University of Southampton

Faculty of Environmental and Life Sciences
School of Health Sciences

Investigation of factors affecting return to play following acute lateral ankle sprains

By

Saed Abdulla Zahir Al Bimani

Thesis for the degree of Doctor of Philosophy

April 2020

University of Southampton

ABSTRACT

Faculty of Environmental and Life Sciences

School of Health Sciences

Thesis for the degree of Doctor of Philosophy

INVESTIGATION OF FACTORS AFFECTING RETURN TO PLAY FOLLOWING ACUTE LATERAL ANKLE SPRAINS

Saed Abdulla Zahir Al Bimani

Lateral ankle sprain is a common injury amongst the sport population, yet uncertainty exists regarding what influences return to play (RTP), as there is a lack of evidence-based guidance on RTP in the current literature. The identification of relevant influencing factors may help to construct guidance that informs effective practice in terms of optimising sport performance and prevention of recurrent injuries. Knowledge of such factors will help clinicians making safe and timely decisions for RTP. Consequently, the aim of this thesis was to explore factors, specifically physiological, clinical and personal, that influence RTP among sportspeople with a conservatively treated lateral ankle sprain using a mixed methods investigative approach.

A systematic review of the literature (thesis study one) was first conducted to examine the current evidence related to factors influencing RTP. The findings of the review showed that there is a lack of evidence on the factors influencing RTP after a lateral ankle sprain, most notably poor understanding of both personal and clinical factors. In response to this, three investigations were planned that followed both quantitative and qualitative approaches. In the first study (thesis study two), the epidemiological investigation included a population of patients, which was characterised by their demographic, clinical and sport factors, with lateral ankle sprain presenting to a UK emergency department. The population at risk of lateral ankle sprain, as defined by cause of injury and primary sport, was also described. In addition, the investigation identified important clinical factors, including the fact that the majority of patients were discharged without adequate information about conservative treatment nor were they given advice on when would be safe to RTP once their ankle injury had recovered.

The next investigation (thesis study three) involved a retrospective observational study of the associations between a self-reported demographic, sport related and clinical factors and RTP in a sports population of individuals who had had a lateral ankle sprain. Three factors were found to be important contributions to influencing RTP: 1) mechanism of injury, 2) restricted active dorsi flexion because of pain, and 3) treatment methods. The findings from thesis study three also revealed that the majority of participants did not receive any professional treatment and resumed training with residual symptoms. A final follow-up qualitative study (thesis study four), with a similar population to thesis study three, explored the reasons behind that behaviour and the various influencing factors for RTP. Eight themes were identified as main influencing factors for RTP 1) Previous negative experience with health care services. 2) Limitation of resources. 3) Level of sport played. 4) Self-management of injury towards RTP. 5) Perception of self, injury and RTP. 6) Previous history of managing ankle injury. 7) Symptoms dictating RTP. 8) External motivation, expectations and support. In addition, although participants recognised resolving symptoms such as pain as indicators for recovery, they resumed their training with residual symptoms. It was evident that they had different priorities related to their behaviour that led them to resume training with symptoms. Future researchers may consider investigating the patterns of behavior surrounding the decision to return to playing their sports in more depth to provide measurable strategies to correct them.

Therefore, to improve clinical outcomes following lateral ankle sprain, it is recommended that the next stage of work should focus on the development of an educational programme that focuses on why it is important to RTP safely following a lateral ankle sprain, which should be a pre-cursor to a rehabilitation programme plan.

Table of contents

List of tables

List of figures

Declaration of authorship

I, Saed Abdulla Zahir Al-Bimani declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree (PhD) at this University.
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated
3. Where I have consulted the published work of others, this is always clearly attributed
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself
7. Parts of this work have been published as:
    - **Al Bimani SA**, Gates L, Warner M, Crouch R and Bowen C (2018a) Characteristics of patients with ankle sprain presenting to an emergency department in the south of England (UK): A seven-month review. *Int. Emerg. Nurs.* 41: 38-44
    - **Al Bimani SA**, Gates LS, Warner M and Bowen C (2018b) Factors influencing return to play following conservatively treated ankle sprain: a systematic review. *Physician and Sportsmedecine* 47(1): 31-46
    - **Al Bimani, S.,** Gates, L., Warner, M. and Bowen, C. (2016). Prognostic factors for return to play following conservatively treated acute ankle sprain: a systematic review. Journal of Ankle and Foot (Suppl).

    Signed: Saed Al Bimani

    Date: 04/4/2020

Acknowledgements

I would like to express my sincere gratitude to the following people for their contributions toward the completion of this thesis:

- My family, for being a continuous source of encouragement and support in all of my pursuits and inspiring me to achieve my dreams.
- My supervisors, Professor Catherine Bowen, Dr Martin Warner and Dr Lucy Gates, for providing time, energy, and expertise throughout the past period of my study.
- Professor Robert Crouch, for his tremendous effort to provide me with necessary support for the epidemiological study from the emergency department of Southampton General Hospital.
- Jane Flewitt for her valuable efforts to arrange a PPI review for study three documents (Questionnaire, PIS and advertisement poster).
- Arthritis Research UK Centre for Sport, Exercise and Osteoarthritis, for providing valuable PPI review of study three documents.
- Dr Sean Ewings whose statistical expertise was invaluable to make the analysis and interpretation of my results meaningful.
- Dr Amira Al Amri whose expertise made regression analysis an easier task.
- Dr Dawn Bacon for advising on the planning of the qualitative study (Study four).

List of abbreviations

AOFAS	The American Orthopaedic Foot and Ankle Score
AROM	Active range of motion
ATFL	Anterior talofibular ligament
BMI	Body mass index
CASP	Critical Appraisal Skills Programme
CFL	Calceneofibular ligament
CI	Confidence intervals
ED	Emergency department
FAOS	Foot and Ankle Outcome Score
IRR	Incidence Rate Ratio
N	Population or as it is in this thesis, the original sample
n	Sample size
NCAA	National Collegiate Athletic Association
PPI	Patient and Public Involvement
PRICE	Protection, rest, ice, compression and elevation
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PTFL	Posterior talofibular ligament
RICE	Rest, ice, compression and elevation
RTP	Return to play
ROM	Range of motion
SF36PF	Short Form–36 Physical Function scale

SGH	Southampton General Hospital
VAS	Visual analogue scale

Research staff abbreviations

SB	Mr. Saed al Bimani, PhD candidate and a Physiotherapist
CB	Professor Catherine Bowen, Professor in Podiatry
MW	Dr. Martin Warner, Senior Research Fellow in Musculoskeletal Biomechanics
LG	Dr. Lucy Gates, Arthritis Research UK Research Fellow within Health Sciences at the University of Southampton.
RC	Professor Robert Crouch, Consultant Nurse & Honorary Professor of Emergency Care
SE	Dr. Sean Ewings, Research Fellow within Southampton Statistical Sciences Research Institute at the University of Southampton.

Chapter 1: Introduction to the thesis

This thesis presents the work carried out to date as a post-graduate research student at the School of Health Sciences, University of Southampton. The completion of this thesis is required to become a Doctor of Philosophy.

In my clinical experience as a physiotherapist, my work has focused on treating football and volleyball players who suffer different types of musculoskeletal injuries, including lateral ankle sprain. Most sportspeople who had this injury responded successfully to treatment following an appropriate conservative treatment programme, however, some continued to develop chronic symptoms such as pain, swelling, and instability. On questioning this, it was clear that the literature regarding factors that affect recovery from lateral ankle sprain was limited and therefore, inevitably, that treatment in some sportspeople was less likely to be successful. In fact, a key clinical observation was that players with sport injuries, including those with lateral ankle sprain, always have the same question: “When can I return to play?”

The stages of this doctoral thesis therefore follow a sequential programme of original work. Factors, including personal factors, as well as physiological and clinical ones, that affect RTP following lateral ankle sprain have been identified through quantitative and qualitative investigations and recommendations have been made regarding the design and implementation of a person-centred educational programme

1.1 Overview of the research problem

Lateral ankle sprain is a traumatic injury that, based on its severity and mechanism of injury, occurs to one or more of the lateral ankle ligaments, specifically the anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament Kerkhoffs et al. (2012). The most commonly injured ligament is the anterior talofibular ligament, because of the typical mechanism of injury that forces the foot into inversion and plantar flexion (Hubbard and Hicks-Little 2008; Wei et al. 2015). Furthermore, the anterior talofibular ligament is considered to be the weakest of the lateral ligaments (Mai and Cooper 2009). In addition, subsequent pain, swelling, loss of joint motion, reduced muscle strength, gait abnormalities and joint instability is often observed following this injury (Colville et al. 1990). It may also produce chronic symptoms such as pain, joint stiffness, functional and mechanical joint instability and arthritic changes (Gerber et al. 1998; Hertel 2000; Takao et al. 2003; van Rijn 2008a; van Rijn et al. 2008b; Malliaropoulos et al. 2009; Golditz et al. 2014).

Epidemiological studies have shown that, following this injury, many patients complain about chronic symptoms such as pain, instability and arthritis changes (Gerber et al. 1998; Hertel 2000; Takao et al. 2003; van Rijn et al. 2008b; Malliaropoulos et al. 2009; Golditz et al. 2014). The reasons for developing such chronic symptoms are not yet fully understood, therefore it is common for patients that continue to develop chronic symptoms to repeatedly seek medical advice. As a result, in these cases, the burden and expenditure on primary and secondary care increases. In England, NHS expenditure on diseases related to the musculoskeletal system including those affecting ankle joint have increased from £77.18 in 2004 to £102.60 per head in 2013 (Figure 1-1). One of the more prevalent musculoskeletal conditions is lateral ankle sprain, as indicated in epidemiological studies conducted in the UK (Bridgman et al. 2003; Price et al. 2004; Cloke et al. 2009; Cloke et al. 2011; Al Bimani et al. 2018a). For instance, Bridgman et al (2003) calculated an incidence rate for lateral ankle sprains of 52.7 per 10,000 people per year attending emergency department in four urban West Midlands health districts in England. Additionally a systematic review and meta-analysis of English articles calculated a pooled cumulative incidence rate for lateral ankle sprains as 11.55 per 1,000 exposures across sport populations (Doherty et al. 2014). Others also found it common injury in specific sports such as football with a mean incidence of one ankle sprain per player per year and a mean of 20 training days and two matches were missed per ankle injury (Cloke et al. 2009).

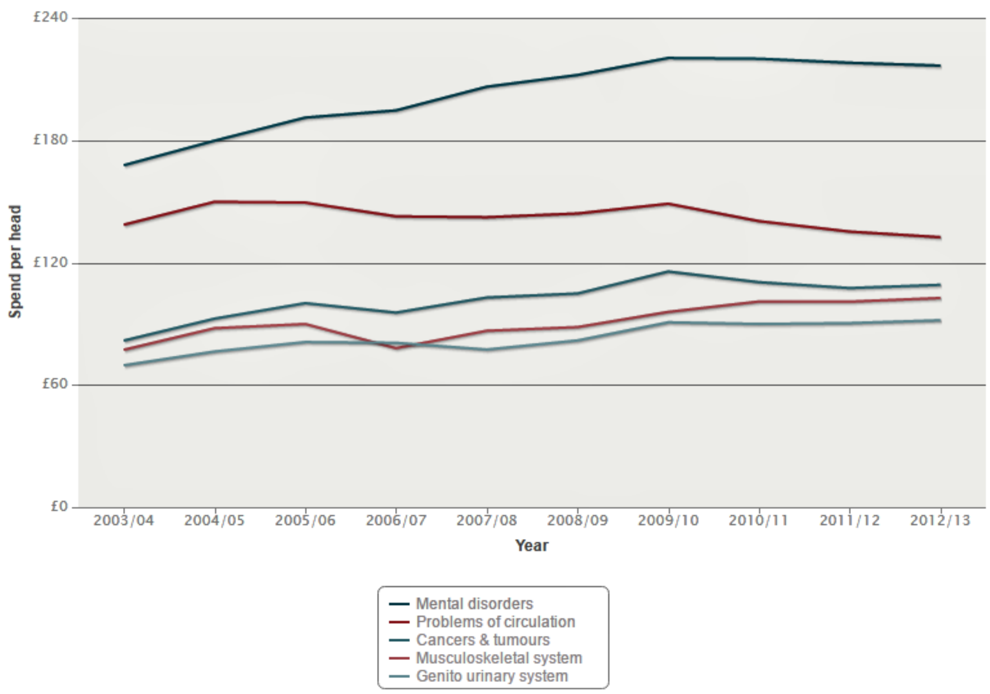


Figure 1-1 NHS spending in England per person. Reproduced with permission from: http://www.nuffieldtrust.org.uk/data-and-charts/top-five-categories-nhs-spending-england-head.

It has been identified that there is a lack of clarity and insight regarding recovery from conservatively treated lateral ankle sprain (Seah and Mani-Babu 2011; Han et al. 2012; Petersen et al. 2013; van den Bekerom et al. 2013; Thompson et al. 2017). Some of the questions consistently raised are:

- What is the influence of the demographic and clinical factors on short and long term recovery from lateral ankle sprain?
- Are some patients returning to sport too early and why?
- Why do sportspeople with a lateral ankle sprain develop residual symptoms?

1.2 Factors affecting return to sport following lateral ankle sprain

Investigators have explored different treatment approaches such as proprioceptive training, balance training, manual therapy, strengthening and stretching, PRICE, electrotherapy and immobilisation for the management of lateral ankle sprain (Green et al. 2001; Eisenhart et al. 2003; Emery et al. 2005; Hupperets et al. 2009; van den Bekerom et al. 2012). Despite the variety of those approaches, many go on to develop chronic symptoms such as pain, swelling, joint instability, re-sprain and osteochondral lesions (Gerber et al. 1998; Hertel 2000; Takao et al. 2003; van Rijn et al. 2008b; Malliaropoulos et al. 2009; Petersen et al. 2013; Prado et al. 2014). Furthermore, they may suffer further long-term effects and can be predisposed to other manifestations such as traumatic osteoarthritis (Golditz et al. 2014).

Pain and joint instability have been described as the most prevalent residual symptoms following lateral ankle sprains (Gerber et al. 1998; van Rijn 2008a; van Rijn et al. 2008b). Following one observational study, investigators found that re-sprains during the first three months following an lateral ankle sprain injury were related to incomplete recovery (van Middelkoop et al. 2012). Although the interventions used in that study were strictly protocolised, it is unknown whether premature RTP or poor compliance with conservative treatment are associated with the occurrence of re-sprains. However, a history of injury and premature RTP have been suggested as being the strongest predictor for recurrent ankle injury (McKay et al. 2001; Stasinopoulos 2004; Boyce et al. 2005; van der Wees et al. 2007; Malliaropoulos et al. 2009).

In sports, it is considered that 'safe RTP is only possible when a sportsperson has completely recovered (Herring et al. 2002; Creighton et al. 2010; Richie and Izadi 2015). Return to sporting activity, generally referred to as RTP in the literature, is defined as “the process of deciding when an injured or ill athlete may safely return to practice or competition” (Herring et al. 2002). As a result, it has been used as an outcome measure for recovery from many sport injuries, including lateral ankle sprain (Wilson and Gansneder 2000; Green et al. 2001; Ardevol et al. 2002; Cross et al. 2002; Petrella et al. 2007; Petrella et al. 2009; Mendel et al. 2010; Van der Linde and Oschman 2011; Bendahou et al. 2014; McKeon et al. 2014; Punt et al. 2016), hamstring strain (Moen et al. 2014), high ankle sprain (Miller et al. 2012) and anterior cruciate ligament injury (Brophy et al. 2012).

As mentioned previously, the primary question asked by sportspeople, medical and coaching staff following most sport injuries is how long it will take to recover and RTP. Unfortunately, in the literature, understanding the factors that influence this is unclear and consequently evidence-based guidance for RTP following lateral ankle sprain is also deficient, despite the fact previous researchers have investigated some potential influencing factors for RTP following lateral ankle sprain (Wilson and Gansneder 2000; Cross et al. 2002; Medina McKeon et al. 2014). To do so, they adopted functional questionnaires and activities and clinical tests (Wilson and Gansneder 2000; Cross et al. 2002). Medina McKeon et al. (2014) investigated the influence of previous injury (new vs recurrent injury) on RTP. However, these three observational studies did not include other potential influencing factors such as age, sex, BMI, history of injury and previous sports activity. These factors were investigated in other injuries such as hamstring strain, ankle syndesmosis injury and ACL (Warren et al. 2010; Brophy et al. 2012; Miller et al. 2012; Richmond et al. 2013; Moen et al. 2014; Sman et al. 2014). In addition, these observational studies presented methodological issues such as a lack of power calculation, poor sampling and inappropriate statistical analysis. For instance, Cross et al. (2002) and Wilson and Gansneder (2000) only included a small sample of 20 and 21 participants, respectively. Moreover, the inclusion of a very limited age span may compromise the ability to generalise their results across a larger population. Therefore, these issues need to be considered when designing future studies, in order to appropriately develop evidence-based recommendations for RTP.

In short, there is a lack of evidence about sound decision-making for RTP, as there is no clear guidance on what constitutes safe RTP, thus making it difficult for clinicians to advise on and sportspeople to know when to safely return to sport. The issue arises when sportspeople with lateral ankle sprain RTP prematurely, as this can negatively affect the injured ligament and predispose the individual to unfavourable complications and/or a recurrence of the injury. The ligament might not have healed completely, and re-sprain could be one of the potentially serious complications, together with chronic pain and instability, among other symptoms.

For sportspeople with a lateral ankle sprain, a timeframe of six to eight weeks, and in severe cases up to 12 weeks, is proposed, to ensure they are fit enough to RTP (Kannus and Renström 1991; Tiling et al. 1994; Shrier 1995; Pijnenburg et al. 2000; Kerkhoffs et al. 2007; Hubbard and Hicks-Little 2008). This timeframe may increase or decrease depending on the severity of the injury and patients’ characteristics yet there is a lack of evidence to support what factors (patients' characteristics) influence these recovery periods for lateral ankle sprains. For example, although Medina McKeon et al. (2014) reported that the median time for RTP was three days for new lateral ankle sprain and one day for a recurrent sprain, what was unclear was whether factors such as the physiological timeframes required for ligamentous tissue healing were taken into consideration. A systematic review of the literature concluded that remodelling and the recovery of the mechanical stability of recovering ligaments takes a minimum of six weeks to three months (Hubbard and Hicks-Little 2008). This indicates that a large proportion of sportspeople may resume their sports training before their ankles are fully recovered.

Therefore, there is clearly a necessity to investigate the factors that influence RTP, in order to help develop clear and evidence-based recommendations for RTP. That, in turn, will help to eliminate any disagreement and poor decision-making among clinicians and sports medical team members, as recommended by the narrative reviews (Anderson 2002; van Rijn et al. 2008b; Clanton et al. 2012; Richie and Izadi 2015).

1.3 The scope of the thesis

The four studies that form this thesis were conducted over a 42-month period from October 2015 to April 2019. All of the data was collected and analysed at the University of Southampton. The thesis develops, through its consecutive investigations, to eventually determine the factors that influence RTP after conservatively treated lateral ankle sprain. However, prior knowledge of the potential factors associated with this was indeed required to determine the demographic, clinical and sport-related characteristics of sportspeople with this injury. Exploring the factors that may be associated with RTP will help to understand what constitutes a safe RTP tine after this type of injury. To understand the factors holistically, and for the first time in the literature, a macro approach is adopted to investigate the personal factors that are associated with RTP after lateral ankle sprain among sportspeople.

1.4 Summary of thesis chapters

1.4.1 Chapter one

Chapter one presents an overview of the research problem and rationale for the studies. Since decisions related to RTP following lateral ankle sprain lack informed evidence, this chapter highlights that the decisions about RTP following a lateral ankle sprain appear to be confused and based on several factors, including both physiological and personal factors. The future development of evidence-informed guidance would be a useful contribution to the field, however prior to this, the investigation of the influencing factors is required.

1.4.2 Chapter two

Chapter two of this thesis seeks to further explore the background and bring together thoughts from the subject material read to date, the important issues regarding RTP such as the mechanical aspects of the injury and the relevance of the physiological and anatomical features of the ankle. The relevance to clinical practice and the confusion surrounding the advice is also highlighted, and the investigation of factors influencing RTP following lateral ankle sprain is justified.

1.4.3 Chapter three

Chapter three explains the methodological approach for the programme of research study and the selection of a study paradigm underpinning the investigations in the entire thesis. The participant samples, observational outcomes, self-reported outcomes, and statistical analyses are discussed and justified in the corresponding chapters of each investigation.

1.4.4 Chapter four

Chapter four details the first phase of the research study, during which a systematic review of the literature is performed to determine the current reported evidence regarding the factors influencing RTP in patients with a lateral ankle sprain. The results of the investigations are discussed in light of current evidence to find out if agreement exists in the current literature on the relationship between the influencing factors and RTP.

1.4.5 Chapter five

Chapter five presents the epidemiological study that investigates the characteristics of patients presenting at an emergency department. The results of the study, detailing the prevalence, demographic, clinical and sport characteristics of the patients with lateral ankle sprain are presented and their uniqueness discussed in light of the current evidence.

Further analyses of common causes for lateral ankle sprain and sport type are also presented and discussed in light of the current evidence.

1.4.6 Chapter six

Chapter six presents the quantitative observational study that explores the factors associated with self-reported RTP following conservatively treated lateral ankle sprain. Results from the quantitative data are presented and the twenty factors associated with RTP are analysed using relevant correlational statistics. The resultant associated factors are then discussed in light of the current evidence.

1.4.7 Chapter seven

Chapter seven presents a qualitative study that explores the experiences and factors that affect sportspeople’s decision to RTP after a conservatively treated lateral ankle sprain in depth. It further illustrates the reasons why most sportspeople with a lateral ankle sprain resume training with residual symptoms. All of these findings are then discussed in light of the current evidence.

1.4.8 Chapter eight

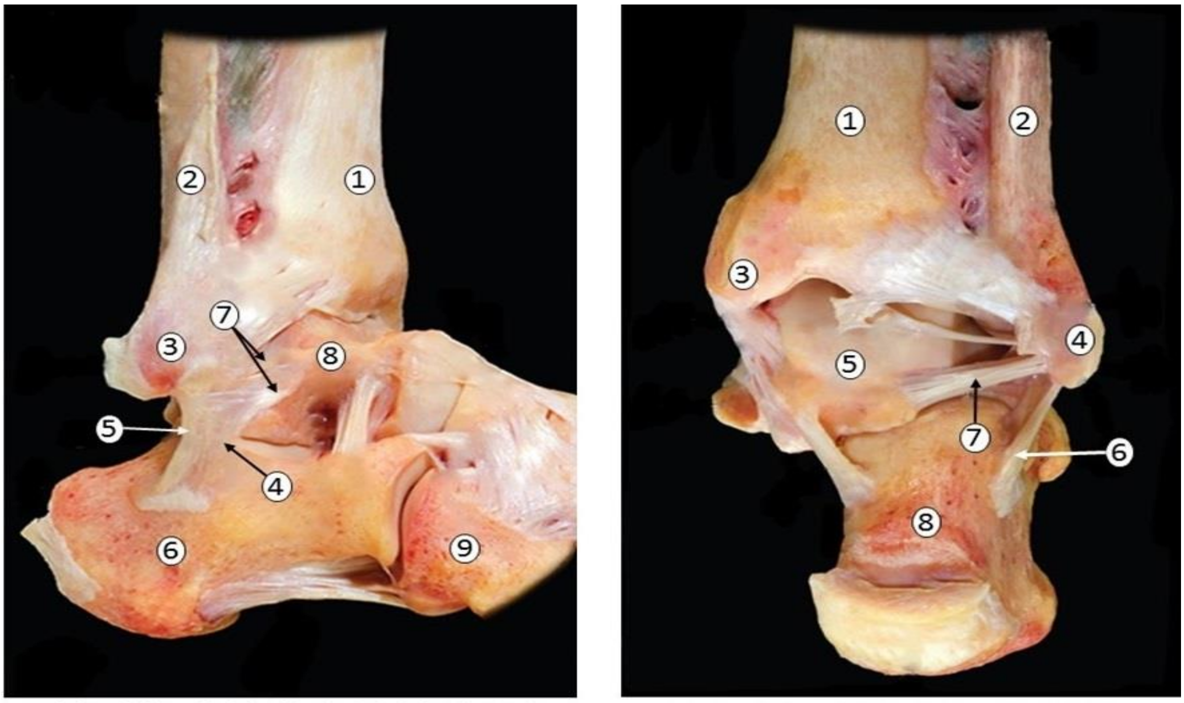
Chapter eight draws the discussions from chapter four, five, six and seven together and further critiques each of the studies’ designs. Suggestions for improvements and plans for future research are offered along with concluding remarks.

