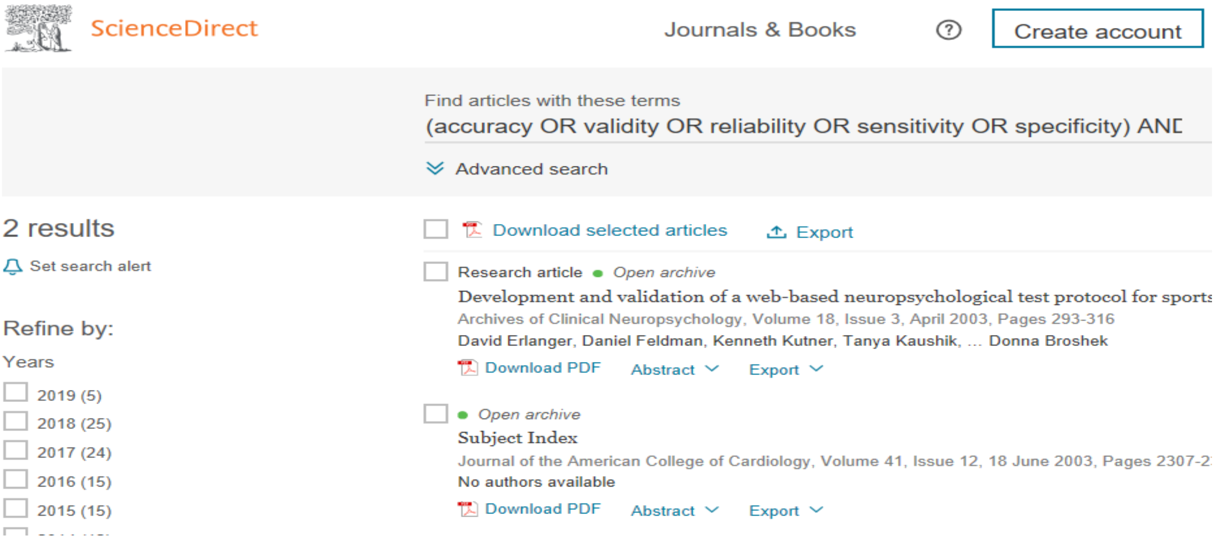

Figure 4.3c: Science Direct search on objective 4

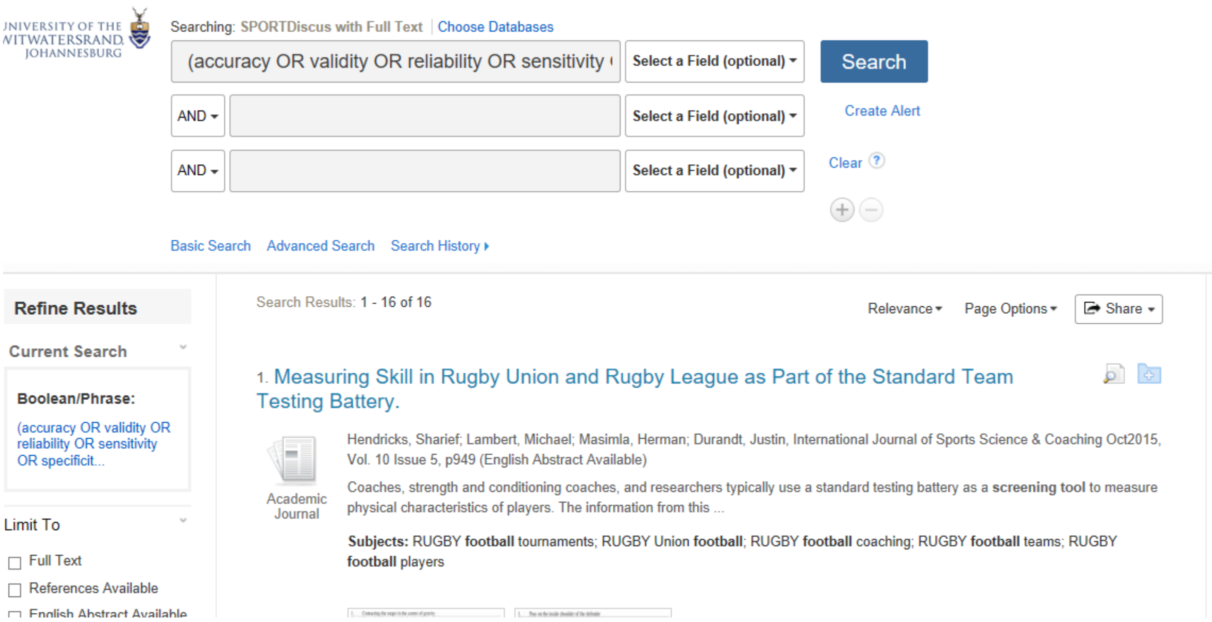

Figure 4.3d: Sport Discus search on objective 4