Chapter 2: Background

The aim of this chapter is to introduce the background to the research study and explore the rationale for the study. The background review considers the various opinions regarding the anatomy and pathological processes of lateral ankle sprain, the mechanism of injury and the consequent conservative management. The main ideas behind the need to define factors that affect return to playing sport are also discussed. Ultimately, this review considers the need for improved understanding of the nature of the injury and the factors that may affect recovery and thus return to playing sport following lateral ankle sprain.

2.1 Anatomy of the lateral ligaments of the ankle joint

The ankle joint is supported by two main groups of ligaments. The lateral part of the joint is supported by lateral collateral ligament and the medial part of the joint is supported by the medial collateral ligament. The lateral collateral ligament, on which the lateral ankle sprain occurs, consists of three ligaments: the anterior talofibular ligament, the calcaneofibular ligament and the posterior talofibular ligament (Figure 2-1). One of these ligaments (ATFL) is called the lateral capsular ligament because it is attached to the fibrous capsule of the ankle joint. All these ligaments collectively reinforce joint stability on the lateral side of the ankle joint. The orientation and size of each one of them determines their function and strength while supporting the ankle joint.



Lateral view of right ankle joint: (1) Tibia. (2) Fibula. (3) Lateral malleolus. (4) Lateral talocalcaneal ligament. (5) Calcaneofibular ligament. (6) Calcaneos. (7) Anterior talofibular ligament. (8) Talus. (9) Cuboid.

Posterior view of right ankle joint: (1) Tibia. (2) Fibula. (3) Medial malleolus. (4) Lateral malleolus. (5) Talus. (6) Posterior calcaneofibular ligament. (7) Posterior talofibular ligament. (8) Calcaneus.

Figure 2-1 Anatomical illustration of lateral ankle ligament. Used with permission from online article (Available at “http://www.aspetar.com/journal/viewarticle.aspx?id=12#.Vy86P4QrJpg”)

2.1.1 **Anterior Talofibular Ligament (ATFL)**

The anterior talofibular ligament (ATFL) is a flat, relatively strong, quadrilateral ligament, but the weakest of the three lateral ankle ligaments (Sauer et al. 1978; Van den Bekerom et al. 2008; Kelikian 2011). It is composed of two bands (upper and lower) that have a common origin from the inferior oblique segment of the anterior border of the lateral malleolus, however, in many anatomical cases, the upper band is attached to the anterior tibiofibular ligament (supporting distal tibiofibular joint) and the lower band to the calcaneofibular ligament. Both bands run anteromedialy and are connected to the body of the talus bone, just in front of its articular surface with the lateral malleolus. This ligament is attached to the joint fibrous capsule and is considered a capsular ligament. Kinematic studies showed that the ATFL restricts anterior slide, as well as inversion and internal rotation of talus bone in relation to its articular contact with tibia (Stormont et al. 1985; Renstrom et al. 1988; Hollis et al. 1995). Tension of this ligament increases as the ankle joint moves from dorsiflexion to plantar flexion (Renstrom et al. 1988).

2.1.2 Calcaneofibular Ligament (CFL)

The calcaneofibular ligament (CFL) is a strong cord-like ligament which is flat oval in shape and originates from the lower part of the anterior rim of the lateral malleolus, just below the origin of the inferior band of the ATFL (Van den Bekerom et al. 2008; Kelikian 2011). It runs obliquely, inferiorly, posteriorly and medially and is attached to a small tubercle on the posterior aspect of the lateral surface of the calcaneus. Unlike the ATFL, this ligament is not attached to the joint fibrous capsule. The main function of the CFL is to restrict excessive inversion and maximum stress is exerted upon this ligament when ankle joint is in the full dorsi flexion position (Beumer et al. 2003).

2.1.3 Posterior Talofibular Ligament (PTFL)

The posterior talofibular ligament is a very strong ligament that is trapezoidal in shape. It originates from the posterior margin of the articular surface of the lateral malleolus and inserts on posterolateral border of the talus (Kelikian 2011). The PTFL restricts excessive inversion and internal rotation when the foot in a weight bearing position (Stormont et al. 1985). It is relatively relaxed in a neutral and plantar flexion foot position and is tensed in a full dorsi flexion.

2.2 The epidemiology of lateral ankle sprain

Lateral ankle sprain is a very common and costly injury for many health care providers across the globe. For instance, the incidence of lateral ankle sprains reported by emergency departments was 70 per 10,000 people per year in Denmark, (Holmer et al. 1994), 20.15 per 10,000 people per year in the United States (Waterman et al. 2010) and 52.7 per 10,000 people per year in four urban West Midlands health districts in England (Bridgman et al. 2003). Furthermore, a recent epidemiological study on lateral ankle sprain showed an incidence of 909 new cases attending an emergency department of Southampton General Hospital over a seven month period (Al Bimani et al. 2018a). They found that over half of lateral ankle sprain injuries (65%) occurred in young patients aged between 14 and 33 years old with a peak prevalence at 21 years. Similar results were also seen in other populations that attend emergency departments in the US (Waterman et al. 2010) and in the UK (Bridgman et al. 2003).

In sports, the incidence of lateral ankle sprain injury has been determined across different sport cohorts. Holmer et al. (1994) reported 70 per 10,000 persons per year suffered lateral ankle sprain injury in Denmark, forty-five percent of which occurred during sporting activities. A systematic review and meta-analysis of prospective epidemiological studies found lateral ankle sprain to be a very common injury among sports players, as well as the general population, with a pooled cumulative incidence rate of 11.55 per 1,000 exposures (Doherty et al. 2014). They calculated a higher incidence of lateral ankle sprain in women compared with men (13.6 vs 6.94 per 1,000 exposures), in children compared with adolescents (2.85 vs 1.94 per 1,000 exposures), adolescents compared with adults (1.94 vs 0.72 per 1,000 exposures). In terms of sports field types, they calculated higher incidence rates in indoor/court sports (7 per 1,000 exposures). Across specific sports, lateral ankle sprain is very common in football/soccer (Brynhildsen et al. 1990b; Cloke et al. 2009; Cloke et al. 2011), Australian football (Orchard et al. 1998; Scase et al. 2012), rugby (Gerrard et al. 1994), field hockey (Murtaugh 2001), handball (Seil et al. 1998), volleyball (Verhagen et al. 2004), figure skating (Dubravcic-Simunjak et al. 2003), squash (Berson et al. 1981), scooter (Mankovsky et al. 2002) and orienteering (Blomberg 1997). In these sports, lateral ankle sprain injury accounts for approximately more than 80% when compared to other sport injuries (Fong et al. 2007).

The increased prevalence of lateral ankle sprain exerts a large burden on the national economy. For example, the direct healthcare cost per patient attending emergency department in England with lateral ankle sprain was £135 for tubular bandage, £170 for below knee cast, £167 for Aircast and £365 for Bledsoe (Cooke et al. 2009). However, there are additional costs that also need to be considered, including the loss of working and sport training hours, number of clinic visits and medication prescriptions. Nevertheless, other costs could also be added such as the management of residual symptoms and re-sprains that are often associated with lateral ankle sprains. Statistics from an emergency department in the US over the course of one year show that charges were $1029 per person on average, with an interquartile range between $723 and $1457 per person (Shah et al. 2016). In addition, an estimated 1.6 million lateral ankle sprain patients visit physician offices, and as many as 8,000 hospital admissions in USA per year were calculated (Praemer et al. 1999) . Moreover, about €187.2 million per year is spent on the management of sport-related lateral ankle sprains in the Netherlands (Verhagen et al. 2005). About 80% of these costs are related to low work production due to absence from paid and unpaid work.

From the clinical experience of the researcher, it has been noted that there is a burden on healthcare system because of the high incidence of lateral ankle sprain and the management of the associated chronic symptoms, however, it is hard to quantify how great this burden is. It is difficult to control the occurrence of this injury unless we study the incidence and characteristics of patients who suffer from lateral ankle sprain. One of the main aims of this thesis was to quantify the number of new cases and characterise patients with lateral ankle sprain based on their demographic, clinical and sport characteristics (Al Bimani et al. 2018a), please refer to chapter 4 (study two) for more details (Chapter 1:).

The increase in prevalence and resultant health care costs have required health care authorities and concerned researchers to establish injury awareness and prevention programmes to reduce the number of patients with lateral ankle sprains. In addition, establishing evidence based and protocolised rehabilitation programmes and recovery thresholds including RTP recommendations may help minimise the incidence of lateral ankle sprain injury.

2.3 Mechanism of injury

Lateral ankle sprain injury affects the integrity of the lateral collateral ankle ligament, especially ATFL and CFL. This has been found to be a common injury in sports such as football (Nelson et al. 2007; Cloke et al. 2009; Cloke et al. 2011), basketball (Hosea et al. 2000; Nelson et al. 2007; Waterman et al. 2010) and volleyball (Aagaard and Jorgensen 1996; Aagaard et al. 1997). Indeed, studies on the football population have shown that the majority (46%-59%) of lateral ankle sprains occur because of contact with the opponent player (Chomiak et al. 2000; Woods et al. 2003; Andersen et al. 2004; Verhagen et al. 2004). Biomechanical studies showed a typical movement pattern for lateral ankle sprains, during which the foot is forced into inversion accompanied with internal rotation and plantar flexion (Wei et al. 2015). However, others have claimed that plantar flexion does not influence the occurrence of lateral ankle sprain (Kristianslund et al. 2011). During the injury, a change in the position of the line of gravity occurs, falling on the lateral aspect of the foot, while transmitting to weight-bearing condition forces the foot to roll inward causing tension in the lateral ankle ligaments (Tropp et al. 1985; Wilkerson et al. 1997). Studies have shown different mechanism of lateral ankle sprain injuries across different sports. For instance, in basketball and volleyball, landing on an opponent’s or teammate’s foot drives the ankle to roll inward (Figure 2-2) and therefore strains the lateral ligament (Dubin et al. 2011).

Figure 2-2 Mechanism of injury of lateral ankle sprain in basketball. Used with permission from Dubin et al. (2011).

Football also has a unique mechanism of injury for lateral ankle sprain and a video analysis study was conducted to describe the mechanisms for ankle injuries in football (Andersen et al. 2004). The injury occurs when a hit is directed at the medial side of the ankle, forcing the player to bear weight on an inverted foot (Figure 2-3) and thus straining the lateral ligament.

Figure 2-3 Mechanism of injury of lateral ankle sprain in football. Used with permission from Andersen et al. (2004).

Understanding injury mechanisms is very important in order to establish preventative measures for lateral ankle sprains. Knowing the involved joint movements might help inform better clinical practice, particularly in terms of applying tape to support the joint either before or after the injury. The current literature has shown that plantar flexion movement does not occur when the ligament is ruptured, therefore taping the foot to prevent plantar flexion might not provide any benefit in terms of preventing lateral ankle sprain injury (Kristianslund et al. 2011). The use of taping as a prophylactic measure to support the joint by preventing over tension of the lateral ankle ligaments is debatable. However, a recent systematic review found that ankle bracing seems to be more cost effective and beneficial than ankle taping regarding preventing acute or recurrent lateral ankle sprain (Messer and Jain 2017).

2.4 Biomechanics and pathophysiology of lateral ankle sprain

Lateral ankle ligament consists of three main ligaments: the anterior talofibular ligament, the posterior talofibular ligament and the calcaneofibular ligament. The lateral ankle ligaments collectively resist excessive inversion and limit various stresses and rotation of the talocrural joint (ankle joint) (Procter and Paul 1982; Sarrafian 1993; Nordin and Frankel 2001). The anterior tibiofibular ligament resists excessive plantar flexion, whereas posterior tibiofibular ligament resists excessive dorsi flexion. The calceneofibular ligament mainly resists inversion and internal rotation of the calcaneus in relation to the fibula. There are three main functions of the lateral ankle ligaments: 1) to resist tensile forces being exerted upon the ankle joint, 2) to provide proprioceptive feedback with regard to joint position and 3) to facilitate joint movement (Safran et al. 1999). In terms of resisting externally generated tensile forces, the ligament elongates to gradually oppose those forces. Those tensile forces could be in the form of distraction or rotational directed forces when moving beyond normal ranges of joint movements such as ankle dorsi flexion, plantar flexion and inversion. Indeed, a ligament will continue to elongate and produce an opposing stiffness to counteract a particular tensile force until a point where the ligament cannot withstand any further stretch (Figure 2-4). The process of load-elongation of a ligament can be divided into three regions or phases (Cereatti et al. 2010): toe region, linear region and yield and failure region. In the first region, there is minimal stiffening of the ligament as a response to mild tensile forces. In the second region, the ligament exerts more stiffening to oppose higher tensile forces. In the third phase, higher tensile forces continue to push the ligament beyond its mechanical properties, causing permanent deformation and may eventually cause the ligament to tear. Therefore, the ligament fails when it is exposed to an extensive amount of stress beyond its mechanical tensile properties resulting in the partial or complete tear of the ligament (West and Fu 2005; Cereatti et al. 2010).

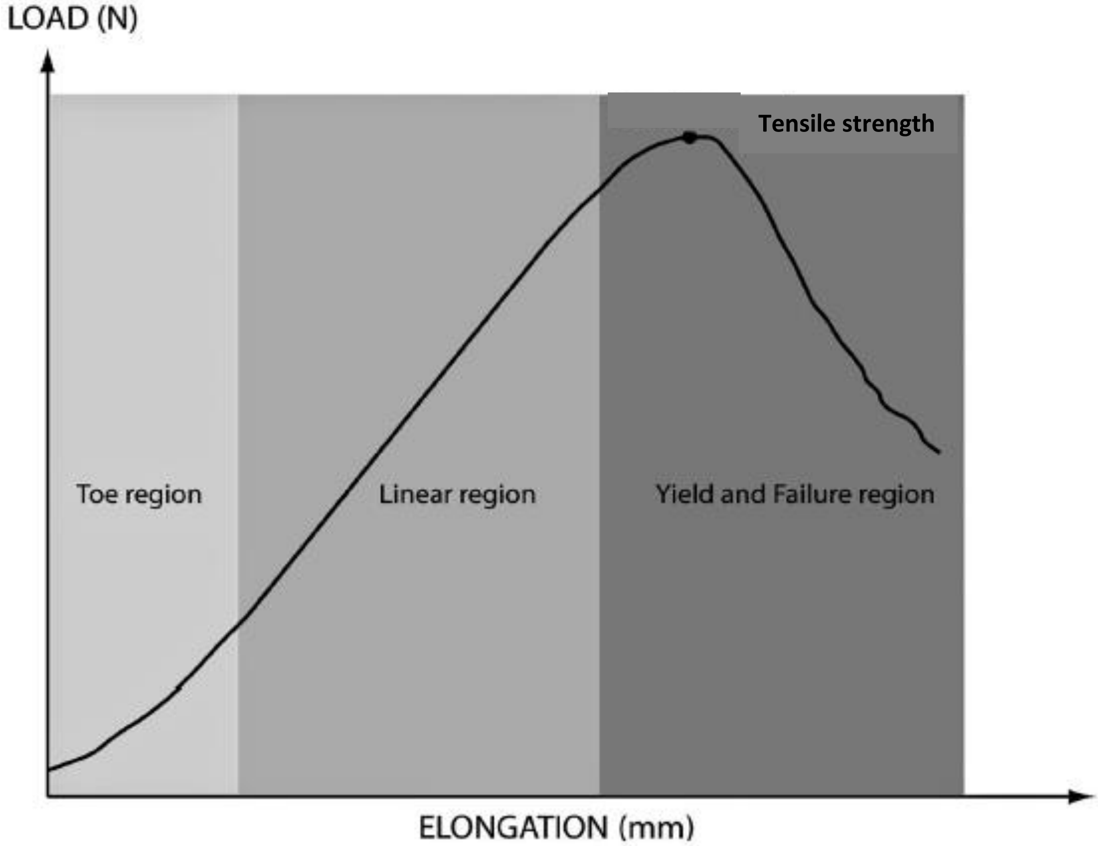


Figure 2-4 Load-elongation curve. Used with permission from Cereatti et al. (2010)

After the failure and tear of a ligament, a subsequent systematic process of inflammation takes place, followed by healing to repair the injured ligament. This process is divided into four phases: the inflammation phase, the matrix and cellular proliferation phase, the remodelling phase and the maturation phase (Figure 2-5) (Cereatti et al. 2010; Hauser et al. 2013).

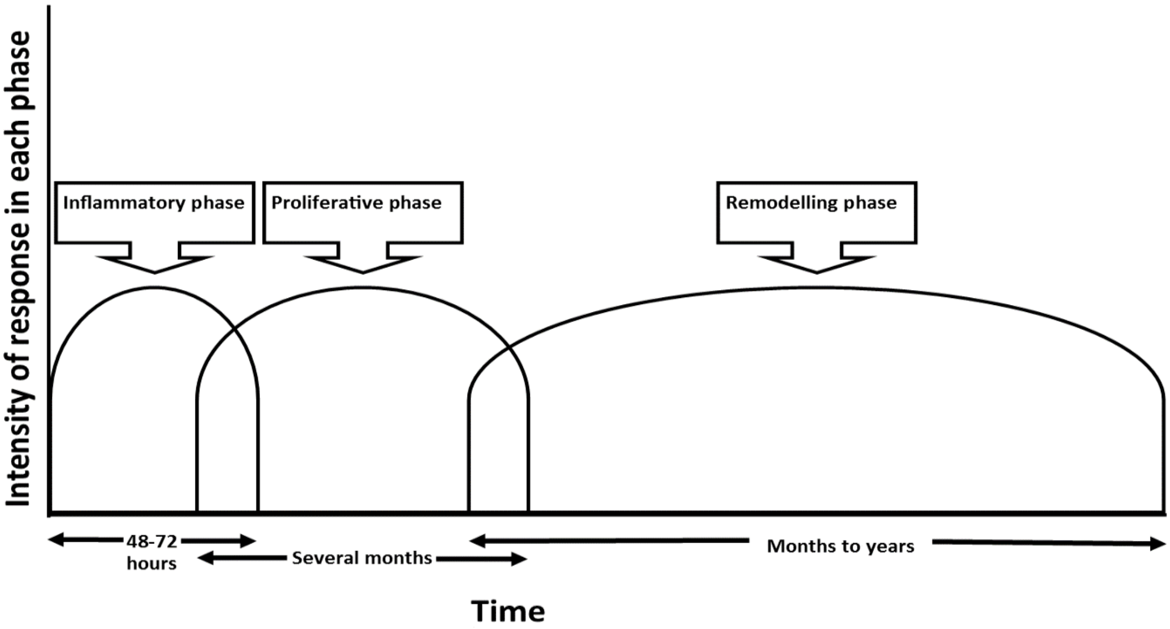


Figure 2-5 Intensity and time of soft tissue healing. Used with permission from Hauser et al. (2013)

The four phases of ligament tissue healing are:

- Phase 1: inflammation. This phase starts immediately after the occurrence of a ligament injury. This process continues over the next 48-72 hours. During this phase, torn fibres pull apart and blood flows into the space between the torn fibres. This process of vascular changes starts immediately after the occurrence of an injury. It is initiated by temporary vasoconstriction of the surrounding small blood vessels (arterioles and venules) followed by a rapid vasodilation of those small blood vessels (Porth 2006) (Figure 2-6).

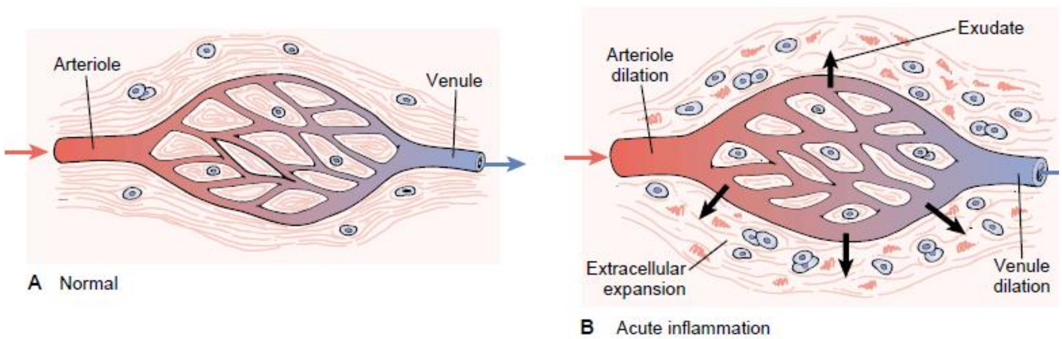


Figure 2-6 Vascular phase of acute inflammation. Used with permission from Porth (2006).

As a result of the increased vasodilation, the area becomes congested causing erythema and warmth which in turn cause acute inflammation. In association with the increased blood flow, capillary permeability increases causing fluids to move into the surrounding tissues causing swelling, pain and loss of function. The movement of the fluid out of the small blood vessels (capillaries) into the surrounding tissue spaces causes stagnation of the flow and initiate blood clotting. Clot formation is initiated because of the interaction between the platelet cells and the matrix of proteoglycans and collagen. This process causes formation of the platelet-rich fibrin clot, which in turn releases growth substances/ factors that are necessary for ligament tissue healing. Examples of those growth factors that have been already identifies are Fibroblast Growth Factor, Vascular Endothelial Growth Factor, Platelet-Derived Growth Factor and Transforming Growth Factor-B. Those factors have unique role during this stage of ligament tissue healing. For example, Fibroblast Growth Factor stimulates and promotes the growth of cells involved in collagen and cartilage formation. Vascular Endothelial Growth Factor helps in new blood vessel formation, which is necessary to increase vascularity in injured areas. Lastly, Platelet-Derived Growth Factor and Transforming Growth Factor-B work to draw immune system cells to the injured area and stimulate them to proliferate. In addition to this, when immune system is stimulated, other cells such as neutrophils, monocytes, and other immune cells are brought to the injured area to ingest and remove dead tissue and damaged cells that were produced during this inflammatory stage so to initiate the next stage of ligament tissue healing which is matrix and cellular proliferation stage (Figure 2-7).

- Phase 2: matrix and cellular proliferation. This phase occurs during the first six weeks of injury. It is characterised by the proliferation of fibroblast cells in order to rebuild ligament tissues (Figure 2-7). This new tissue appears to be disorganised scar tissue that consists of more blood vessels, fat cells, fibroblasts and inflammatory cells than normally found in a normal ligament tissue (Shrive et al. 1995; Frank 2004) Over time, the fibroblast cells deposit several substances such as collagen, proteoglycans, glycoprotein, and other proteins into the matrix to strengthen the newly regenerated tissue. Initially, the resultant collagen tissue from this process is disorganised, however, later in this phase it becomes aligned with the longitudinal axis of the ligament. These collagen fibres are small in size compared to the non-injured ligament fibres. Finally, the new collagen becomes more organised and aligned with the long axis of the ligament during this time.

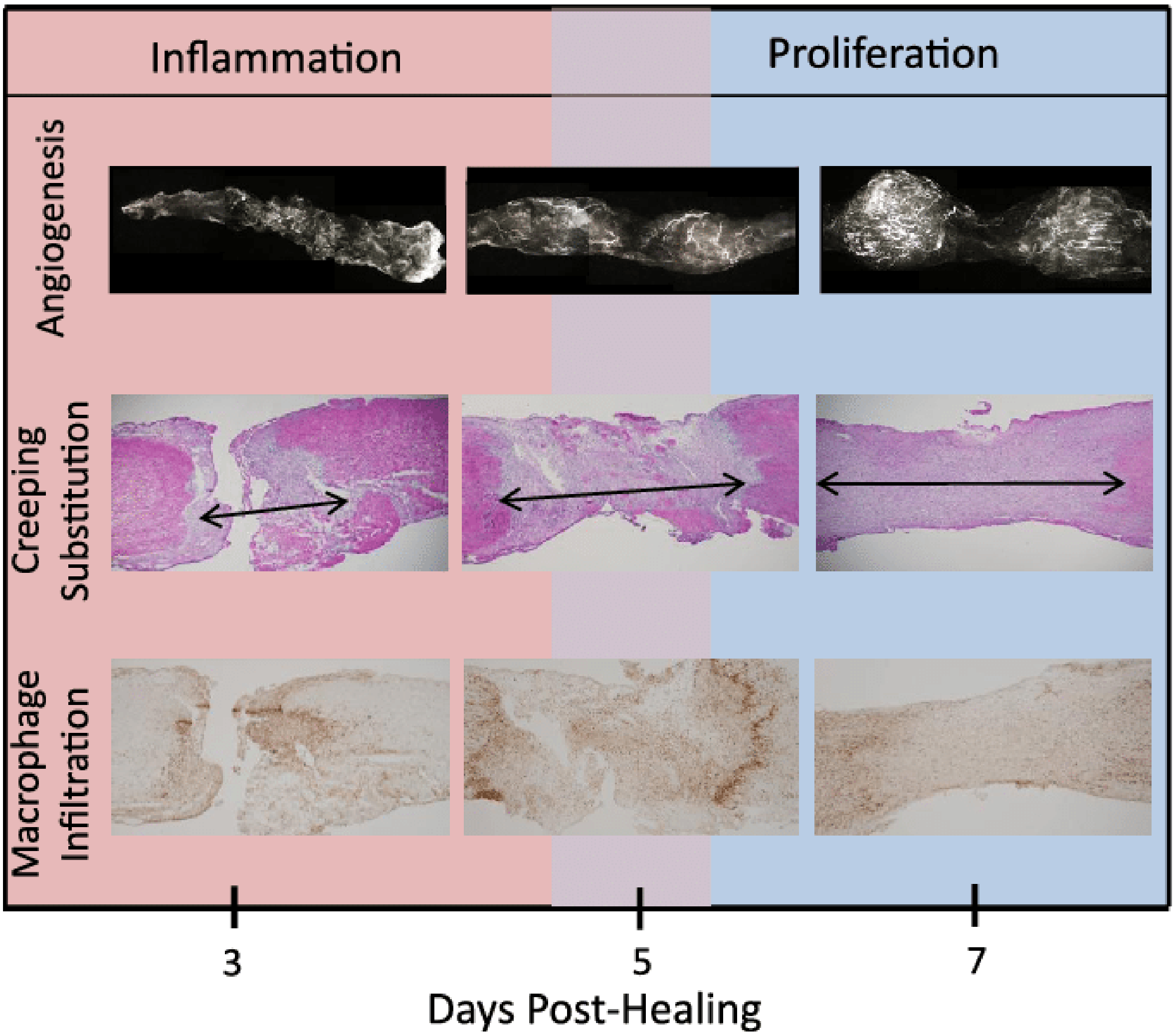


Figure 2-7 Angiogenic granulation tissue and microphage response of an injured medial collateral ligament at 3, 5, 7 days after injury. Used with permission from Chamberlain et al. (1985).

- Phase 3 and 4: remodelling and maturation. Theses phases take place within few weeks and take as long as 12 months. In this phase, the new collagen becomes denser, organised and becomes perfectly aligned with the longitudinal axis of the ligament. This newly regenerated tissue looks like a scare tissue which continues to develop and become more organised (Fang et al. 1937; Jack 1950 ; Frank et al. 1992). Therefore, the fully remodelled ligament tissue still appear to be different from a normal ligament tissue (Frank et al. 1999). Consequently, the repaired fibres gradually regain their tensile strength throughout this phase. This process continues to take place for up to 12 months and maybe longer until complete remodelling occurs.

From the explanation above, it is clear that the healing process of a severely injured ligament takes a very long time to regain its full strength. Interestingly, many sportspeople with lateral ankle sprains RTP very quickly. Medina McKeon et al. (2014) reported that 93% of patients with a new lateral ankle sprain and 86% of patients with a recurrent lateral ankle sprain return to sporting activity within 10 days after injury. Others also noted a very short recovery time from lateral ankle sprain with a median time to recover of fifteen days (Sman et al. 2014). These short time frames seem not to be in agreement with the timelines for ligament healing phases given above (Figure 2-5). This could be considered one the causes for developing latent complications including the very severe ones such as re-sprain of lateral ligament. It is already documented in the literature that the occurrence of are-sprain in the first three months after the initial lateral ankle sprain is related to incomplete recovery (van Middelkoop et al. 2012). A narrative literature review concluded that the ligament healing process takes a period of between six weeks to three months to occur and most individuals with lateral ankle sprains still have ankle joint laxity and instability after six weeks to a year (Hubbard and Hicks-Little 2008). Therefore, it is risky for a sportsperson to resume sporting activities before allowing complete healing process to take place.

2.5 Grading lateral ankle sprains

Based on the extent of ligament injury, lateral ankle sprain is clinically graded as either grade I (mild sprain), grade II (moderate sprain) or grade III (severe sprain) (Chorley and Hergenroeder 1997; Lynch and Renstrom 1999; Ferran and Maffulli 2006). The amount of strain torque is proportionally associated with the severity of the sprain, ranging in severity from a mild overstretch of the ligament to complete tear with a marked joint laxity.

A grade I injury is characterised by tension in the ligament directed more specifically to the ATFL, as it is the weakest among all the three ligaments. Symptoms may include mild pain, swelling and restriction in the range of motion. In this case, the continuity of the ligament is still intact with only a few ligament fibres torn, therefore it does not cause joint laxity. Furthermore, patients may or may not complain of difficulty bearing their full weight.

A grade II injury is characterised by a moderate amount of tension in the lateral ankle ligaments that often lead to a complete tear of the ATFL and a partial tear of the CFL. Patients' symptoms include moderate pain, swelling and tenderness in the lateral ligaments. In addition, other symptoms such as the restriction of joint motion, joint instability and loss of function are frequently associated with this injury. On clinical examination, joint laxity might be present as a result of a complete tear in the involved ligaments.

A Grade III injury is characterised by a complete tear of both the ATFL and the CFL with an occasional tear in the lateral joint capsule. Moreover, a posterior talofibular ligament tear might occur in the case of large tensile forces on the posterolateral side of the ankle joint. Patients have definite swelling, moderate to severe pain and tenderness of the injured ligaments. There is also a marked loss of function and joint instability, and in the clinical examination, moderate to severe laxity of the ankle joint can be observed.

This classification of grading is widely used by clinicians to determine the severity of lateral ankle sprains, and this depends on both subjective (pain) and objective examination (laxity). To assess the laxity of the ligament, an anterior drawer test is used to check the integrity of the ATFL and a talar tilt test is used to check the integrity of the CFL. However, researchers have questioned the objectivity of these manual stress tests in terms of their reliability to determine the severity of the injury (Harper 1992; Tohyama et al. 1995; Frost and Amendola 1999; Kovaleski et al. 1999; Tohyama et al. 2003). They have argued that these manual stress tests might not be reliable because of the large variations among different clinicians, as it is unclear how much stress should be applied by clinicians to elicit differences between injury grades (Hubbard and Hicks-Little 2008). Therefore, further studies are needed to verify the reliability of stress tests for grading the severity of lateral ankle sprains.

2.6 **Conservative treatment of lateral ankle sprain**

Although most lateral ankle sprains recover spontaneously (Aiken et al. 2008), clinicians and researchers are always concerned about the development of chronic symptoms. Indeed, treating this injury as early as possible may minimise the occurrence of residual symptoms such as chronic pain, disability and osteoarthritis (Larsen et al. 1999; Konradsen et al. 2002). Lateral ankle sprain injuries can be treated surgically or conservatively according to the grade and stability of the injury. Research has suggested that conservative treatment is more applicable for the majority of stable injuries (grade I and in some cases grade II), as it results in good functional outcomes and fewer complications (Kerkhoffs et al. 2007; Guillo et al. 2013). Surgical treatment is regarded as appropriate for more severe and unstable cases (grade III), since it is more effective in restoring joint stability and a faster return to work and sport (Kerkhoffs et al. 2007; White et al. 2016). The focus of this thesis is on the influencing factors for RTP after conservatively treated lateral ankle sprain, therefore only conservative treatment will be discussed in this thesis.

Researchers have explored a variety of treatment methods for managing lateral ankle sprains to restore optimal pre-injury function. Many treatment methods such as, Protection, Rest, Ice, Compression and Elevation (PRICE) (Cote et al. 1988; Rocinski et al. 1991; Green et al. 2001; Tsang et al. 2003; Bleakley et al. 2006; Prado et al. 2014), manual therapy (manipulation and mobilisation) (Eisenhart et al. 2003; Cosby et al. 2011; Truyols-DomÍNguez et al. 2013), electro-physical means (Bradnock et al. 1996; de Bie et al. 1998; Nyanzi et al. 1999; Stergioulas 2004; Zammit and Herrington 2005; Mendel et al. 2010), exercise therapy (Holme et al. 1999; van Rijn et al. 2007b; Lamb et al. 2009; Hultman et al. 2010) and immobilization (Leanderson and Wredmark 1995; Hertel et al. 2001; Watts and Armstrong 2001; Beynnon et al. 2006; Lamb et al. 2009).

Previous systematic reviews have tried to provide a solid conclusion of the best available conservative treatment for lateral ankle sprains (Seah and Mani-Babu 2011; Han et al. 2012; Petersen et al. 2013; van den Bekerom et al. 2013; Vuurberg et al. 2018). However, the heterogeneity in the treatment methods used in various trials has created an inconsistency in drawing sound conclusions on the optimal treatment. The trials included in those reviews implemented different treatment techniques during inconsistent periods of rehabilitation and measured different outcome over varying follow-up periods.

A summary of treatment recommendations from reviewing relevant literature were outlined in order to inform current clinical practice (Table 2-1):

Table 2-1 Summary of conservative treatment methods for acute lateral ankle sprain

Treatment	**Effects**	**Reference**
Rest	Not encouraged to be used for less severe sprains. For the management of severe sprains, a period of 10-14 days of immobilisation in a below the knee cast/ brace and non-weight bearing crutch walking is advised. After that, the application of a lace-up brace or functional taping may reduce the risk of recurrent injuries.	(Seah and Mani-Babu 2011; Petersen et al. 2013; van den Bekerom et al. 2013; Vuurberg et al. 2018)
Non-steroidal anti-inflammatory drugs (NSAIDs)	Very effective in reducing pain and improving function during early stage of recovery. However, care should be taken	(Seah and Mani-Babu 2011; van den Bekerom et al. 2013; Vuurberg et al. 2018)

	when these drugs are administered in the first week of injury, as they might hinder the natural healing process by interrupting the inflammatory stage of tissue healing.	
Ice, Heat, Compression and Elevations	• A ten-minute intermittent ice application is beneficial to control joint oedema. • Heat is not superior to ice in decreasing oedema, pain and time to return to sport. • No strong evidence to support the theory that compression and elevation provide therapeutic benefits.	(Han et al. 2012; Petersen et al. 2013; van den Bekerom et al. 2013; Vuurberg et al. 2018)
Talocrural/ankle joint mobilisation/ manipulation.	Effective in reducing pain, increasing the range of motion and improving gait parameters. Further improvements were seen when it was combined with myofascial therapy.	(Seah and Mani-Babu 2011; Petersen et al. 2013; Vuurberg et al. 2018)
Electro physical agents	Should only be used in combination with other treatment methods.	(Seah and Mani-Babu 2011; Han et al. 2012; Petersen et al. 2013; van den Bekerom et al. 2013; Vuurberg et al. 2018)
Functional based exercises that include stretching, strengthening, mobility and cycling	Recommended to be introduced as early as possible.	(Seah and Mani-Babu 2011; Han et al. 2012; Petersen et al. 2013; Vuurberg et al. 2018)
Ankle bracing.	Recommended in place of regular taping as a prophylactic measure to prevent acute or recurrent lateral ankle sprain	(Seah and Mani-Babu 2011; Han et al. 2012; Petersen et al. 2013; van den Bekerom et al. 2013; Vuurberg et al. 2018)

Although RTP is important after an injury, it was not considered as an outcome measure in most of these studies. Instead, different outcome measures were used to evaluate recovery.

Consequently, determining a clear recovery according to evidence-based criteria for RTP was not possible. It would be useful for sportspeople with lateral ankle sprains to know when they can safely RTP, to limit the chance of injury re-occurrence and decrease the occurrence of residual/chronic symptoms.

2.7 Justification for the study

The purpose of this project is to investigate the potential factors influencing RTP after conservatively treated lateral ankle sprain. A review of the relevant literature highlighted gaps in previous studies, showing that there is a need to investigate factors that affect RTP (Anderson 2002; van Rijn et al. 2008b; Clanton et al. 2012; Richie and Izadi 2015).

Sportspeople commonly ask when they can resume training after a lateral ankle sprain. Unfortunately, the current literature lacks adequate information regarding what affects RTP, and clear evidence-based guidance for RTP after this type of injury is also lacking. Disagreement and poor clinical decision-making have been highlighted as contributors to the problem of recurrent lateral ankle sprain (Anderson 2002; van Rijn et al. 2008b; Clanton et al. 2012; Richie and Izadi 2015). Pijnenburg et al. (2000) found that a greater number of residual symptoms occur in patients who receive minimal or no treatment after an ankle sprain. Furthermore, these patients might be discharged without knowing when they can safely RTP. Robust evidence-based clinical recommendations would, thus, be a useful addition to the field, however, before these can be developed, factors that influence RTP following a lateral ankle sprain need to be investigated.

This thesis was therefore devised to fill the gaps that had been identified in the current practice, specifically that there is lack of evidence regarding the factors, including personal and clinical, as well as physiological, influencing RTP after a conservatively treated lateral ankle sprain. The ultimate goal of the research is to improve clinical outcomes following lateral ankle sprain by contributing to the development of an educational programme that focuses on why it is important to RTP safely following a lateral ankle sprain.

In summary, the key issues identified are:

1. "When can I return to play?" is a multifactorial question that requires a thorough understanding of the factors that influence RTP before that question can be answered.
2. The factors affecting RTP following lateral ankle sprain are important but under-investigated.
3. It is not clear whether there is an agreement on the definition and criteria for RTP after lateral ankle sprain.

4. Demographic, clinical and sport-related characteristics, which could be considered as potential factors associated with RTP, have not been fully determined.
5. It is not clear who makes the decisions for RTP and whether sportspeople with a lateral ankle sprain follow safe RTP decisions.
6. The association between patients' demographic characteristics and injury/sports related factors and time to RTP is under investigated.
7. Sportspeople's personal experience of making return-to-play decisions is under investigated.

2.8 Thesis Research Question

This thesis was constructed to answer the following main question:

"What are the factors affecting return to play in sportspeople with a conservatively treated lateral ankle sprain?"

2.9 Thesis Aims

The primary aim of the thesis is to investigate the physiological and personal factors, as well as the clinical ones, that influence RTP after conservatively treated lateral ankle sprain. The secondary aim of the thesis research is to provide evidence that determines which factors should be included in the future development of an educational programme for safe RTP following a lateral ankle sprain.

To achieve the thesis aims, four consecutive studies (phases) were performed to cumulatively answer the main research question. The first study employed a systematic review to determine the current reported evidence related to the factors influencing time to RTP following a conservatively treated lateral ankle sprain. In addition, it also aimed to determine the definition of and criteria for RTP after a conservatively treated lateral ankle sprain. The second study was conducted to determine the prevalence of, as well as the demographic, clinical and sport characteristics of patients with lateral ankle sprains. It was conducted within a UK NHS Emergency department; as most previous investigations had reported this was the primary centre for the presentation for lateral ankle injury in the UK. The third study aimed to determine the factors reported by sportspeople that affected their RTP following a conservatively treated acute lateral ankle sprain. The final, fourth study was conducted to explore the experiences and decision-making process of sportspeople regarding their RTP after a conservatively treated lateral ankle sprain more in depth.

2.10 **Summary of chapter two**

This chapter has laid the foundations for the thesis. It has introduced the research problem, background literature, justifications for the study and the research questions. Based on these foundations, the report can proceed with a detailed description of the research. The methodology and results are therefore discussed in chapters three, four, five, six and seven of this doctoral thesis. Conclusions are also given (chapter eight), followed by implications for future research.

Chapter 3: Methodology

This chapter presents the philosophical approaches underpinning the use of the research designs in this thesis. It provides a scientific justification and rationale for the selection of the proposed methods. Furthermore, the overall dimensions (ontology, epistemology and methodology) of the adopted research paradigm are described in relation to the philosophical projections of this thesis.

3.1 **Research Paradigm**

Adopting a specific research paradigm is essential when constructing any research study. According to Kuhn (1962), a research paradigm is defined as “the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed”. In order to construct a paradigm, researchers mainly combine ontological, epistemological and methodological attributes together **(**Figure 3-1**)** (Morrow 2007; eLearn Center (UOC) 2013). To clarify, ontology incorporates the nature of reality by describing how things exist in nature, whereas epistemology comprises of different forms of knowledge and the relationship between the knower (researcher) and the known (research idea), or in other words, the way things are known. It is important to note that a researcher’s personal set of views and beliefs and previous philosophical experience always influence the construction and development of these two attributes, and that they eventually translate into a researchable question. Lastly, in order to gain knowledge from the emerging research question, a set of procedures (methodology) need to be developed to find a scientific answer to that question.

The choice of a particular research paradigm impacts the subsequent methods for data collection and analysis (Morrow 2007). Therefore, it is important that the research paradigm is well defined and articulated and based on the sound background of both the researcher and the existing literature.

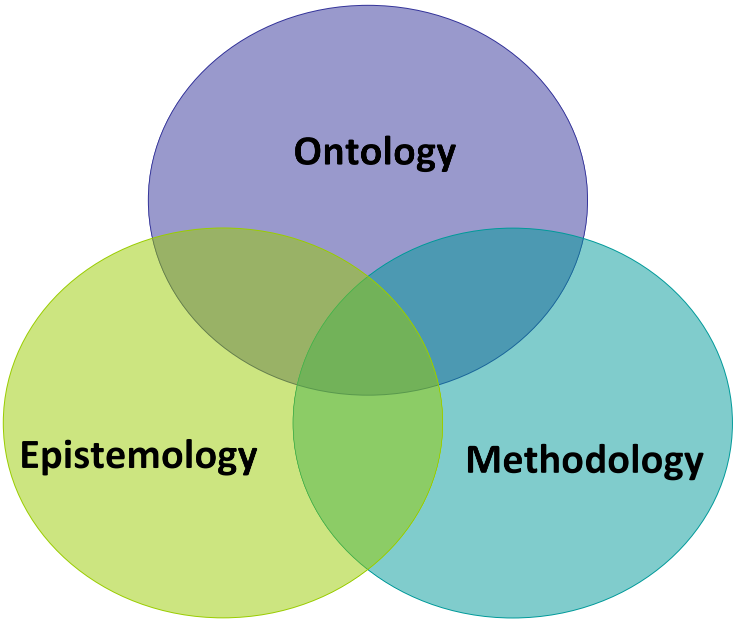


Figure 3-1 Research paradigm. Used with permission from an online presentation slide (Available at: http://www.slideshare.net/eLearnCenter/research-methods-uoc-2013), Accessed on 07th Dec 2016.

This thesis used a mixed-methods approach in order to address the main research question. It is defined as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (Johnson & Onwuegbuzie, 2004, p. 17). Mixed methods are philosophically associated with the pragmatic paradigm (Creswell and Plano Clark 2011). Using this paradigm enables researchers to employ multiple methods to answer a particular research question. This paradigm was developed as an alternative to using exclusive positivist or post-positivist paradigms (Wicks and Freeman 1998). It supports the use of a holistic approach that employs different research methods, in order to produce results of different research perspectives (Johnson and Onwuegbuzie 2004) In addition, the use of a pragmatic paradigm has been found to be more practical and outcome-oriented, both philosophically and methodologically. Furthermore, using this paradigm allows researchers to device their preferred research methods to appropriately answer the proposed research questions.

Mixed-methods research is relatively new compared to other research approaches. However, there has been a prominent interest of researchers to consider it as a separate and effective approach on its own entity (Johnson and Onwuegbuzie 2004). The early use of this approach was limited to only mixing quantitative research methods (Creswell 2013). However, it then became used as a means for converging or triangulating various quantitative and qualitative methods (Jick 1979). Later, it took on the form of a distinct entity, as being a well-defined and unique approach (Teddlie and Tashakkori 2009; Creswell and Plano Clark 2011).

3.2 Mixed methods

Creswell and Plano Clark (2011) presented six main features to describe a mixed-methods approach. Firstly, mixed methods enable researchers to collect and analyse both quantitative and qualitative data. Secondly, researchers can mix the two types of data, quantitative and qualitative, by nesting one within the other or doing them sequentially, one after the other, as was the case in this thesis. Thirdly, priority can be shown to one type of data over the other, which means the conclusion of the results is more focused on one type of data. Fourthly, researchers have the freedom to conduct all of the research procedures during one stage or at multiple stages (studies). In this thesis, the four studies were conducted separately, and therefore the results of one study informed the methodology of the following study and so on and so forth. Fifthly, the selected research procedures must be framed within the same philosophical framework/ paradigm, which in this case was the pragmatic paradigm. Lastly, all research procedures are conducted so they inform one overarching research question.

In this thesis, both quantitative and qualitative designs were considered to answer the main research question. The quantitative design involved the use of a positivist epistemological perspective (Study two and Study three), whereas the qualitative design involved using a constructivist epistemological perspective (Study four) (Campbell and Fiske 1959). A positivist perspective (quantitative) was used to quantify the prevalence of ankle sprain new cases and to illustrate different demographic, clinical and sport-related information in this thesis (Study two). In addition, a positivist perspective was also used to quantify the relationship between different associated factors and the RTP after a lateral ankle sprain (study three). However, a constructivist perspective (qualitative) was used to explore the experiences of people regarding their RTP after their lateral ankle sprain injury (Study four). Both epistemological perspectives made up a mixed-methods approach, which was found to be the most appropriate one for this thesis.

The knowledge sought from the four studies in this thesis was important to improve clinical practice and to inform future research, since clinical practitioners, including the researcher, are uncertain about potential influencing factors for RTP after a lateral ankle sprain. Therefore, the idea of this research evolved from a basic question asked by athletes, which then became a researchable scientific question that was possible to investigate, quantify, explore, and eventually transform the results into evidence-based, clinical recommendations.

This question went through several steps, in order to evolve, develop and become a scientifically researchable question. These steps involved answering three basic questions:

- What is already known?
- How do we know it (questions)?
- How do we examine it (methodology)?

It is essential that this type of enquiry be well defined, to determine the most appropriate scientific method for answering any research questions. Therefore, four consecutive investigations were conducted in this thesis: a systematic review, an epidemiological study, a cross-sectional survey and qualitative investigations. These four investigations are thoroughly discussed in the following chapters. The methods used in this study included participant samples, self-reported outcomes, observational outcomes, and statistical analyses, and are discussed and justified in the corresponding chapters of each investigation:

3.2.1 **Participants samples**

Study two See 0, section 5.4.4, page 82

Study three See 0:, section 6.3.2, page 117

Study four See 0, section 7.4.7, page 182

3.2.2 **Self-reported outcomes**

Study two See 0, section 5.4.8.1, page 85

Study three See 0, section 6.3.4.1, page 118

Study four See 7.4.4, section 7.4.4, page 175

3.2.3 **Observational outcomes**

Study two See 0 , section 5.6, page 90

Study three See 0, section 6.3.4.2, page 120

Study four See 0, section 7.4.4, page 175

3.2.4 **Data analyses**

Study two See 0, section 5.4.9, page 87

Study three See 0, section 6.4, page 126

Study four See 0, section 7.4.12, page 187

Chapter 4: Study one, Factors influencing time to RTP following conservatively treated lateral ankle sprain: a systematic review*

***Al Bimani SA**, Gates LS, Warner M and Bowen C (2018b) Factors influencing return to play following conservatively treated lateral ankle sprain: a systematic review. *Physician and Sportsmedecine* 47(1): 31-46

The aim of the PhD thesis was to investigate evidence on the influencing factors affecting recovery (RTP) from lateral ankle sprain. As presented in Chapter one, there is lack of evidence, and in turn clear recommendations, in terms of what affects RTP after conservatively treated lateral ankle sprain. Consequently, a review of existing evidence related to RTP following lateral ankle sprain was conducted to establish what is currently known about the subject and inform the investigations that underpin this thesis.

This systematic review was registered with PROSPERO, which is an international database of systematic reviews in health and social care on 31st May 2017 (http://www.crd.york.ac.uk/NIHR_PROSPERO, PROSPERO 2017:CRD42017067839).

4.1 Background

Following an ankle injury, patients complain of and/or the following are observed: pain, swelling, loss of joint motion, reduced muscle strength, and gait abnormalities and joint instability (Colville et al. 1990). Most lateral ankle sprains recover spontaneously (Aiken et al. 2008), however, many athletes develop long-term symptoms such as pain, swelling, loss of joint motion, reduced muscle strength, gait abnormalities, joint instability and arthritic changes (Gerber et al. 1998; Hertel 2000; Takao et al. 2003; van Rijn 2008a; van Rijn et al. 2008b; Malliaropoulos et al. 2009; Golditz et al. 2014). It is currently unknown if premature RTP contributes to this. Additionally, there appears to be no consistent advice on what constitutes an optimal threshold for returning to sporting activities. In addition, is also not clear what factors might contribute to the development of those chronic symptoms.

Return to play is defined as “the decision-making process of returning an injured or ill athlete to practice or competition” (Herring et al. 2002), and has been used as an outcome measure in various sports injuries such as lateral ankle sprain (Bendahou et al. 2014; McKeon et al. 2014;

Punt et al. 2016), hamstring strain (Moen et al. 2014) and high ankle sprain (Miller et al. 2012). Athletes, coaches and sports medical teams consider an RTP decision as being the definitive sign that a player or athlete has recovered from a sports injury. Therefore, it is important that this decision be made correctly to ensure a safe and timely return to sporting activities. As a consequence, a decision-based model for RTP after sports injuries was devised in order to inform better decision-making and minimise confusion (Creighton et al. 2010). Their model is based on three fundamental decision-making steps: firstly, the player or athlete's health status; secondly, the participation risk; and finally, a number of decision modifiers (Figure 4-1).

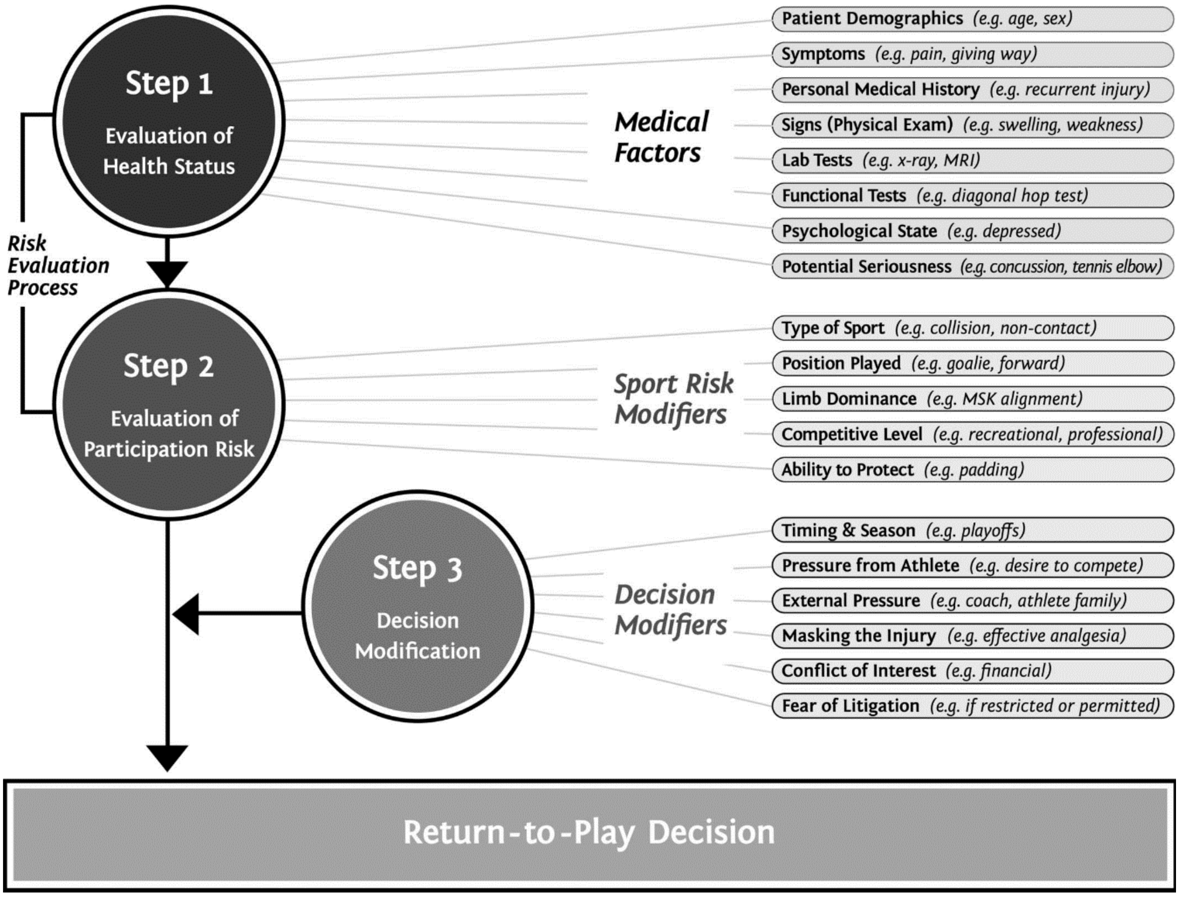


Figure 4-1 Decision-based RTP model. Used with permission from Creighton et al. (2010).

The first step refers to the health status of the athlete, which requires comprehensive clinical evaluation at the time of injury, including the patient's demographics, symptoms, personal medical history, physical signs of injury, laboratory tests, functional testing and psychological state. The second step indicates the need to assess the risk associated with participation in the sporting activity for that particular individual. Examples of factors that may determine the risk of sports participation include the type of sport being played, the player's position, limb dominance, competitive level and the ability to protect the player. Indeed, the sport being played is a very important determiner regarding the level of risk of injury. For instance, a higher incidence of lateral ankle sprain has been recorded in football (Nelson et al. 2007; Cloke et al. 2009; Cloke et al. 2011), basketball (Hosea et al. 2000; Nelson et al. 2007; Waterman et al. 2010) and volleyball (Aagaard and Jorgensen 1996; Aagaard et al. 1997; Verhagen et al. 2004). The last step in the decision-making model is to provide the athlete with the actual decision to resume sporting activities. This decision is based on the previous two steps and can be modified according to the individual demographic, clinical and sport characteristics. Unfortunately, there is a lack of evidence of those characteristics in sportspeople with lateral ankle sprain.

The decision to RTP safely and timely has always been a topic of interest of previous research and a number of findings have been presented. For example, it has been shown that a second Jones fracture surgery and a decrease in a player’s performance were significantly associated with early RTP of less than 9 weeks (Parekh 2017). Other studies have confirmed that there are a lack of valid and clear RTP guidance with regards to muscle injuries (Orchard et al. 2005 ; van der Horst et al. 2016) and common paediatric fractures (Randall et al. 2017).

In addition, to date, there is limited evidence regarding guidance for RTP following conservatively treated lateral ankle sprains (van Rijn et al. 2008b). Various authors in a number of narrative reviews have highlighted that athletes, parents, club medical teams and club management require appropriate guidance about the approximate time that an athlete should take to return to a sporting activity in order to eliminate any disagreement and poor decision-making (Anderson 2002; Clanton et al. 2012; Richie and Izadi 2015). However, constructing evidence-based guidance requires a thorough understanding of the clinical course of lateral ankle sprain, including potential influencing factors for recovery (van Rijn et al. 2008b), yet such guidance would inform coaches, athletes, physiotherapists and other related professionals in their treatment decision making for RTP. Moreover, the provision of a clear and evidence-based definition of and criteria for RTP may, in turn, also help to reduce chronic complications later. Therefore, it is important to explore the current evidence on the association between an athlete’s demographics, injury, sport related factors and RTP.

4.2 Aims

The aims of this study:

Primary: To determine the evidence related to factors influencing the time required to RTP following a conservatively treated lateral ankle sprain.

Secondary: To explore the evidence if a clear definition and criteria exist for RTP after conservatively treated lateral ankle sprain.

4.3 Objectives

The objectives of this study are the following:

1. Determine the current reported evidence for influencing factors for RTP in patients with lateral ankle sprain.
2. Investigate if an agreement exists regarding the relationship between the influencing factors and RTP.
3. Review the literature related to the definition of and criteria for RTP after lateral ankle sprain.

4.4 Methods

4.4.1 Study design

A systematic review was conducted to investigate the evidence related to factors influencing RTP after lateral ankle sprain. Systematic reviews have become widely used in medical research to summarise the existing evidence of what is already known about a particular clinical topic. It is defined as “a review of a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant research, and to collect and analyze data from the studies that are included in the review” (The Cochrane Collaboration 2005). In addition, they are used to summarise evidence, examine the methodological quality of the included articles and to identify the gaps in the current literature, in order to inform the methodology of future research (Kitchenham 2004). Furthermore, systematic reviews aim to provide an overall and up-to-date view of a particular field. They are also conducted to minimise bias by making scientific conclusions, thus resulting in effective clinical decision-making. Moreover, they are widely regarded as a gold standard and the highest level of evidence that produces scientifically robust results (Figure 4-2).

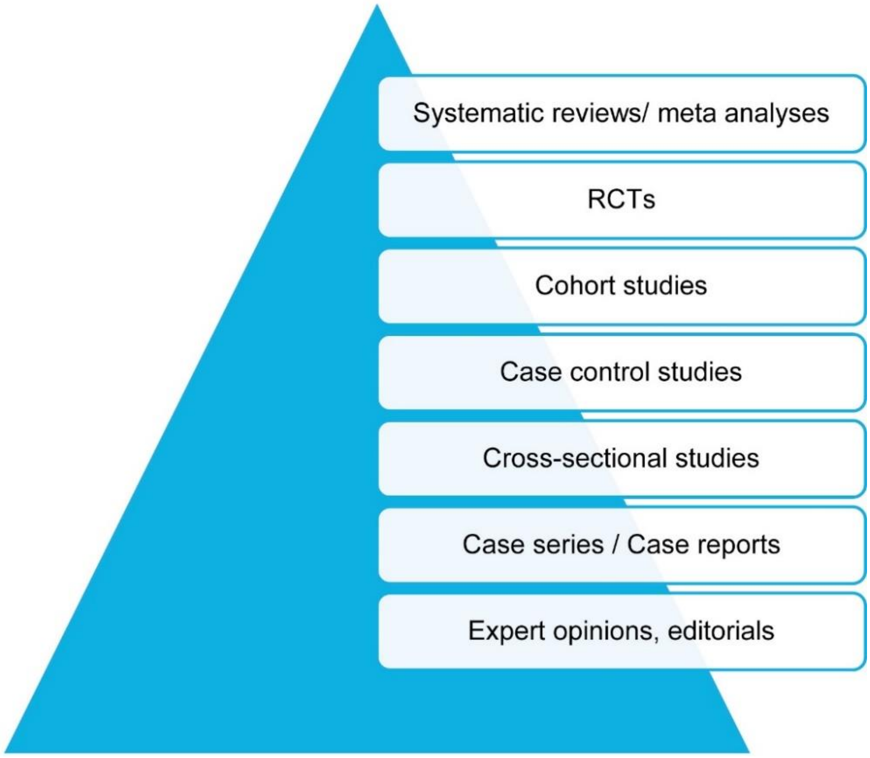


Figure 4-2 The hierarchy of evidence. Used with permission from Ham-Baloyi and Jordan (2016).

Another important point to note is that systematic reviews differ from traditional narrative reviews, as the search process is systematic and replicable (Cook et al. 1997). Indeed, they involve a comprehensive systematic search strategy of explicit and reproducible criteria and the selection of relevant articles (Appendix 1).

4.4.2 **Data sources**

A systematic search of online databases was conducted to identify the evidence related to the factors influencing RTP after lateral ankle sprain. One reviewer (SB) searched the following online databases from inception until May 2018: AMED - The Allied and Complementary Medicine Database, CINAHL Plus with Full Text, EMBASE, MEDLINE (EBSCO), PsycINFO, Scopus, SPORTDiscus, Physiotherapy Evidence Database (PEDro) and Cochrane library (Appendix 2). These databases were chosen because they have unique, individual features that helped to conduct a comprehensive search and retrieve as many relevant articles as possible. The only limitation applied was to only accept studies published in English. Following this, a secondary search was performed, in order to address publication and selection bias, using the following sources: Open Grey (to search for unpublished literature and ongoing trials) and Google Scholar. The reference list of all the included articles was also reviewed to identify any possible additional publications.

4.4.3 **Generating and executing the search strategy**

Four expert professionals in physiotherapy (SB), podiatry (LG and CB) and mechanics (MW) independently devised the main search terms (Appendix 3).

This review was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher D et al. 2009) as illustrated in Figure 4-3.

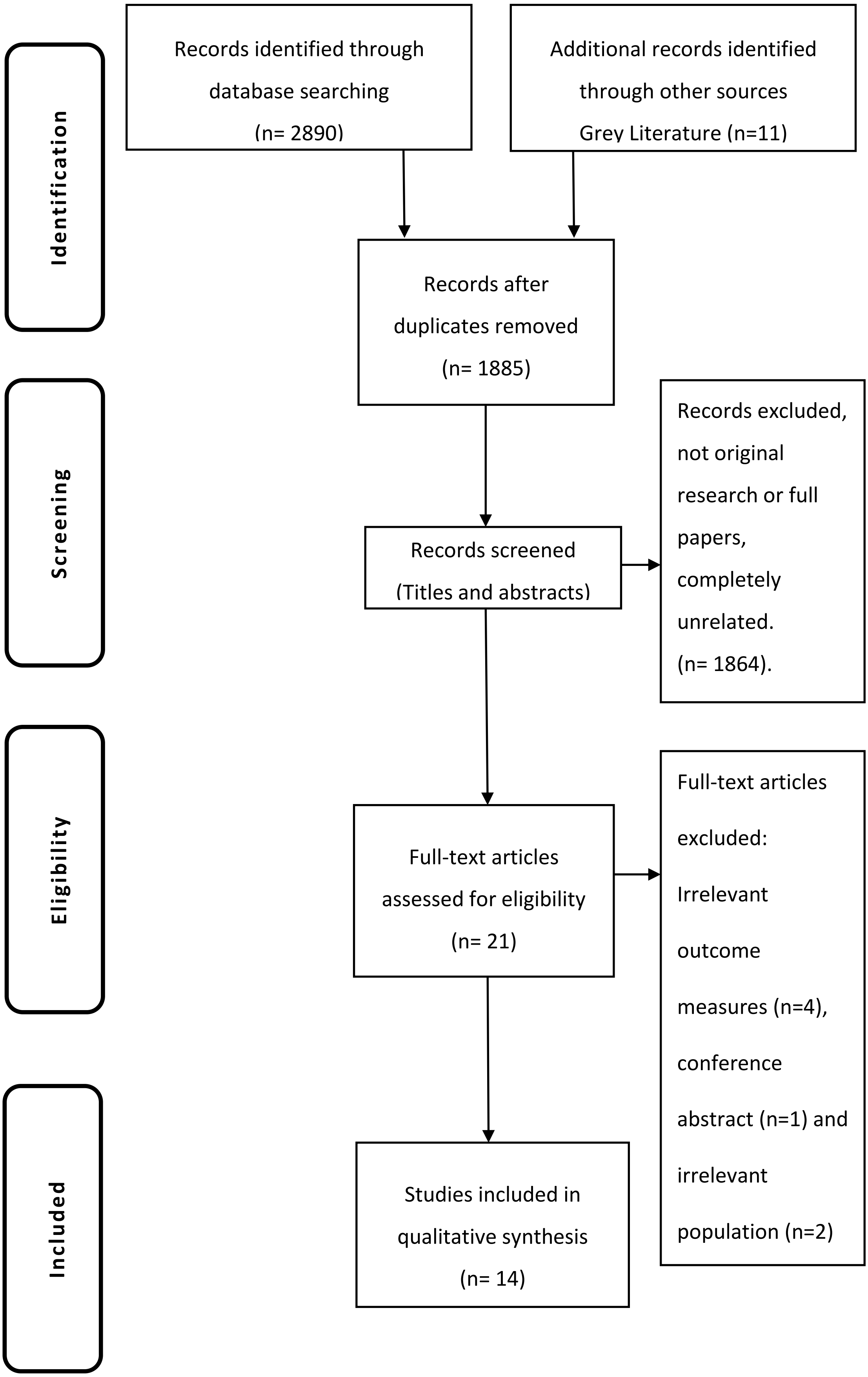


Figure 4-3 PRISMA flow diagram of the selected studies

After searching all the data sources, studies were transferred to EndNote bibliography software (Thomas Reuters EndNote X7.2.1) for screening and inclusion.

4.4.4 Duplicates

A total of 2,991 articles were found after searching the targeted online databases and other sources, including the grey literature, Google scholar and the reference list of included articles. Many articles were found in multiple databases, therefore it was inevitable that a duplicates check was required to be run. The duplicate check was performed using EndNote software, and all the results of the search were saved. This feature is found by clicking on “Find Duplicates” under the “References” menu in the main EndNote interface. EndNote de-duplication was supplemented with hand searching to ensure that all duplicate articles were deleted from the main group of identified articles. After the duplicates had been removed, 1,885 articles were considered for screening.

4.4.5 Eligibility criteria

The eligibility criteria were continually revised and updated during the development of the search terms and strategy. They were used to minimise bias by assessing potential eligible articles against the inclusion and exclusion criteria. The inclusion criteria was developed according to the research question and the aims and objectives of the study (Knoll et al. 2017). The inferred inclusion criteria for this review were articles assessing factors that influence RTP following conservatively treatment of lateral ankle sprain; any grade of lateral ankle sprain; new and recurrent injuries; athletes practising any sports activity at any level; both male and female patients and full text articles published in English from inception until May 2018. All types of study designs were considered for inclusion in this review. However, articles were excluded if they included participants following ankle surgery. In addition, animal and cadaver studies were also excluded.

4.4.6 Title and abstract review

At this stage, abstracts and titles of the articles were reviewed (by SB) against the inclusion criteria. Key information such as patients with lateral ankle sprain and RTP was sought from titles and abstracts to identify relevant articles. Articles were immediately excluded if they did not include that key information. Following this process, articles were grouped in a separate EndNote group in order to be considered for full-text review. In the cases that information from an abstract was not clear, then the article was considered for a full-text review in order to make the final decision to include it or not. By the end of this step, 1,864 articles had been excluded, as they were not original research or full papers or completely unrelated.

4.4.7 **Full-text review**

This process followed the same principles of the abstract screening. The only difference at this stage was that a final decision had to be made whether to include an article in the review or not. After screening the full text articles against the inclusion criteria, seven articles were eliminated from further inclusion in this review. Articles were excluded if they did not include time to RTP as an outcome measure of the follow-up assessment. In this review, time to RTP was defined as the time taken from injury until an athlete is able to return to a sports activity. In addition, articles that included surgical treatment methods were also excluded, as the course of recovery might vary from that of conservative treatment. Lastly, those articles that were not written in English were also excluded, as translation services were not available at the time of executing this review. Following the full-text review, one reviewer (SB) organised the articles that met the inclusion criteria into an independent subgroup within the EndNote library for the purpose of quality assessment.

4.4.8 **Quality assessment tools**

The quality of the included articles was assessed using the Downs and Black tool for randomised trials (Sara and Nick 1998) and the Critical Appraisal Skills Programme (CASP) for observational studies (Critical Appraisal Skills Programme 2013).

The Downs and Black quality assessment criteria consists of twenty-seven items. These items are derived from 5 main subscales:

1. Reporting (9 items): Determine whether the researcher/s provided adequate information for the reader in order to make a clear judgment of the findings.

2. External validity (3 items): Judge the generalisability of the findings for the population where the study participants were recruited.

3. Bias (7 items): Address any potential bias in the measurement of the intervention and the outcome measures.

4. Confounding (6 items): Examine the bias in the selection of study participants.

5. Power (1 item): Determine if any negative results in the study occurred due to chance rather than the intervention used.

The Quality Index of the Downs and Black assessment tool was found to have high internal consistency and good test-retest (r 0.88) and inter-rater (r 0.75) reliability (Sara and Nick 1998). In addition, it had a high correlation with an existing established tool for assessing randomised trials. Furthermore, it has been widely used in assessing the quality of studies with various designs including randomised trials (Hartling et al. 2004; David et al. 2007; Crow et al. 2011). For each article, a total score of >20 was considered good, 11 to 20 moderate, and <11 poor (Hignett 2003; Hartling et al. 2004).

CASP is a set of twelve questions that is widely used to systematically inform the quality of research papers including observational studies. The key domains in the checklist include appropriate participant recruitment, accurate measurements of the exposure and the outcome, the presentation of precise and accurate results and the implication of results in clinical practice. Furthermore, it has been adopted as a quality assessment tool in various musculoskeletal systematic reviews (Reilly et al. 2006; Smith et al. 2007; Postle et al. 2012; Smith et al. 2014).

4.4.9 **Critical appraisal process**

Four reviewers in three independent groups (SB and LG), (SB and MW) and (SB and CB) assessed the methodological quality of each article using the Downs and Black assessment tool for randomised trials and the CASP quality criteria for observational studies. Each article was independently reviewed by one reviewer (SB) and verified by another reviewer from the same group (LG, MW or CB). A consensus meeting was held to resolve any disagreement between the reviewers. In the case of disagreement persisting between the two reviewers, a third reviewer was consulted to reach a final decision. Lastly, the quality of all the eligible papers was summarised in a table format.

4.4.10 **Data extraction and synthesis**

The extracted data was synthesised in a way to answer the main study question of this review. Similarities and differences in the results of the included articles were illustrated in a descriptive format. The process of data extraction and synthesis in this review consisted of two stages. The first stage focused on the characteristics of individual articles. Data including study design, population, setting/ recruitment, influencing/ predictive/ prognostic factors, outcome measure, follow up and results were recorded. The second stage involved identifying information related to the definition of and criteria for RTP from the included articles. Both stages were conducted by one reviewer (SB), who extracted and synthesised the relevant data from all the eligible papers (n=14) into a predefined form**.**

4.5 **Results**

After screening all the papers and assessing their inclusion eligibility, fourteen articles were included in this review (Duncan and Farr 1988; Karlsson et al. 1996; Wester et al. 1996; Wilson and Gansneder 2000; Green et al. 2001; Ardevol et al. 2002; Cross et al. 2002; Petrella et al. 2007; Petrella et al. 2009; Mendel et al. 2010; Van der Linde and Oschman 2011; Bendahou et al. 2014; McKeon et al. 2014; Punt et al. 2016). Of these, eleven articles were randomised controlled trials and three articles were prospective observational studies.

4.5.1 **Study characteristics and quality**

4.5.1.1 **Randomised controlled trials (RCTs)**

The randomised controlled trials that were included involved different treatment methods:

- Functional treatment versus immobilisation (Ardevol et al. 2002).
- Compression stockings versus placebo compression (Bendahou et al. 2014).
- The use of 150 mg Diclofenac (75 mg twice daily) versus 1.2 g aspirin three times daily (Duncan and Farr 1988).
- Anteroposterior mobilisation versus a protocol of RICE (Green et al. 2001).
- Functional treatment using specially designed compression pads, elevation of the injured foot (24 h), repeated elastic wrapping (compression bandage followed by ankle tape), early full weight-bearing and proprioceptive range-of-motion training versus conventional treatment with an elastic bandage, partial weight bearing and crutches until the pain subsided (Karlsson et al. 1996).
- Near-continuous live high-voltage pulsed current (HVPC) versus placebo HVPC (Mendel et al. 2010).
- Periarticular injection with hyaluronic acid (HA) and standard care (RICE) versus placebo injection and standard care (RICE) treatment (Petrella et al. 2007; Petrella et

al. 2009). These two studies are exactly the same except that the later study (Petrella et al. 2009) reported the long term effects, adverse effects and return to sport two years after the initial lateral ankle sprain.

- Nintendo Wii Fit™ exercise therapy versus physical therapy group versus no treatment (Punt et al. 2016).
- The Jump Stretch Flex Band (JSFB) programme versus conventional ankle rehabilitation programmes (Van der Linde and Oschman 2011).
- Wobble board training programme versus no training (Wester et al. 1996).

The quality of the included studies, according to Downs and Black quality assessment tool, varied from moderate (n=5) to good (n=6), as described in Table 4-1. The investigated study populations were patients recruited from emergency departments (Karlsson et al. 1996; Green et al. 2001; Ardevol et al. 2002; Bendahou et al. 2014; Punt et al. 2016) and professional and recreational athletes (Duncan and Farr 1988; Wester et al. 1996; Petrella et al. 2007; Petrella et al. 2009; Mendel et al. 2010; Van der Linde and Oschman 2011). Two articles were double blind, in terms of the subjects and assessors (Duncan and Farr 1988; Mendel et al. 2010). Two articles were only assessor blind (Green et al. 2001; Punt et al. 2016) and four articles were only patient blind (Duncan and Farr 1988; Petrella et al. 2007; Petrella et al. 2009; Mendel et al. 2010). The remaining articles did not feature any blinding (Karlsson et al. 1996; Wester et al. 1996; Ardevol et al. 2002; Van der Linde and Oschman 2011; Bendahou et al. 2014). Six studies provided information on the calculation of power for the sample size (Ardevol et al. 2002; Petrella et al. 2007; Petrella et al. 2009; Mendel et al. 2010; Bendahou et al. 2014; Punt et al. 2016). Other studies did not provide any information about power calculation for the recruited sample (Duncan and Farr 1988; Karlsson et al. 1996; Wester et al. 1996; Green et al. 2001; Van der Linde and Oschman 2011).

Table 4-1 Downs and Black Checklist Scores of Included Studies.

	Criteria	(Ardevol et al. 2002)	(Bendahou et al. 2014)	(Duncan and Farr 1988)	(Green et al. 2001)	(Karlsson et al. 1996)	(Mendel et al. 2010)	(Petrella et al. 2009)	(Petrella et al. 2007)	(Punt et al. 2016)	(Van der Linde and Oschman 2011)	(Wester et al. 1996)
1	Clear hypothesis/aim/objective	1	1	1	1	1	1	1	1	1	1	1
2	Outcomes described	1	1	1	1	1	1	1	1	1	1	1
3	Subjects described	1	1	1	1	1	1	1	1	1	0	1
4	Interventions described	1	1	1	1	1	1	1	1	1	1	1
5	Principal confounders in each group of subjects clearly described	2	2	2	1	2	1	1	1	2	0	0
6	Main findings clearly described	1	1	1	1	1	1	1	1	1	1	1
7	Measures of random variability	1	1	1	1	1	1	1	1	1	0	0
8	Important adverse effects reported	0	1	1	0	0	1	1	1	1	0	0
9	Characteristics of patients lost to follow-up described	0	1	0	1	0	1	1	1	1	0	1
10	Reporting of probability values	1	1	1	0	0	1	1	1	1	1	0
11	Subjects asked to participate are representative of entire population	0	0	0	0	0	0	0	0	0	0	0

	Criteria	(Ardevol et al. 2002)	(Bendahou et al. 2014)	(Duncan and Farr 1988)	(Green et al. 2001)	(Karlsson et al. 1996)	(Mendel et al. 2010)	(Petrella et al. 2009)	(Petrella et al. 2007)	(Punt et al. 2016)	(Van der Linde and Oschman 2011)	(Wester et al. 1996)
12	Included subjects are representative of entire population	0	0	0	0	0	0	0	0	0	0	0
13	Intervention was representative of that in use in the source population	1	1	1	1	0	1	1	1	1	1	0
14	Subjects blinded to intervention	0	0	1	0	0	1	1	1	0	0	0
15	Assessors blinded to measurement	0	0	1	1	0	1	0	0	1	0	0
16	Planned analysis	1	1	1	1	1	1	1	1	1	1	1
17	Time period between the intervention and outcome the same for cases and controls	1	1	1	1	1	1	1	1	1	0	1
18	Appropriate statistics	1	1	1	1	1	1	1	1	1	1	1
19	Compliance with the intervention/s reliable	0	1	1	1	0	0	1	1	0	0	0
20	Accuracy of outcome measures	1	1	1	1	1	0	1	1	1	1	1
21	All participants recruited from the same population	1	1	1	1	1	1	1	1	1	1	1

	Criteria	(Ardevol et al. 2002)	(Bendahou et al. 2014)	(Duncan and Farr 1988)	(Green et al. 2001)	(Karlsson et al. 1996)	(Mendel et al. 2010)	(Petrella et al. 2009)	(Petrella et al. 2007)	(Punt et al. 2016)	(Van der Linde and Oschman 2011)	(Wester et al. 1996)
22	All participants recruited over the same period of time	1	1	1	1	1	1	1	1	1	0	0
23	Subjects randomised to intervention group	1	1	1	1	1	1	1	1	1	1	1
24	Concealed randomisation	0	0	1	0	0	0	1	1	0	0	1
25	Adequate adjustment for confounding in the analyses	0	1	1	1	0	1	1	1	0	0	0
26	Loss of patients in the follow-up taken into account	0	1	0	1	1	1	1	1	1	0	0
27	Sufficient power calculations	0	1	0	0	0	1	1	1	1	0	0
Total score/ 28		17	23	23	20	16	22	24	24	22	11	13

4.5.1.2 **Prospective observational studies**

The quality scores for the included observational studies was 6-8/14 on the CASP quality checklist (Table 4-2).There was a high degree of heterogeneity between the included prospective observational studies, in particular between the definition of the outcome measure, which is the RTP and the follow up period. The main quality issues in those studies were:

1. Using poor statistical methods including the selection of appropriate regression tests. For example, the number of days as a criterion variable was treated as a continuous variable rather than a count data.
2. The linearity of the data was not described, which may have had an influence on the selection of appropriate regression tests (Cross et al. 2002).
3. None of the included articles provided results for colinearity assessment to investigate if multicollinearity exists between the predictor variables.
4. It was not clear how the variables were eliminated from the multivariable model and at what significance level.
5. In all the articles, the outcome measure was not well defined. There was also no clear description on the criteria for RTP.
6. In some cases, low sample size, which, in turn, might have affected the validity and generalisability of the results.

Table 4-2 CASP Checklist Scores of the Included Observational Studies.

	CASP criteria	(McKeon et al. 2014)	(Cross et al. 2002)	(Wilson and Gansneder 2000)
1	Clearly focused issue stated	1	1	1
2	Appropriate recruitment	0	n/c	0
3	Exposure accurately measured to minimise bias	1	1	1
4	Outcome accurately measured to minimise bias	1	1	1
5	Confounding factors identified	n/c	0	0
6	Confounding factors accounted	0	0	0
7	Subjects' follow up is complete	1	0	0
8	Subjects' follow-up is long enough	0	1	1
9	Clear results	1	0	1
10	Precise statistical results	0	0	1
11	Results are believable	0	0	0
12	Ability to generalise results to local population	1	0	0
13	Interpretation related to the existing evidence	1	1	1
14	Clear implications of this study for practice	1	0	n/c
	Total score/14	8/14	5/14	7/14

1 yes, *0* no, *n/c* not clear

4.5.2 **Main findings**

4.5.2.1 **RCTs**

The included RCTs provided data for 897 patients with lateral ankle sprain. The age range across all these studies was between 20 to 64 years. The follow-up period ranged between four days and twenty-three months. The included RCTs showed a variety of treatment methods that resulted in a shorter time to RTP after lateral ankle sprain (Table 4-3 and Table 4-4). They included functional treatment (Karlsson et al. 1996; Ardevol et al. 2002), the use of compression stockings (Bendahou et al. 2014), anteroposterior joint mobilisation(Green et al. 2001), periarticular injection with hyaluronic acid (HA) (Petrella et al. 2007; Petrella et al. 2009), the use of 150 mg diclofenac (75 mg twice daily (Duncan and Farr 1988) and the Jump Stretch Flex Band programme (JSFB) (Van der Linde and Oschman 2011). In addition, treating grade I lateral ankle sprain with near-continuous live high-voltage pulsed current (HVPC) compared to placebo treatment resulted in shorter RTP (Mendel et al. 2010).

4.5.2.2 **Prospective observational studies**

The prospective observational studies included in this review investigated the relationship between different prognostic factors and time to RTP. The findings showed that time to RTP was not influenced by either new or recurrent injuries (Medina McKeon et al. 2014). However, measures of global function, Short Form–36 Physical Function scale (SF36PF), athlete's ambulation status (Cross et al. 2002) and weight-bearing activity scores and self-reported athletic ability (Wilson and Gansneder 2000) were strong predictors of time to RTP (Table 4-4).

One study recruited athletes from high schools (Medina McKeon et al. 2014), whereas the other two studies recruited athletes from the National Collegiate Athletic Association (NCAA) (Wilson and Gansneder 2000; Cross et al. 2002). Study participants in all the investigations were athletes who competed in different sports and had sustained a primary lateral ankle sprain**.** Furthermore, all the studies recruited athletes with an approximate age range of 14-22 years old. The sex ratio of participants was 2:1 men:women (Wilson and Gansneder 2000; Medina McKeon et al. 2014) and 1:2 men:women (Cross et al. 2002). Two studies investigated both subjective prognostic factors (Self-reported Athletic Ability, global function, SF36PF, visual analogue pain scale) and objective prognostic factors, specifically measurement of joint swelling, range of motion and weight bearing activities, ankle muscles strength, ambulation status (Wilson and Gansneder 2000; Cross et al. 2002). The third study investigated the patients' history of injury comparing new versus recurrent lateral ankle sprain as predictive factors (Medina McKeon et al. 2014).

Table 4-3 Summary of Papers Included in the Review

Study	Study design	Population/ characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
Ardevol J et al., 2002	Randomised controlled trial	121 patients with grade III lateral ankle sprain treated in an emergency department. Aged under 35 years old 93 men and 28 women.	Treatment methods: 1. Immobilisation. 2. Functional treatment.	1. Objective laxity. 2. Subjective functional instability, swelling, pain and stiffness. 3. Sporting level on return to physical activity. 4. Time before returning to sport.	3,6 and 12 months	Functional group showed significantly earlier and better return to physical activity. Functional treatment also showed better decrease in joint laxity. No intergroup differences were found in the re-injury rate.
Bendahou et al., 2014	Multicentre randomised controlled trial	126 patients, 18-55 years old with recent (less than 48 hours) lateral ankle sprain seen in an emergency department. 66 men and 51 women.	1. Compression stockings. 2. Placebo Compression.	1. Time to recovery of normal painless walking without requirement for analgesic drug. 2. Time to return to sport activity. 3. Pain, analgesic consumption, and ankle oedema.	90 days	No significant differences in pain, analgesic consumption, and bimalleoar and midfoot circumferences. Time to return to sports activity was significantly shorter for patients treated with compression stockings. Median time was 38(30-60) days in the compression-stocking group and 60 (35-81) days in the placebo group.
Cross et al., 2002	Prospective observational	20 intercollegiate athletes from National Collegiate Athletic Association	Visual analogue pain scale, global function question, Short Form–36 Physical	Number of days to return to sport (days).	Last participant returned to play on 40th	Global function question, SF 36PF and athlete's ambulation status are strong predictors of time to RTP.

Study	Study design	Population/ characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
		(NCAA) (7 men, 13 women; mean age = 19.2 ± 1.1 years old.	Function scale (SF36PF), ankles active range of motion (AROM) and isometric strength.		day.	
Duncan and Farr, 1988	Randomised, double-blind, parallel-group clinical trial	139 patients with acute sprains and/or strains of the knee or ankle within the previous 36 hours. Knee (n=31), Ankle (n=88) Mean age 25 years old 85 men and 11 women.	1. Diclofenac, 150 mg (75 mg twice daily). 2. Aspirin, 3.6 g (1.2 g three times daily).	1. Swelling and limitation of active range of motion and patient assessment of pain on active motion. 2. Days required to resume athletic activities.	10 days	1. Insignificant difference between groups for swelling, limitation of range of motion and self-reported pain. 2. Diclofenac group resumed athletic activities on average in 4.7 days, compared with a mean of 5.9 days for patients in the aspirin group.
Green et al., 2001	Randomised controlled trial with blinded assessors	41 subjects with acute ankle inversion sprains (undefined grade of injury) with less than 72 hours from emergency department. 26 men and 12 women. Mean age experimental group (26.1 ± 2.0) and	1.Anteroposterior mobilisation (intervention) 2. A protocol of RICE and (control).	1.Dorsi flexion and gait characteristics 2.Return to sport	14 days	1. Intervention group required fewer treatment sessions to achieve full pain-free dorsiflexion, had greater improvement in range of movement before and after each of the first 3 treatment sessions and had greater increases in stride speed during the first and third treatment sessions. 2. Patients in intervention group, returned to sports (n=13) after 12.2 days.

Study	Study design	Population/ characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
		control (24.9 ± 1.6).				Patients in control group, returned to sports (n=16) after 13.4 days.
Karlsson et al., 1996	Randomised trial	86 patients with acute (<24 h) grade II or III lateral ligament ruptures 57 men and 29 women. Mean age was 22 (16-38) years old.	1. Functional treatment using specially designed compression pads, elevation of the injured foot (24 h), repeated elastic wrapping (compression bandage followed by ankle tape), early full weight bearing and proprioceptive range-of-motion training. 2. Conventional treatment with an elastic bandage, partial weight bearing and crutches until the pain subsided.	Return to sport. Number of days.	Mean follow-up period was 18 months.	1. Return to sports activities was significantly earlier in the functional treatment group, 9.6±4.8 days compared with 19.2±9.5 days in the conventional treatment group. 2. Mean sick leave was significantly shorter in the functional treatment group; 5.6±4.2 days compared with 10.2±6.8 days in the conventional treatment group.
Medina McKeon et al., 2014	Observational	204 high school athletes with lateral ankle sprain. 140 men, 65 women.	History of injury: New or recurrent injury	RTP intervals: same day return, next day return, 3-day return, 7-day return, 10-day return, 21-day return, >22-day return.	21 days	No significant difference ($p = 0.89$) between the time until RTP curves for new and recurrent lateral ankle sprains.

Study	Study design	Population/ characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
Mendel et al., 2010	Multicentre randomised, double-blind, placebo-controlled trial	50 intercollegiate and professional athletes aged 17 - 33 years old.	1.Treatment (n = 22): Near-continuous live High-Voltage Pulsed Current (HVPC) 2. Control (n = 28): Placebo HVPC for 72 h post-injury in addition to routine acute and subacute care.	Time lost to injury measured from time of injury until declared fit to play.		1. Overall, no different between treated and control groups. 2. Treated grade I sprains had longer TTRTP than control (p=.049). 3. No differences between groups for grade II sprains (p=.079).
Petrella et al., 2007	Randomised controlled prospective trial	158 competitive athletes with acute grade I or II lateral ankle sprain. Mean age 26±7 years old Hyaluronic acid (HA) and 24±8 years old for the placebo injection (PL) group.	1. Periarticular injection with hyaluronic acid (HA) + standard of care (RICE). 2. Placebo injection (PL) + standard of care (RICE) treatment.	1. Pain scale (VAS) (0–10 cm) on weight bearing and walking 20 m. 2. Patient global assessment of ankle injury (5-point categorical scale). 3. Patient satisfaction with treatment (5-point categorical scale). 4. Time to return to pain-free and disability-free sport. 5. Adverse events.	4, 8, 30 and 90 days	1. Significant reduction in VAS pain on weight bearing on day 8, 30 and 90 for HA compared with PL ($P < 0.05$). 2. Significant reduction in VAS pain when walking on day 8for HA compared with PL ($P < 0.05$). 3. Significantly greater patient satisfaction for HA versus PL on days 4 ($P< 0.05$), 8 ($P< 0.001$), 30 ($P< 0.001$), and 90 (P, 0.05). 4. Patient global assessment of ankle injury was significantly better compared with the baseline in the HA group on day 8, but this was not different between groups. 5. Time to pain-free and disability-free return to sport

Study	Study design	Population/ characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
						was 11 (±8) versus 17 (±8) days for HA and PL, respectively (P < 0.05).
Petrella et al., 2009	Same as in Petrella et al., 2007	Same as in Petrella et al., 2007	Same as in Petrella et al., 2007	Same as in Petrella et al., 2007 Plus: 1. Recurrent lateral ankle sprain. 2. Total number of days missed from primary sport activity.	4, 8, 30, 90 and 712	1. Significant reduction in VAS pain when both weight bearing and walking at all follow-up assessments for HA compared with PL (P < 0.001). 2. Time to pain-free and disability-free return to sport was 11 (± 8) versus 17 (± 8) days for HA and PL, respectively (P < 0.05). 3.At 24 months, in the PL versus HA group, there were 2 versus 0 lower limb fractures, 16versus 7 second lateral ankle sprains (P < 0.05), 3 versus 1 third lateral ankle sprains, 4. Significantly greater number of days missing primary sport activity (41 versus 21; P < 0.002).
Punt et al., 2016	Single blinded RCT	Patients with mild (grade I) or moderate (grade II) lateral ankle sprain. Aged from 18 to 64 years old.	1. Nintendo Wii Fit™ exercise therapy (n=30). 2. Physical therapy group (n=30). 3. Control group (n=30), received no treatment.	1. Foot and Ankle Ability Measure (FAAM) questionnaire. 2. VAS for pain at rest and while walking. 3.RTP	6 weeks	1. No treatment effect difference between the groups at 6 weeks follow-up. 2. No difference in pain at baseline and at6-week follow-up between the groups.

Study	Study design	Population/ characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
				4.Patients' satisfaction 5. Subjective perception of the effectiveness of the allocated treatment.		3. No difference in RTP between all groups. 4. No differences between the groups for both variables – satisfaction and effectiveness.
Van der Linde and Oschman, 2011	RCT	25 sport patients with acute lateral ankle sprain aged 18-40 years old.	Jump Stretch Flex Band (JSFB) programme and conventional ankle rehabilitation programmes.	1.The time from injury to return to sport 2. Means of swelling, thickness and appearance.	-	Shorter time to RTP with the JSFB programme.
Wester et al., 1996	A Prospective Randomised Study	61 active athletes more than 2 hours a week with primary lateral ankle sprains. 19 women and 29 men with a mean age of 25 (+7.2).	1. Twelve week training programme using a wobble board. 2. No training.	1. Pain at rest, during walking, or during sports activities (yes/no). 2. Oedema	1,6 and 12 weeks	1. No significant difference in oedema. 2. No differences in the time which elapsed before patients were painless when walking, running or playing sports between the groups.
Wilson et al., 2000	Prospective multivariate design	21 intercollegiate athlete who compete in NCAA Division I sports. 13 men and 8 women Mean age = 20.3 + 1.7 years old.	Joint swelling, ROM, and activity scored by performing 6 weight-bearing activities and Self-reported Athletic Ability (VAS)	Disability duration (time to RTP).	-	Weight-bearing activity scores and self-reported athletic ability, were stronger predictors of time to RTP.

Table 4-4 Summary of Investigated Factors in the Included Articles

	Factors	Influencing/ predicting RTP
Clinical assessment	Intensity of pain (VAS) (Cross et al. 2002).	No
	Swelling (Wilson and Gansneder 2000).	Yes, predictive
	Active range of motion (Cross et al. 2002).	No
	Dorsiflexion and planter flexion passive range of motion (Wilson and Gansneder 2000).	Yes, predictive
	Ankle dorsi flexion and planter flexion isometric strength (Cross et al. 2002).	No
Functional assessment	Weight-bearing activities (Wilson and Gansneder 2000).	Yes, predictive
	Patient's ambulation status (Cross et al. 2002).	Yes, predictive
	Self-reported Athletic Ability (VAS) (Wilson and Gansneder 2000).	Yes, predictive
	Global function question (Cross et al. 2002).	Yes, predictive
	Short Form-36 Physical Function scale (SF36PF) (Cross et al. 2002).	Yes, predictive
Treatment methods	Functional treatment Vs immobilization (Ardevol et al. 2002).	Yes, shorter RTP
	Compression stockings Vs Placebo Compression (Bendahou et al. 2014).	Yes, shorter RTP
	Anteroposterior mobilisation (intervention) Vs a protocol of RICE (control) (Green et al. 2001).	Yes, shorter RTP
	Functional treatment using specially designed compression pads, elevation of the injured foot (24 h), repeated elastic wrapping (compression bandage followed by ankle tape), early full weight-bearing and proprioceptive range-of-motion training Vs Conventional treatment with an elastic bandage, partial weight bearing and crutches until the pain subsided (Karlsson et al. 1996).	Yes, shorter RTP
	Nintendo Wii Fit™ exercise therapy (n=30) Vs physical therapy	No

Factors		Influencing/ predicting RTP
	group (n=30) Vs control group (n=30), which received no treatment (Punt et al. 2016).	
	Twelve week training programme using a wobble board Vs no training (Wester et al. 1996)	No
	Near-continuous live High-Voltage Pulsed Current (HVPC) Vs placebo HVPC for 72 h post-injury (Mendel et al. 2010).	No
	Periarticular injection with hyaluronic acid (HA) + standard of care (RICE) Vs placebo injection (PL) + standard care (RICE) treatment (Petrella et al. 2007; Petrella et al. 2009).	Yes, shorter RTP
	Jump Stretch Flex Band (JSFB) programme versus conventional ankle rehabilitation programmes.	Yes, shorter RTP
Medication	Diclofenac, 150 mg (75 mg twice daily) Vs aspirin, 3.6 g (1.2 g three times daily) (Duncan and Farr 1988).	Yes, shorter RTP
	NSAID use (Mendel et al. 2010)	No
History of injury	New injury Vs recurrent injury (Medina McKeon et al. 2014).	No

4.5.3 Definition and criteria for RTP

All included studies used time to RTP as a main outcome measure for recovery after lateral ankle sprain. However, they defined RTP differently in each individual study (Table 4-5).

Table 4-5 Definition and Criteria for RTP

Study	Study design	Definition of lateral ankle sprain	Definition of RTP after lateral ankle sprain	Criteria for RTP
(Ardevol et al. 2002)	RCT	First phase of a grade III tear of the ATFL or ATFL plus CFL (<72 hours).	Complete training session.	No pain and/or swelling and/or stiffness

Study	Study design	Definition of lateral ankle sprain	Definition of RTP after lateral ankle sprain	Criteria for RTP
(Bendahou et al. 2014)	RCT	Recent (<48 hours) lateral ankle sprain.	Return to normal painless sport activity.	Not provided
(Cross et al. 2002)	Prospective cohort study	Lateral ankle sprain (<24 hours).	Return to full athletic participation without limitations.	Successfully completed functional testing specific to their sports.
(Duncan and Farr 1988)	RCT	Acute sprains (<36 hours) with moderate or severe swelling, tenderness, and limitation of range of motion.	Full activity or playing fitness.	Not provided
(Green et al. 2001)	RCT	Acute ankle inversion sprains (<72 hours).	Return to sports.	Not provided
(Karlsson et al. 1996)	RCT	Grade II or III lateral ligament injury (<24 hours) with moderate to severe swelling and moderate to severe instability, both in the frontal and sagittal planes.	Return to full sports activity, including jumping and running activities.	Not provided
(McKeon et al. 2014)	Prospective cohort study	Injury to the lateral ligamentous or capsular tissue of the ankle.	Back to participation.	Not provided
(Mendel et al. 2010)	RCT	Grade I (mild) or 2 (moderate) lateral ankle sprain (<25	Fit to play.	Not provided

Study	Study design	Definition of lateral ankle sprain	Definition of RTP after lateral ankle sprain	Criteria for RTP
		hours).		
(Petrella et al. 2009)	RCT	Acute Grade I or II lateral ankle sprain (<48 hours).	Return to normal function/activity in sport.	Pain-free and disability-free sport
(Petrella et al. 2007)	RCT	Acute Grade I or II lateral ankle sprain (<48 hours).	Return to normal function/activity in sport.	Pain-free and disability-free sport
(Punt et al. 2016)	RCT	Mild (grade I) or moderate (grade II) lateral ankle sprain.	Being able to return to sport.	Not provided
(Van der Linde and Oschman 2011)	RCT	Acute grade I and IIfirst time lateral ankle ligament sprain.	Return to competitive level of sport.	Not provided
(Wester et al. 1996)	RCT	Primary lateral ankle sprains (Stage 2).	Not provided	Painless during walking and during sports
(Wilson and Gansneder 2000)	Prospective cohort study	Grade I or II ankle inversion sprain.	Return to full participation in practice or competition.	Not provided

4.6 Discussion

The aim of this review was to determine if a consensus exists about the factors that influence the time to RTP after lateral ankle sprain. In addition, it discussed the definition of and criteria for RTP, as described in the included articles. This review included fourteen investigations of moderate to high quality evidence. Of the fourteen investigations, eleven were randomised controlled trials. This study informed the following studies in this thesis by highlighting potentially important aspects related to RTP after lateral ankle sprain acknowledged within the literature. It identified the need to investigate various demographic, clinical and sport related factors that may affect RTP after injury and informed factors to be considered in analysis to investigate influencing factors for RTP (study 3 and 4). It also provided guidance on how the methodology of the following studies can be better designed. Therefore, to simplify the analysis and discussion, potential influencing factors that were identified from the included articles were categorised into five domains: clinical assessment, functional assessment, treatment methods, medication and history of injury.

4.6.1 Clinical assessment

Clinical assessment refers to findings from subjective and objective examinations such as intensity of pain, range of motion, muscle power and so on. In this review, four clinical measures were identified: intensity of pain, oedema, range of motion and muscle power. Only pain (Cross et al. 2002) was found to be a predictive factor for RTP after an lateral ankle sprain. Interestingly, other clinical measures such as range of motion, measurement of joint swelling and muscle power were not found to be predictive of RTP (Wilson and Gansneder 2000; Cross et al. 2002). In addition, pain and difference in muscle strength, compared to the other side, were found to be important criteria to decide safe RTP following hamstring strain (C.M. Askling 2010; De Vos et al. 2014; Jacobsen et al. 2016). Jacobsen et al. (2016) found that a combination of an initial and follow-up assessment of pain, muscle strength and playing football explained 97% of the variance of RTP after a hamstring injury.

In terms of lateral ankle sprain, only a few clinical factors have been investigated. This review identified five clinical factors: intensity of pain, oedema, range of motion, muscle power and severity of injury. The inclusion of different clinical factors in future studies might better inform practice by identifying influencing factors for RTP after lateral ankle sprain. Furthermore, the inclusion of reliable clinical tests such as the dorsiflexion lunge lest, the star excursion balance test, the Agility T-test and the Sargent/vertical jump test in prospective studies is equally necessary (Clanton et al. 2012). In addition, well-designed studies that endeavour to take into account confounding factors may produce better results. In this review, Wilson and Gansneder (2000) conducted a clinical assessment within three days of injury, which might have influenced the validity of their results, since in the first 3 days after injury, symptoms such as pain and swelling might have influenced the outcomes of the clinical assessments. This is because performing clinical assessments 3-5 days after the injury has happened produces better results, with a sensitivity of 96% and specificity of 84% (van Dijk et al. 1996; Aradi and Wong 1997).

4.6.2 **Functional assessment**

Functional assessment refers to measuring body functions, activities and participation in a particular context such as sport, commuting and daily life activities (WHO 2002). This review identified four functional measures that have been used to indicate their effect on RTP after lateral ankle sprain. Wilson and Gansneder (2000) adopted a set of weight bearing activities that included a 40-metre walk, a 40-metre run, a figure-8-run, a single hop, a cross-over hop and a stair hop. They also included assessment by subjects in the form of self-reported athletic ability questionnaire, measured by the visual analogue scale (VAS), whereas others investigated global function and physical function (SF36F) (Cross et al. 2002). All these measure were found to be predictive factors for RTP after lateral ankle sprain. Additionally, functional assessments were used as objective measurements to determine an athlete's ability to RTP following ankle injuries (Clanton et al. 2012). The latter authors concluded that the dorsiflexion test, the star excursion balance test, the agility T-test and the Sargent/vertical jump test could be reliable objective measures to make a safe RTP decision after ankle injuries. Therefore, integrating functional measures when deciding on a safe RTP time could be very important. For instance, the SF36 health survey questionnaire was found to be reliable and valid when used as a functional outcome measure for the general population in primary health care settings (Brazier et al. 1992). Furthermore, using such easy patient self-administered outcome measures may help determine optimal recovery from injuries including lateral ankle sprains. In addition, investigating those functional outcome measures in prospective studies as potential prognostic factors is warranted.

4.6.3 **Treatment methods**

Most articles included in this review examined the relationship between conservative treatment methods and RTP. They investigated a variety of conservative treatment methods such as functional treatment, immobilisation, compression stockings, joint mobilisation, Nintendo Wii Fit™ exercise therapy, a wobble board training programme, HVPC, JSFB and HA. No contradicting results were found in this review. Functional treatment was the only factor that was investigated in more than one trial (Karlsson et al. 1996; Ardevol et al. 2002; Van der Linde and Oschman 2011). In those trials, it was found to shorten the duration that an athlete needs to return to sporting activities.

Furthermore, functional treatment was found to have superior results over other types of conservative treatments of lateral ankle sprains (Lardenoye et al. 2012; Prado et al. 2014; Naeem et al. 2015). It was concluded that treating lateral ankle sprain with functional treatment rather than immobilisation might lead to better results including shorter time to return to sports and daily life activities (Freeman 1965; Karlsson et al. 1996; Green et al. 2001; Ardevol et al. 2002). In this review, a shorter time to RTP was recorded in groups that have been provided with early mobilisation and functional treatments (Karlsson et al. 1996; Green et al. 2001; Ardevol et al. 2002). These studies investigated patients with grades of injury ranging from moderate (grade II) to severe (grade III). Two of them took into account testing of joint instability to decide the severity of the injury (Karlsson et al. 1996; Ardevol et al. 2002), however, the third study depended on palpating joint tenderness to diagnose the involvement of the different lateral ankle ligaments (Green et al. 2001).

Testing the clinical joint instability is very important to characterise and eventually grade the severity of injury (Ferran and Maffulli 2006). For instance, using a talar tilt test or stress radiographs may provide more information about the ligament laxity for laterally located ligaments and the anterior draw test can be used for anterior talofibular ligament, which in turn, may support the findings of other clinical assessments. Moreover, clear criteria to differentiate the grades of injury of lateral ankle sprain and their relationship with recovery is important in order to avoid unnecessary confusion. It is important to note that the in Green et al. (2001) study follow-up took place after 14 days, which might not have allowed for an adequate period of time to pass before deciding the recovery of a ligament injury. This is because, ideally, ligament healing takes at least six weeks to three months to occur, and even longer to regain full strength and stability (Hubbard and Hicks-Little 2008). It might be difficult to determine the effect of specific treatment methods, at least in the cases of moderate to severe ligament injury, without considering the adequate time required for the injured ligament to repair.

Other treatment methods identified in this review were compression stockings (Bendahou et al. 2014) and HA (Petrella et al. 2007; Petrella et al. 2009). The RTP was significantly shorter in the group treated with compression stockings compared with that treated with placebo compression, and it is common practice, especially in the emergency departments, to provide patients with an lateral ankle sprain with compression stockings. However, there is lack of evidence to support their clinical application over other conservative treatment methods (Pollard and Cronin 2005). Indeed, previous studies that supported the use of compression stockings and elastic bandaging presented poor quality evidence, making it difficult to draw valid conclusions (Hansrani et al. 2015). To the best of the researcher's knowledge, only one study, which is included in this review, investigated the connection between the use of compression stockings and time to RTP after lateral ankle sprain, and the findings of this study showed that it is more effective than placebo compression (Bendahou et al. 2014). It would be interesting to determine the effect of compression carried out with other common conservative treatments such as mobilisation and exercises, since the usual treatment programme for lateral ankle sprain consists of RICE and/or other treatment methods such as exercises and joint mobilisation techniques (Kerkhoffs et al. 2012).

Regarding the use of HA joint injections, previous studies have shown that Intra-articular injections with HA has been effective in treating tennis elbow (Petrella et al. 2010) and non-radicular chronic lumbar pain (Fuchs et al. 2005), and after tendon surgery (Abate et al. 2014). The current review included one study that compared the effectiveness of HA periarticular injection with standard care (RICE) and placebo injection with standard care (Petrella et al. 2007; Petrella et al. 2009). Results showed significant improvement in all outcome measures including the time to RTP. Despite the positive results, they should be interpreted with caution, as they were drawn from a single study. In addition, this review confirmed a discrepancy in the reporting of the results of those two articles. They stated that there was a significantly greater patient satisfaction in favour of HA over PL at all follow-up assessments. However, the table of results indicated significant patient satisfaction between the two groups on days 4 and 8 but not for days 30, 90 and 712. Therefore, future trials should be well designed in order to appropriately compare the effect of HA when treating lateral ankle sprain injury.

4.6.4 **Medication**

The use of non-steroidal anti-inflammatory drugs (NSAIDs) is widely used to reduce pain, swelling and improve function following different musculoskeletal conditions including lateral ankle sprain (van den Bekerom et al. 2015). Despite the wide use of these medications in treating lateral ankle sprain, only two studies, which were included in this review, investigated their effects on RTP after lateral ankle sprain injury (Duncan and Farr 1988; Mendel et al. 2010). These two studies showed mixed results. Duncan and Farr (1988) found that the group treated with diclofenac resumed sporting activity earlier than the other group; however, that difference was not statistically significant (Duncan and Farr 1988). The other study found no statistical difference between the two treatment groups in terms of the percentage of injury time when NSAIDs were taken (Mendel et al. 2010). It would be more useful if NSAIDs were compared with other conservative treatments to determine their influence on RTP. Future research should also consider investigating the relationship between different types of NSAIDs, specifically oral, topical and intramuscular, and RTP after lateral ankle sprain. In addition, randomised controlled trials should investigate the effect of NSAIDs on RTP in the presence of other conventional conservative treatment methods such as exercise, joint mobilisation and functional treatment.

4.6.5 **History of injury**

History of previous injury was considered a risk factor for many injuries including ankle injuries (McKay et al. 2001; Swenson et al. 2009). In basketball, ankle injury was found to be five times more in those players who had a history of previous ankle injury (McKay et al. 2001). This review included one study that prospectively investigated the effect of history of lateral ankle sprain on RTP and found no significant difference between patients with new and recurrent lateral ankle sprain (McKeon et al. 2014). Although that study collected data about sex, sport and referrals, they did not examine their influence on the RTP, yet these potential confounders (sex, sport and referrals) might have influenced the results. In addition to these factors, age, body mass index and health status can also contribute to a longer or shorter RTP. As a result, these factors have been partly or collectively investigated to establish their relationship with RTP in other injuries such as anterior cruciate ligament injury (Muaidi et al. 2007; Brophy et al. 2012) and hamstring strain (Moen et al. 2014; Jacobsen et al. 2016).

4.6.6 **Definition and criteria of RTP**

In this review, all the studies used time to RTP as an outcome measure to determine the recovery threshold after lateral ankle sprain. However, most studies in this review did not provide a clear definition of RTP. For example, it was defined as: return to sports (Green et al. 2001), back to participation (McKeon et al. 2014), being fit to play (Mendel et al. 2010) and being able to return to sport (Punt et al. 2016). In addition, most studies in this review failed to provide clear criteria for return to sport after lateral ankle sprain (Duncan and Farr 1988; Karlsson et al. 1996; Wilson and Gansneder 2000; Green et al. 2001; Mendel et al. 2010; Bendahou et al. 2014; McKeon et al. 2014; Punt et al. 2016). This is significant as unclear definitions and criteria for RTP have always created confusion and disagreement when assessing the readiness of an athlete to be allowed to resume sporting activity once again (Anderson 2002; van Rijn et al. 2008b; Clanton et al. 2012;

Richie and Izadi 2015). A consensus statement was made by a group of physicians in the US to address when an athlete should be returned to sporting activity after a specific injury (Herring et al. 2002). They provided a list of criteria for safe RTP that included the following:

1. Restoration of sport-specific function to the injured part.
2. Restoration of musculoskeletal, cardiopulmonary and psychological function, as well as overall health of the injured or ill athlete.
3. Restoration of sport-specific skills.
4. Ability to perform safely with equipment modification, bracing, and orthoses.
5. The status of recovery from acute or chronic illness and associated sequelae.
6. Psychosocial readiness.
7. The athlete poses no undue risk to themselves or the safety of other participants.
8. Compliance with American federal, state, local and governing body regulations and legislation.

Unfortunately, most of these requirements were not considered or described in the articles that were included in this review. Athlete trainers or treating physiotherapists or patients themselves subjectively took most of the decisions for RTP, which is perhaps why most patients develop long-term complications such as chronic pain, swelling, restricted movements, chondral lesions, joint instability and re-sprains (Gerber et al. 1998; Hertel 2000; Takao et al. 2003; van Rijn et al. 2008b; Malliaropoulos et al. 2009; van Middelkoop et al. 2012; Petersen et al. 2013).

One narrative review provided evidence based recommendations for RTP for patients with ankle injuries, including lateral ankle sprains (Clanton et al. 2012). They concluded that testing balance and proprioception (The Star Excursion Balance Test), strength (Sargent/Vertical Jump Test), range of motion (The Dorsiflexion Lunge Test) and agility (Agility T-Test), along with psychological stress might assist in deciding the readiness of a player or athlete to RTP. However, these recommendations were not implemented or tested in later trials. Therefore, future research should develop clear and well-defined criteria for RTP after lateral ankle sprain injury. In addition, randomised trials should clearly describe the criteria that has been used to decide RTP in order to inform better practice.

4.7 Recommendations

The review systematically examined the available literature in order to inform the decision for RTP. There were many issues confirmed in this review such as the factors that influence RTP and the definition and criteria for RTP after lateral ankle sprain. In this review, many factors that affect the decision to RTP were identified such as the intensity of pain, the severity of the injury, participation in weight-bearing activities, the patient's self-reported athletic ability, global function question, physical function scale, functional treatment, the use of compression stockings, anteroposterior mobilisation, HA, JSFB and the use of diclofenac. Those factors can be integrated and tested in future prospective studies. In addition, testing the influence of these factors when also taking into consideration other demographic and clinical factors, for example age, sex, BMI, sport type, training intensity, is recommended to understand the whole picture on influencing factors for RTP. Future research should consider recruiting various age groups who practise different types of sports at different intensities and variety of sport types in order to correlate the findings between different sports populations. Identifying those influencing factors will help sport health teams, coaches, players and parents to make better decisions. Safe decisions for RTP may, in turn, improve current clinical practice and minimise unfavourable chronic complications. These recommendations are in line with findings from other narrative reviews that encouraged clinicians and researchers to develop clear recommendations for RTP after lateral ankle sprain (Anderson 2002; Clanton et al. 2012; Richie and Izadi 2015).

4.8 Strengths

To the best of the author's knowledge, this is the first systematic review that has investigated the influencing factors for RTP after lateral ankle sprain injury. The quality of the included studies was critically appraised in order to produce robust evidence based results. Furthermore, broad criteria for the data search was adopted by accessing different data sources such as online databases, grey literature, Google scholar and a reference list of the included studies. A multidisciplinary team that consisted of a physiotherapist, a podiatrist and a sports science researcher developed the search terms and strategy. In addition, two reviewers critically appraised each individual study to minimise the risk of bias.

4.9 Potential limitations

As with any other review, some potential limitations need to be acknowledged. Although there was a broad search strategy, there exists the possibility that some data was not accessed. The choice of the online databases to be searched was decided based on the availability of those databases in the library website of the University of Southampton. One researcher (SB) conducted the search and identification of potential eligible studies. Introducing another person to verify the inclusion of studies at this stage was not possible due to limited resources. However, the search strategy was followed carefully in order to reduce any risk of selection bias.

Limitations with regards to the results of this review may include the heterogeneity of the included studies. Most studies in this review separately investigated influencing factors, thus it was difficult to reach a valid conclusion. Most studies failed to clearly define and list the criteria for RTP, therefore it was not possible to accurately determine the recovery threshold after treatment. Some studies in this review provided a very brief statement about the definition and criteria for RTP, which was not adequate to draw a conclusion regarding a safe time to RTP after lateral ankle sprain.

Lastly, the methodological quality of future studies investigating the influencing factors of RTP following conservative treatment on lateral ankle sprain needs to be improved. For example, the lack of blinding which could have led to incorrect estimation of the study results. Furthermore, the sample size seemed to be a major issue, particularly in the included observational studies, and that may have affected their findings. Consequently, future studies with appropriate power calculation or estimates of sample size would reduce the risk of bias and would eventually increase the validity of the results. There were also a number of confounders that have not been investigated and might have affected the results such as age, sex, BMI, history of injury and past sport activity. This is relevant, as these covariates might be important to consider as determinants of the recovery threshold following lateral ankle sprain.

4.10 **Future research**

Despite the increased prevalence of lateral ankle sprains, current practice does not adhere to clear guidance for RTP. That is to say, no sound decision has been made with regards to potential associated factors that affect RTP following these injuries. Yet, investigating these factors will ultimately identify those patients who require individualised rehabilitation programs. Moreover, making a good decision on the time to RTP can be achieved by evaluating the functional status of the athlete, determining the risk factors associated with that sport and modifying the RTP decision according to an individual’s needs (Dennis et al. 2008).

The definition of and criteria for RTP after lateral ankle sprain has not been clearly presented in previous studies, despite the fact this is very important in order to prevent disagreement and facilitate good decision-making. A future Delphi study involving experts in the field is required, so that a consensus can be reached regarding the definition of and criteria for RTP after lateral ankle sprain.

This review has confirmed many issues related to the factors influencing RTP following conservative treatment of lateral ankle sprains. These issues need to be considered in future observational that investigate the factors influencing RTP after lateral ankle sprain. Information from this study (Study one) was used to inform the development of the questionnaire and potential explanatory (associated) factors of the third study in this thesis.

4.11 **Conclusion**

Lateral ankle sprain is a very common injury among sport and non-sport populations, yet there is lack of evidence about the factors influencing RTP. This review was designed to examine the studies that have investigated the relationship between different factors and RTP after lateral ankle sprain. The findings from this review identified some factors that influence RTP (Table 4-4). However, it was evident from the findings of this review that little agreement exists in current literature on the factors that affect RTP and the relationship between influencing factors and RTP'. The next investigation in this thesis therefore focusses on identifying key characteristics such as age, sex, BMI, level of sport and injury related factors in a known population of individuals attending for treatment at a UK NHS Emergency Department.

Chapter 5: Study two, Characteristics of patients with lateral ankle sprain presenting to an emergency department in the south of England (UK)*

***Al Bimani SA**, Gates L, Warner M, Crouch R and Bowen C (2018a) Characteristics of patients with ankle sprain presenting to an emergency department in the south of England (UK): A seven-month review. *Int. Emerg. Nurs.* 41: 38-44

Findings from study one (the systematic review) indicated fifteen factors that could be considered potential factors influencing the decisions to RTP. However, nine of those factors were treatment methods. Other potential factors were not included such as age, sex, BMI, history of injury and past sport activity etc. Those factors are equally important to understand what affects RTP after lateral ankle sprain. However, a prior knowledge of the population at risk of this injury and the characteristics of that population was deemed important. Identifying those characteristics were important to inform the methodology of the following study in this thesis (Study three) which was planned to determine associated factors for RTP after lateral ankle sprain.

5.1 Background

Lateral ankle sprain is one of the most common injuries that patients present with at emergency departments. It has the greatest incidence in emergency department in the US, with a rate of 2.06 per 1,000, what is more younger patients (14-35 years old) are more likely to suffer this injury (Lambers et al. 2012). Similarly, an overall incidence rate of 3.29 lateral ankle sprains per 1000 person-years (Shah et al. 2016) and 2.15 per 1000 person-years (Waterman et al. 2010) was recorded across emergency departments in the US.

In the UK, annual statistics of accident and emergency attendances in 2014-15 reported 19.6 million attendances to major emergency departments across England with an annual increase of 5.6 percent from 2013-14 (Hospital Episode Statistics Analysis 2015) (available from: https://digital.nhs.uk/data-and-information/publications/statistical/hospital-accident--emergency-activity/2013-14). Of those emergency attendances in England, sport injury cases accounted for 1.9 percent (367,093 admissions). A statistical report calculated 688,000 patients who were admitted to emergency departments with a ligament injury/ sprain across England in 2013-14 (Carl 2015) (available from: https://commonslibrary.parliament.uk/researchbriefings/sn06964/). Furthermore, a population based epidemiological study estimated the incidence rate in emergency departments of new lateral ankle sprains to be 302,000 per year in the UK (Bridgman et al. 2003).

The increased prevalence of lateral ankle sprain exerts a large burden on the national economy. For example, it is estimated that €187.2 million per year is spent on the management of sport-related lateral ankle sprains in the Netherlands (Verhagen et al. 2005; Fernandez et al. 2007; Hupperets et al. 2010). In the UK, a systematic review estimated the direct costs of lateral ankle sprain to range from $292 to $2,268 per patient (Bielska et al. 2017). However, these estimations were not found in the annual national reports, which make it difficult to precisely determine the socioeconomic impact of this injury. In addition, the national reports lack statistics on the epidemiology of lateral ankle sprains across the UK or England. The two national statistical reports from emergency departments across England do not provide specific information about lateral ankle sprain injury admissions (Carl 2015; Hospital Episode Statistics Analysis 2015). As a result, it is difficult to appropriately determine the epidemiology of this injury and estimate the related health care expenditures. Providing information about patients' demographic and clinical characteristics might be helpful for future research that is concerned with the planning of prevention and intervention strategies.

The high incidence of lateral ankle sprains demands a thorough understanding of patients' characteristics and injury/activity related factors that might affect the recovery following conservative management. In order to prevent an injury, it is very important to identify factors that are associated with that injury (Meeuwisse 1994). Understanding those related risk factors and the cause of injuries may significantly help in designing prevention programmes that will eventually improve health care quality (Barss et al. 1998), while the understanding of those patient characteristics may help construct and implement prevention programmes. Despite an extensive literature review (Chapter 1:), no study has illustrated the demographic, clinical and sport related characteristics of patients with lateral ankle sprain attending emergency departments in the UK.

To the best of this author's knowledge, this is the first study that has assessed and characterised patients admitted to the emergency department with lateral ankle sprain based on their primary sport and cause of injury in England. Such details have the potential to improve the quality of care by informing referral after triage assessment. It may also help to prevent lateral ankle sprain injury by identifying population at risk and the causes of this injury. Therefore, the main aim of this study was to determine prevalence, demographic and clinical characteristics of patients with lateral ankle sprain and to characterise them by their common cause of injury and type of sport played.

5.2 Aim

The aim of this study is to determine the prevalence, demographic, clinical and sport characteristics of patients with lateral ankle sprain.

5.3 Objectives

The objectives of this study are the following:

1. Determine the number of new patients who present with lateral ankle sprain (prevalence) to Southampton A&E department.
2. Determine the demographic and clinical characteristics of patients with lateral ankle sprain.
3. Determine the common causes of lateral ankle sprain.
4. Inform the next study (Study three) participant recruitment targets about the most commonly affected population, as defined by their primary sport.

5.4 Methods

5.4.1 Planning of study methods

The planning phase of this study consisted of five systematic steps to ensure appropriate development and execution. These included:

1. The development of the research question and aims: the research question of this study was initially developed based on the findings from literature review. There is lack of evidence related to the demographic and clinical characteristics of patients presenting at emergency departments with lateral ankle sprain in the UK. Therefore, this study was conducted to explore and determine those characteristics and discuss them in relation with the existing literature. Such evidence was also essential to inform the methodology of the third study of this thesis by determining the burden on emergency department, in terms of patient numbers, as well as identifying the population most at risk of this injury and the discharge outcome.

2. Making contact with a staff member from the emergency department: contact was made with Professor Robert Crouch (RC), in order to have an overview of routine clinical practice in the emergency department and help with data collection. Preliminary information such as the average number of patients per month, types of cases, diagnosis recording, and discharge summaries was discussed and noted. This information was useful for making decisions about the potential study variables that could be included in the data collection and analysis. The distribution of work during the data collection and analysis was also discussed and agreed on with the local collaborator (RC). A project schedule was agreed, which included a clarification and allocation of both the workload and a proposed time deadline accordingly.

3. Deciding the study variables: a list of variables were initially drafted and discussed based on the findings from the current literature and information from the local collaborator (RC). After that, the most relevant variables were selected for data collection and analysis. The final list of study variables were either useful in scaling the burden of referrals to the emergency department or to inform the methodology of the third study.

4. The choice of the data collection method: the study employed a retrospective chart review of patient records. This method was deemed the most appropriate method to collect data from a large sample of patients in the emergency department (Gilbert et al. 1996), since information about study variables are readily available and can be retrieved from the online database of patient records.

5. Deciding data collection schedule, the interval and time schedule for the data collection was collaboratively agreed on by the researcher and the local collaborator (RC). The schedule consisted of three segregated research work missions: activities that were solely conducted by the investigator, activities that were solely conducted by the collaborator, and activities that were jointly conducted by both of them. Due to ethical considerations, it was also agreed that the collaborator would handle identifiable patient records, whereas the main researcher would take over after the data had been anonymised.

6. Deciding the data transfer and analysis: a staff nurse from the emergency department initiated the data transfer and provisional analysis. After that, the researcher (SB) completed the analysis and presented the findings in the form of descriptive statistics.

5.4.2 Research design

This study employed a cross-sectional descriptive epidemiological study design (retrospective review) to determine the prevalence and characteristics of new patients with lateral ankle sprain seen at the emergency department of Southampton General Hospital (SGH). This study was conducted to help scale the problem by determining the prevalence of new cases of lateral ankle sprain. It will help in counting and characterising the patient admissions to the emergency department of University Hospital Southampton. The main outcomes from this study were the occurrence of new cases, and the identification of the demographic and clinical characteristics of lateral ankle sprain.

The study of measuring how frequent a disease is and why it manifests in a particular population is called epidemiology (Coggon et al. 2003). Information provided from epidemiological studies helps to devise health care strategies in terms of disease prevention and management of the population in which the disease occurs. Furthermore, the results of epidemiological studies provide knowledge of the population at risk of a disease, how widespread a disease is, and quantifies and scales an epidemic or a disease. In turn, knowing this kind of information helps healthcare authorities to determine the costs to health services and allocate resources such as manpower, funds and patient support appropriately. It can also, if risk factors are identified, reduce the number of new cases, and therefore reduce health care expenditure.

Epidemiology is also defined as the “study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems” (WHO 2016). A key feature of epidemiological studies is that the findings must relate to a defined population at risk of a disease or injury (Coggon et al. 2003). As was stated earlier, emergency departments were found to be the most appropriate source for recruitment, therefore one was selected for this study. As a result, the different demographic and clinical characteristics of the concerned population were able to be identified and explicitly described.

When studying a population, it is essential to first identify them by identifying some common characteristics of people of that population. As a result, a study sample can therefore be selected and then investigated, based on a specific research question. The results from the selected sample will eventually represent the entire source population. The baseline or initial characteristics that define a particular population might be geographical, occupational, age related, disease or injury specific or sex specific. For instance, the characteristics of patients that defined the source population in this study were men and women (sex specific) aged 14 and above (age related) from Southampton (geographical) who had lateral ankle sprain injury (disease or injury specific) and attending the emergency department of Southampton General Hospital (health care provider) as illustrated in Figure 5-1.

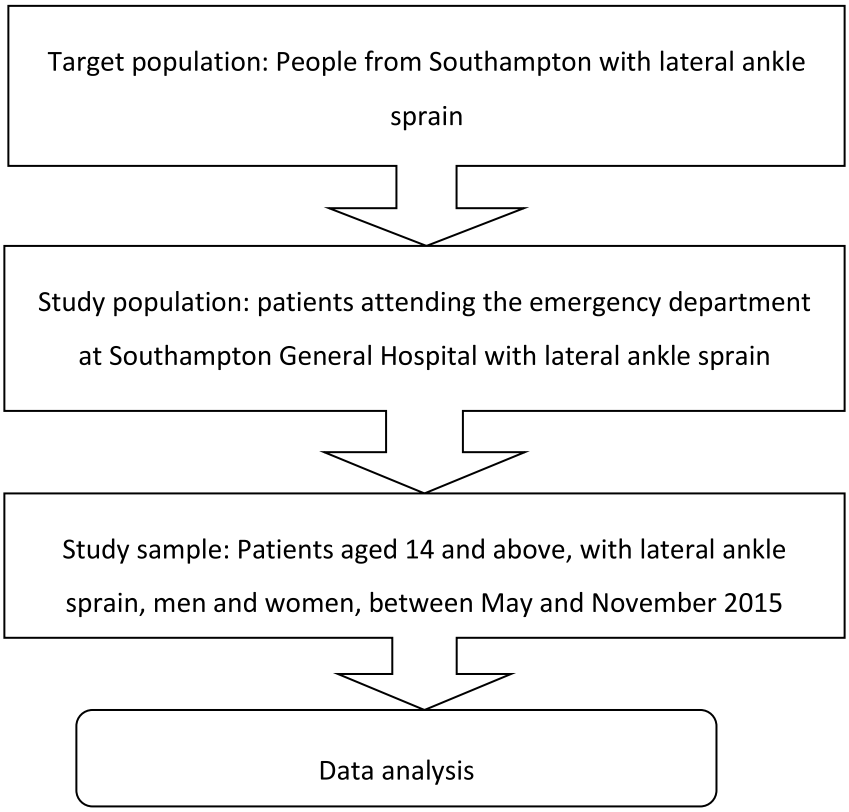


Figure 5-1 Defining the study population.

Epidemiological studies differ from clinical studies in terms of the scope of the implication of the study findings. The main difference is that epidemiological studies primarily determine a decision about a group of people rather than about individuals (Coggon et al. 2003). Therefore, the appropriate method to know about the distribution (frequency and pattern) of a specific disease or an injury in a large population is to conduct an epidemiological study. It will help to scale (prevalence) and identify the unique characteristics of that specific population. One of the methods used to achieve that purpose is to investigate a sub sample (study population) in order to understand and control and/or prevent different diseases or injuries. Many study designs exist to answer an epidemiological research question such as cross-sectional studies and longitudinal studies (Pearce 2012). Cross-sectional studies record and analyse a snapshot of data at a particular time, whereas longitudinal studies (cohort studies) involve repeated observations and/or measurements over time.

In cross-sectional studies, both exposure and outcome are recorded simultaneously (Carlson and Morrison 2009). For instance, a cross-sectional study to investigate lateral ankle sprain in a particular setting implies taking a snapshot of the data about a particular population of interest at a set point in time. The snapshot of data includes both the exposure variables (patient demographic or clinical characteristics) and the outcome (lateral ankle sprain). These two elements have already occurred in the past; thus they were retrieved to answer the research question of this study.

A primary limitation of the cross-sectional study designs is that the temporal relationship between exposure variables and an outcome might not be clear because they are simultaneously measured (Carlson and Morrison 2009). In addition, certain exposure variables might develop after the outcome of interest has been investigated. However, the nature of the temporal relationship becomes clearer if the exposure variables, like those in this study, are patient characteristics such as age and sex and documented clinical information in patient records system.

In general, data for observational studies including cross-sectional study designs can be collected from two sources: primary and secondary (Carlson and Morrison 2009). Primary data is exclusively collected to serve a specific study purpose, whereas Secondary data was already collected in the past to serve another purpose but is now used again to answer another research question. The use of either type of data depends on time constraints, research resources and the capability of the investigator to control the collection and measurement of the investigated variables (Table 5-1).

Table 5-1 The Advantages and Disadvantages of Using Primary and Secondary Data in Observational Research

Primary Data		**Secondary Data**	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
• Investigator has full control of designing, sampling, data collection and follow-up • All variables of	• Time consuming • Expensive	• Relatively fast and inexpensive • Sample sizes tend to be large • Sample may cover a large geographic area, may provide	• Data may not include all variables of interest • Maybe difficult to understand how and why data elements were

interest can be measured	ability to assess national trends • Unobtrusive to subjects	collected

This study adopted a retrospective chart review (RCR) of patients attending the emergency department with lateral ankle sprain (secondary data), as this method was deemed appropriate to address the research question of this study. In addition, it was an efficient method to explore various patient characteristics across a large number of patients and determine the trends of patient referrals to the emergency department.

A retrospective chart review, also referred to as medical record review, is a research method that is implemented to answer a specific research question (Worster and Haines 2004). It has been regarded by three emergency medicine journals as a major method for collecting data from emergency departments (Gilbert et al. 1996). Furthermore, data from online databases, patient notes and tests results can be a valuable data source to inform epidemiology of a specific disease or injury, and subsequently inform future prospective research. Indeed, one primary purpose of conducting this RCR is to inform the methodology of the next study in this thesis (study 3). However, it is very important to appropriately plan and execute the process of data collection in order to produce rigorous findings (Table 5-2), therefore a summary of considerations were listed to ensure good results were achieved from the RCR studies (Vassar and Holzmann 2013). Then, as much as possible, those issues were considered during the planning phase and execution of this review.

Table 5-2 A Summary of Considerations for Designing RCR Studies

1	Create well-defined, clearly articulated research questions
2	Consider sampling questions a priority
3	Operationalise variables included in retrospective chart review
4	Train and monitor data abstractors
5	Develop and use standardized data abstraction forms
6	Create a data abstraction procedure manual
7	Develop explicit inclusion and exclusion criteria

8	Address interrater and intrarater reliability
9	Conduct a pilot test
10	Address confidentiality and ethical considerations

Adopted with permission from (Vassar and Holzmann 2013)

5.4.3 **Setting**

A retrospective review of the patients' records from the patients' database system (Symphony) was conducted to explore the demographic and clinical characteristics of patients with lateral ankle sprain. "Symphony" is an electronic patient record system designed to store and manage patients' data in emergency departments in the UK. The study took place at the emergency department in the city of Southampton, UK.

The Emergency Department of SGH provides assessment and treatment for patients with serious injuries 24 hours a day, 365 days of the year (University Hospital Southampton NHS Foundation Trust). It manages in excess of 100,000 patients a year, serving the City of Southampton and wider rural area, which combined have a population of approximately 1.9 million. Furthermore, it is the Major Trauma Centre for the Wessex region covering a population of approximately 3 million. The department consists of a number of discrete areas: Majors (where patients who have presented with significant illness or injury are assessed), a resuscitation room, a Minor injury/illness receiving area, two clinical decision units and a paediatric emergency department within the overall unit.

From the clinical experience of the researcher, most patients with lateral ankle sprain attend emergency departments (ED) rather than their GP or a physiotherapy clinic. It was also noted, in a planning meeting, with the local collaborator (RC) in the ED of SGH that more than 100 patients present with lateral ankle sprain per month for treatment at the ED. This was verified in the third study of this thesis, since when the researcher approached local physiotherapy clinics and GPs, they stated that they receive few patients with lateral ankle sprains. That could be the reason for the increased prevalence of lateral ankles sprain in the emergency departments across the UK with an incidence rate of 60.9 per 10 000 (Bridgman et al. 2003). A Systematic Review and Meta-Analysis of Prospective Epidemiological Studies also found a pooled incidence rate of 0.54 per 1,000 cumulative units of exposure in low-quality studies and 11.55 per 1,000 cumulative units of exposure in high-quality studies (Doherty et al. 2014).

5.4.4 **Participants**

The review included data from patients admitted to the emergency department of SGH with lateral ankle sprain between May and November 2015, inclusively. Patients were included if they were diagnosed with lateral ankle sprain and aged 14 and above. The start age of 14 years was chosen. All records within that time period that had a diagnostic code of ankle sprain were retrieved and included in the analysis. All cases were included in this study whether they had been seen by a triage nurse only or other health care professionals. The triage nurse might have decided to refer a patient to be seen by other health care professionals based on initial screening and examination. The included patient records were anonymised and coding was allocated to each individual patient record.

5.4.5 **Sampling**

All the records for patients who presented at the emergency department with lateral ankle sprain between May and November 2015 (inclusive) were studied. A total number of 909 patient records were identified by combining the diagnostic codes: “lower limb-ankle” and “sprain” in the online patient record database. These records were considered for descriptive statistics including: prevalence, age, sex, attendance outcome, radiography referrals and arrival date and time. At this stage, all the patient records that met the inclusion criteria (n=909) were transferred from an electronic copy onto an Excel spreadsheet for the purpose of data analysis.

To answer objective 3, a subsample from the total number of records was manually reviewed to determine the common causes of injury and sport type. This subsample was decided because only direct health care staff who work in the mentioned emergency department can access identifiable patient records. As a result, since the researcher (SB) was totally dependent on the collaborator in the emergency department (RC), who works in a very busy setting, it made a manual review of all cases not possible. Therefore, a subsample of 106 patient records was selected using the stratified sampling method. Therefore, a sample of 106 patient records was drawn to obtain descriptive statistics of these two variables. This sample (n=106) was chosen according to the formula proposed by Morisette and Khorram (1998). The width of the confidence intervals (CI) is expected to be no wider than 0.19 (or +/- 0.39) based on predefined proportions that 49.3% of lateral ankle sprain are caused by sports (Waterman et al. 2010).

A stratified random sampling method was used to select the subsample from the original study sample (n=909). Firstly, the number of patient records (N) was divided into 4 separate age groups (strata). The age groups were: teenagers (14-17 old), young adulthood (18-35 years old), middle age (36-55 years old) and older adulthood (56 years and older). These age groups were similar to those reported in previous literature (Petry 2002; Lenhart et al. 2010). This method was chosen to ensure that the subsample represented the key subgroups (age groups) including those which have a smaller number of records (Trochim 2006). The number of patient records in each age group was documented on an Excel spreadsheet. Secondly, the representing percentage was calculated by dividing the number of records in each individual age group by the total number of records in the original sample, as illustrated in Table 5-3.

Table 5-3 The Representing Percentage of Records for Each Age Groups of the Subsample (n=106).

Age groups	No. of patients in each age group (n)	No of subsets of n from N = %	No. of records to be sampled from each age group	Intervals of selection in each group
14-17 years	122	13.42%	14	Every 8 records
18-35 years	499	54.89%	55	Every 9 records
36-55 years	212	23.32%	23	Every 9 records
>55 years	76	.08%	8	Every 10 records
Total number	909		106	

Thirdly, a systematic random sampling method was followed to select records from each group. The intervals of selection was determined by dividing the number of patient records in each age group by the number of records to be sampled from them (Trochim 2006).

5.4.6 **Ethics approval**

Ethics approval for this study was sought from the University of Southampton, as well as from the NHS. The study was firstly submitted to Ethics and Research Governance Online (ERGO) on 25th February 2016 for ethics approval and sponsorship. It received approval from the university ethics committee (ERGO) on 9th of March 2016 (REC No 18515). Then it was submitted for NHS ethics approval via the Integrated Research Application System (IRAS) on 24th March 2016. As a result, it received a “favourable opinion” from the NHS REC on5th April 2016 (IRAS ID 202053). After that, it was submitted to the Health Research Authority (HRA) on 25th April 2016 for approval. Eventually, it received IRAS ethics approval on 8thAugust 2016 (Appendix 5 and Appendix 6).The whole process of obtaining ethics approval for this study took almost 6 months.

5.4.7 **Access to setting and data**

After receiving ethics approval, several steps were followed in order to gain access to the emergency department and study the data:

1. Contact was made with the local research and development office (R&D) based at Southampton General Hospital. This office was approached to apply for a “research passport” and “letter of access” in order to get access to the emergency department, as well as to the study data (Appendix 9). This passport was obtained because the researcher (SB) is not part of the direct health care team at the emergency department. The researcher also completed Good Clinical Practice” (GCP) online course to ensure that the researcher is aware of the rights, safety and wellbeing of the participants involved in the research (Appendix 7 and Appendix 10).

2. After meeting the requirements for a research passport, a letter of access to collect data from the emergency department was received on 23rd August 2016**.**The letter of access is required to enable researchers from higher educational institutions to enter and collect data from NHS premises.

3. Finally, the local collaborator at the emergency department (RC) was contacted again to agree on the start date for the data collection. A preliminary meeting was conducted to discuss and agree on how the data was going to be collected. An appropriate time to come to the emergency department and carry out data collection was also agreed on.

5.4.8 **Procedure**

Data of patients diagnosed with lateral ankle sprain between May and November 2015 (inclusive) were reviewed and retrieved from the emergency department electronic database (Symphony). The whole data collection process was carried out from September to November 2016. Both the researcher (SB) and local collaborator (RC) conducted a meeting to discuss the procedures to identify and retrieve data from the eligible records. In addition, the search mechanism of the patients’ records system and how the data would be identified among all the records in the system was constructed.

The process of data collection was conducted in two phases. Firstly, all the records for patients who had presented at the emergency department with lateral ankle sprain were identified and selected for statistical analysis. The variables of interest were: age, sex, radiography referrals, arrival date, arrival time and disposal outcome. Secondly, a subsample was manually reviewed (in the form of anonymised paper records) in order to determine the common causes of injury and sport type.

5.4.8.1 **Phase 1**

The local collaborator (RC) started the search procedure of all the records that had been recorded on a daily basis by clinical staff at the emergency department. All the records that had been stored in the patients’ record system between May and November 2015 (inclusive) were identified and considered for screening (Figure 5-2). Firstly, eligible records that met the inclusion criteria in this study were identified by (RC) by combining the diagnostic codes: “lower limb-ankle” and “sprain” in the online search. Patients with injuries or diseases other than lateral ankle sprain were immediately excluded. The age of patients was also specified as being from 14 years old and above. Then anonymity coding for each record was assigned by (RC) to maintain the confidentiality and privacy of patients’ records and to comply with ethics recommendations. Information including a patient’s name, address, phone/fax number, email address, full postcode, NHS number, any other identifying reference number, photograph and names of relatives were removed from the identified records. A random number was allocated to each individual record. In short, only the relevant information related to the study variables could be retrieved from the online patient record system. All these steps, including identifying eligible records and the selection of study variables, were created electronically. Then the anonymised data was transferred onto excel spread sheets and handed over to the researcher (SB) for the purpose of the statistical analysis of the study variables, specifically: age, sex, radiography referrals, arrival date, arrival time and disposal outcome.

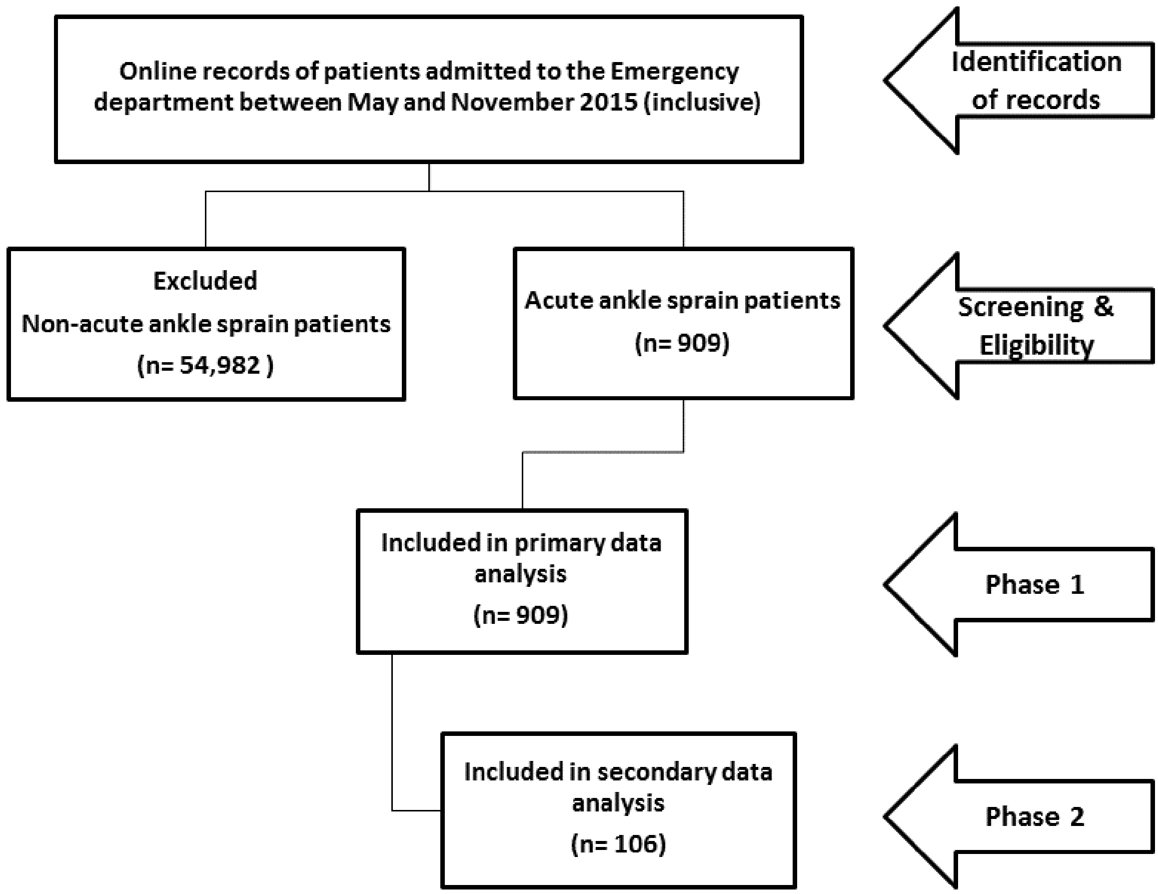


Figure 5-2 The process of screening and inclusion of patients' records.

5.4.8.2 **Phase 2**

In this phase, a subsample of records was randomly selected from the total sample that was identified in phase 1. The selected records were printed and manually reviewed in order to obtain information about the common causes of injury and type of sport being played at the time of injury, since details on the cause of injury and sport type could not be collected directly from the electronic data, as they were not able to be identified through the automated search. These two variables had been documented by individual clinicians on the patients records, thus they could only be identified by conducting a manual search of each individual patient record. Therefore, a subsample was selected across all the age ranges from the original electronic sample. Please refer to 5.4.5 for more details. As these two variables were collected from the original identifiable patient notes, the local collaborator (RC) identified and selected records that were included in the subsample. Then, the selected patient records were printed out from the online system. Those records were also anonymised before they were submitted to the researcher (SB). Patients' personal details were removed from these records and random numbers were allocated to each individual record. The researcher (SB) reviewed the selected records and the relevant statistical analyses were carried out. Once all the information had been extracted, all the paper records were destroyed by the local collaborator (RC).

5.4.9 **Data analyses**

The data gathered from this study was transferred from the patient records system (Symphony) onto excel spread sheets for descriptive analysis. Descriptive statistics were obtained using excel (2013) and/or SPSS statistical package software (version 21; SPSS Incorporation). Variables included in the analysis are the number of new lateral ankle sprain cases during the specified period (May –November 2015) patients' demographic and/or clinical related data, common causes of injury and sport type (Table 5-4).

Table 5-4 Explanatory Variables.

Variables	**Integer**
Age	Years , 14 and over: Injury risk increases dramatically from age of 14 onwards (Backous et al. 1988; Cloke et al. 2009; Cloke et al. 2011; Lambers et al. 2012) . Therefore, it was an opportunity to compare the results within the chosen population in this study.
Sex	Men, Women
Attendance outcome	No follow up, to A/E clinic, to fracture clinic
Arrival date	Month, day
Arrival time	Time, Hour/minute
Cause of injury	Walking, running, jumping, playing, Dancing, playing sport
Sport type	Football, Basketball, Volleyball etc.

Descriptive statistics were recorded to determine the demographic and clinical characteristics of patients and the common causes of injury and sport type resulting in lateral ankle sprain. The choice of statistical analysis was based on the type of study variables. For continuous variables such as age, means and standard deviations (SD) were calculated for normally distributed data, otherwise a median and IQR were calculated. For categorical variables such as sex, cause of injury and sport type, frequencies and percentages were calculated. All procedures of data analyses were developed in discussion with a statistician from the school of health sciences (Appendix 11).

5.5 Governance

The researcher (SB) is a qualified and experienced physiotherapist and was aware of the ethics guidelines and professional code of conduct as specified by the university throughout all stages of this project: (http://www.southampton.ac.uk/ris/policies/ethics.html).

5.5.1 Data management

All the data collected from this study was managed in accordance with the ethics guidelines, professional code of conduct and the data protection act (1998). The personal data related to individuals was handled carefully solely within the direct care team and in accordance with the

Data Protection Act 1998. The confidentiality of participants was maintained and the privacy of participants was protected in any publication arising from the research.

The data is stored in compliance with the Data Protection Act and in accordance with the University of Southampton Research Governance Office policy. The researcher (SB) kept the collected data in a password protected excel sheet/SPSS program stored in a password protected file in a secure encrypted hard drive owned by the researcher. The researcher (SB) acknowledges that all data obtained from the hospital patient record system is anonymous, as only one member from the direct care team (RC) sourced identifiable data from the patient record system, as well as also coding all the records before submitting it to the research team.

This data was shared with the study management team (CB, MW and LG) and a statistician from the University of Southampton (SE) to provide support with the data analysis. The collected data has been kept in a password-protected University PC for no more than 10 years, according to the University of Southampton Ethics and Research Governance policy. After 10 years, the University Estate and facilities at the University of Southampton will destroy all study data carefully, as they provide a service for the removal of confidential waste. They define confidential waste as "material containing sensitive personal or business sensitive data which requires destruction to ensure that the contents remain private in order to comply with the Data Protection Act". In addition, the local collaborator (RC) immediately destroyed the printed patient records that were used in determining the cause of injury and sport type.

5.5.2 Operational definitions of the study variables

- Age: how old the patient was at the time of admission to the emergency department with lateral ankle sprain.
- Sex: set of biological characteristics that determine the sex of patients, categorised as men or women.
- Radiography referrals: number of patients with lateral ankle sprain that were sent to the radiography department for a foot or ankle x-ray
- Attendance outcome: the discharge decision taken by the attending clinician or triage nurse based on the initial or clinical examination.
- Attendance day and time: the date and time when the patient presented at the emergency department with lateral ankle sprain.

- Cause of injury: specific external contributing factors that rendered the lateral ankle sprain to occur.
- Sport type: the primary sporting activity that was being practised by the individual patient, as recorded in the patient records.

5.6 **Results**

In total, 909 new cases of lateral ankle sprain out of 54,982 (the total number of patients admitted to the emergency department) were identified in the in the online database search. As is routine practice in emergency departments, patients were first assessed by a triage nurse to evaluate the severity of their injury before further action and/or referral was decided. In general, those patients who present with more severe symptoms are sent to a clinician for further assessment and/or referral. This study included all patient records, regardless of whether a triage nurse or other health care professionals saw them. The prevalence of new patients attending the emergency department of Southampton General Hospital between May and November 2015 was calculated by the following formula:

$$\frac{Number\ of\ ankle\ sprain\ patients\ between\ May\ and\ November\ 2015}{Number\ of\ all\ patients\ admited\ between\ May\ and\ Novermber\ 2015} \times 10^{n}$$

*The value of 10^n set to be 100 (Department of Health and Human Services 2011)

$$\frac{909}{54982} \times 100$$

$$= 1.7$$

Therefore, this study determined a prevalence rate of 1.7% for new lateral ankle sprain cases attending the emergency department of Southampton General Hospital between May and November 2015. The results from this study also included information about the age and sex of attending patients, radiography referrals, attendance outcome, attendance day and time, cause of injury and sport type.

5.6.1 **Age**

Patients who attended the emergency department had a median age of 27 years old (IQR 20), with ages ranging from 14 to 92 years old, and with a peak prevalence between 19-23 years old

(22%) (Table 5-5). The age of patients was not normally distributed therefore median and interquartile range were used to describe the data.

In younger ages (14- 37 years old), men had a higher prevalence of injury than women did. However, in older ages (38-92 years old) women had a higher prevalence than men did. The distribution curve showed a positive skewness indicating that most of those who sustained lateral ankle sprain in the study period were young patients (Figure 5-3).

Table 5-5 The Descriptive Statistics of the Age of Patients

N	909
Median	27
IQR	20
Minimum	14
Maximum	92

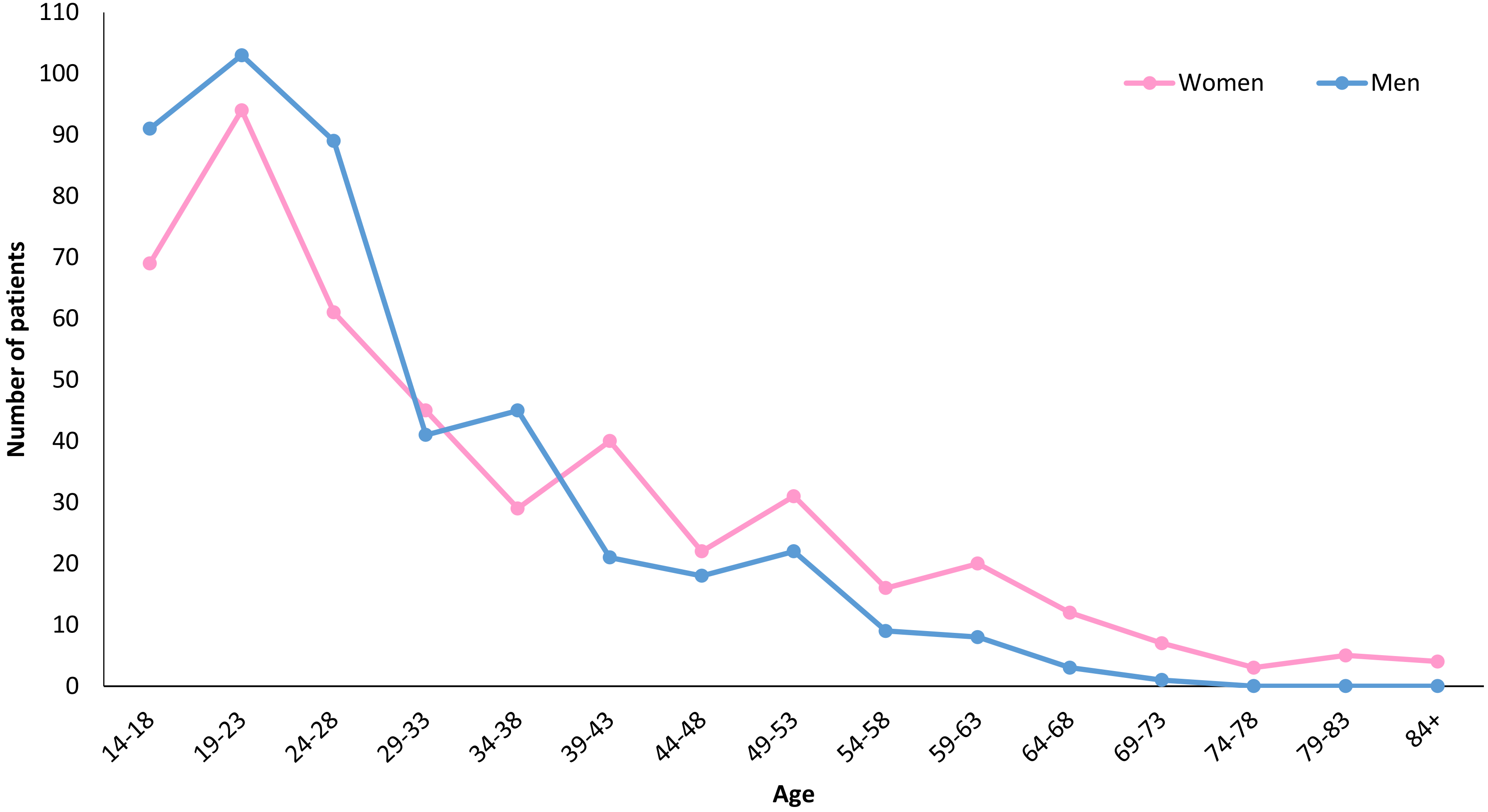


Figure 5-3 Age-sex specific rates of ankle sprain patients.

5.6.2 **Sex**

The prevalence of injury was equally distributed between men and women (Figure 5-4), with 451 lateral ankle sprains having been sustained by men, and 458 by women.

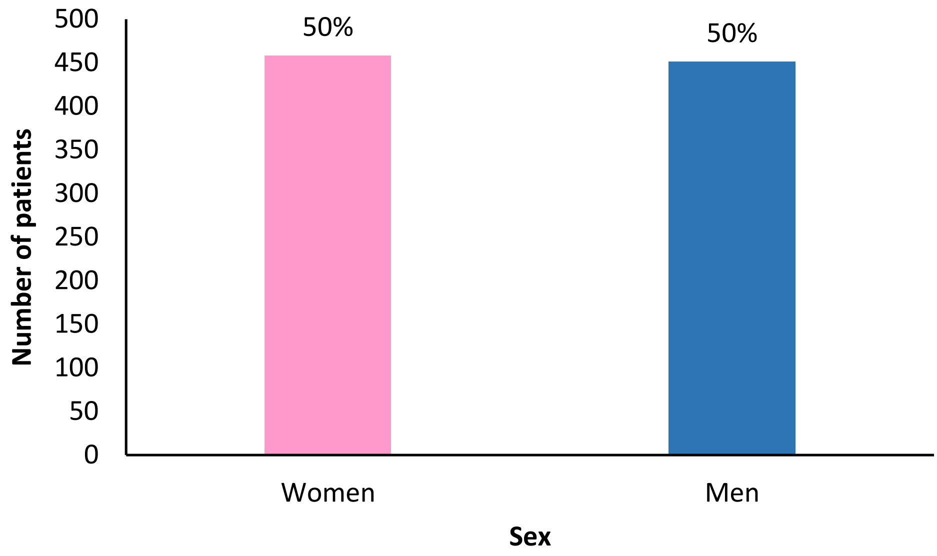


Figure 5-4 The prevalence rates for female and males patients.

5.6.3 **Radiography referrals**

Eighty-nine percent (n=808) of patients who attended the emergency department with lateral ankle sprain were referred to the radiography department for a foot or ankle x-ray during their initial visit (Figure 5-5).

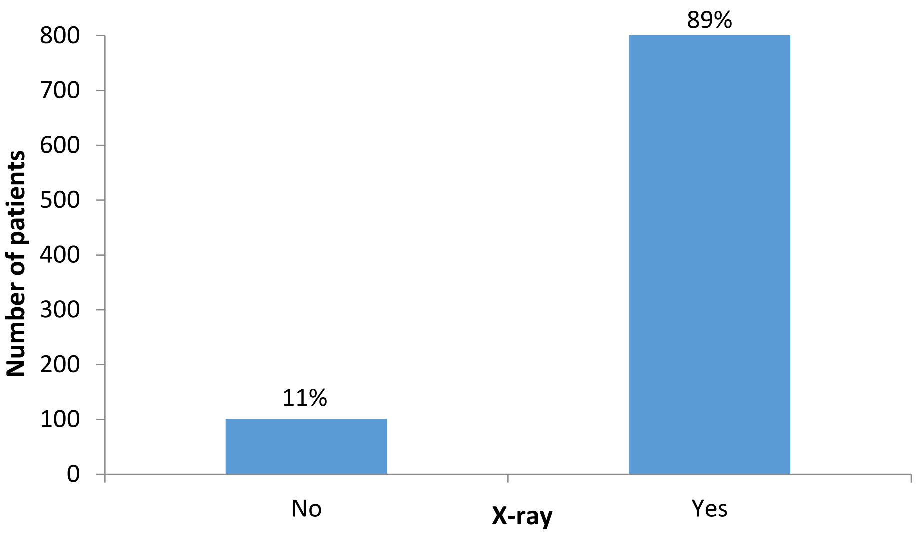


Figure 5-5 Radiography referrals.

5.6.4 **Attendance outcome**

As part of the daily routine in the emergency department, patients are either discharged home or referred to another health care provider by the end of their assessment and treatment. The results of this study showed that:

- About 58% (n= 528) of patients were sent home with no follow up treatment.
- About 22% (n=200) were referred to the emergency department follow-up clinic.
- About 15% (n=132) were discharged with instructions to visit their GP for a follow up.
- About 2% (n=20) were admitted to a hospital bed/became a lodged patient of the same Health Care Provider.
- About 2% (n=17) were referred to the fracture clinic.
- About 1% (n=7) were referred to another outpatient clinic.
- About 0.3% (n=3) were referred to another health care professional.
- About 0.2% (n=2) left the department before being treated.

5.6.5 **Attendance month, day and time**

The daily and hourly attendances in the emergency department are shown in. The busiest day was Sunday with a peak of 157 patients. The lowest number of patients (n=95) attended on Saturday. On Sunday, the maximum number of patients attended at 11 am (n=16) and the minimum number of patients attended at 12, 5 and 6 am (n=1, each hour).

In terms of monthly attendances, the maximum number of patients was in July (n=157) and the minimum was in November (n=100).

5.6.6 **Common cause of injury and sport type**

One hundred and six patient records were selected from the original study sample. This subsample was considered for further analysis to determine details that could not be extracted from the automated data search. Knowing both the cause of injury and sport type was important to inform the following study in this thesis in terms of identifying study population and potential sources for recruitment. Those patient records were manually reviewed to identify a common cause of injury and sport type. The selected sample included 59 women and 47 men (Table 5-6). Most of the patients in this sample shared a common mechanism of injury, which was inversion injury (n=104). Results showed a variety of causes of injury across the selected sample (Figure 5-6). Tripping represented the most common cause for patients included in this review (29%). Other common causes were inversion non-specific injury (26.4%), playing sports (26%), inversion injury while walking (12.2%) and other accidental causes (6%). Please refer to Appendix 8 for more details about other accidental causes.

Table 5-6 The Number of Male and Female Patients in the Selcted Sample (n=106).

	Frequency	Percentage
Women	59	55.7%
Men	47	44.3%
Total	106	100%

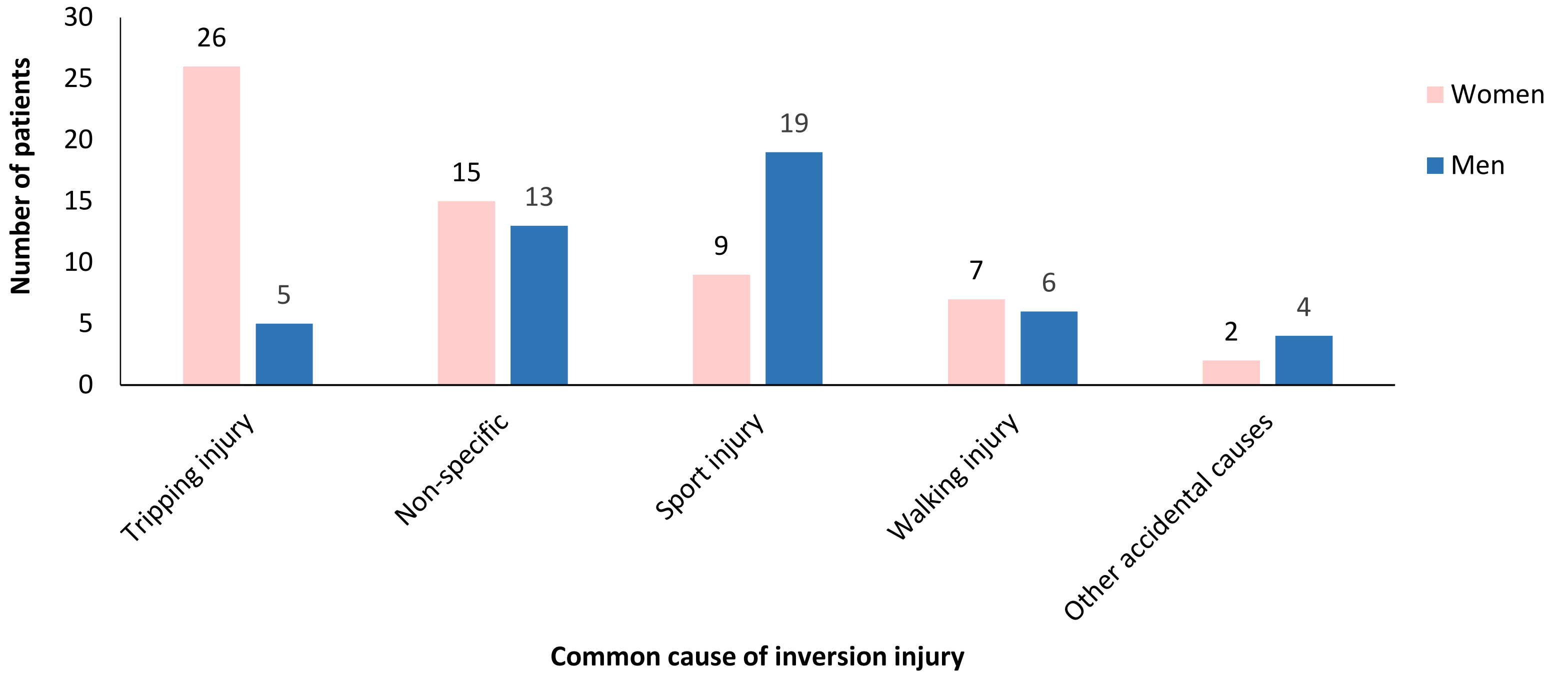


Figure 5-6 Common causes of inversion injury (n=106).

Of those who reported sport as the cause of injury, the leading sport activity that cause most patients to sustain lateral ankle sprain was football (n=14), followed by non-specific sport (n=8), basketball (n=3) and netball (n=2), as illustrated in Figure 5-7**.**

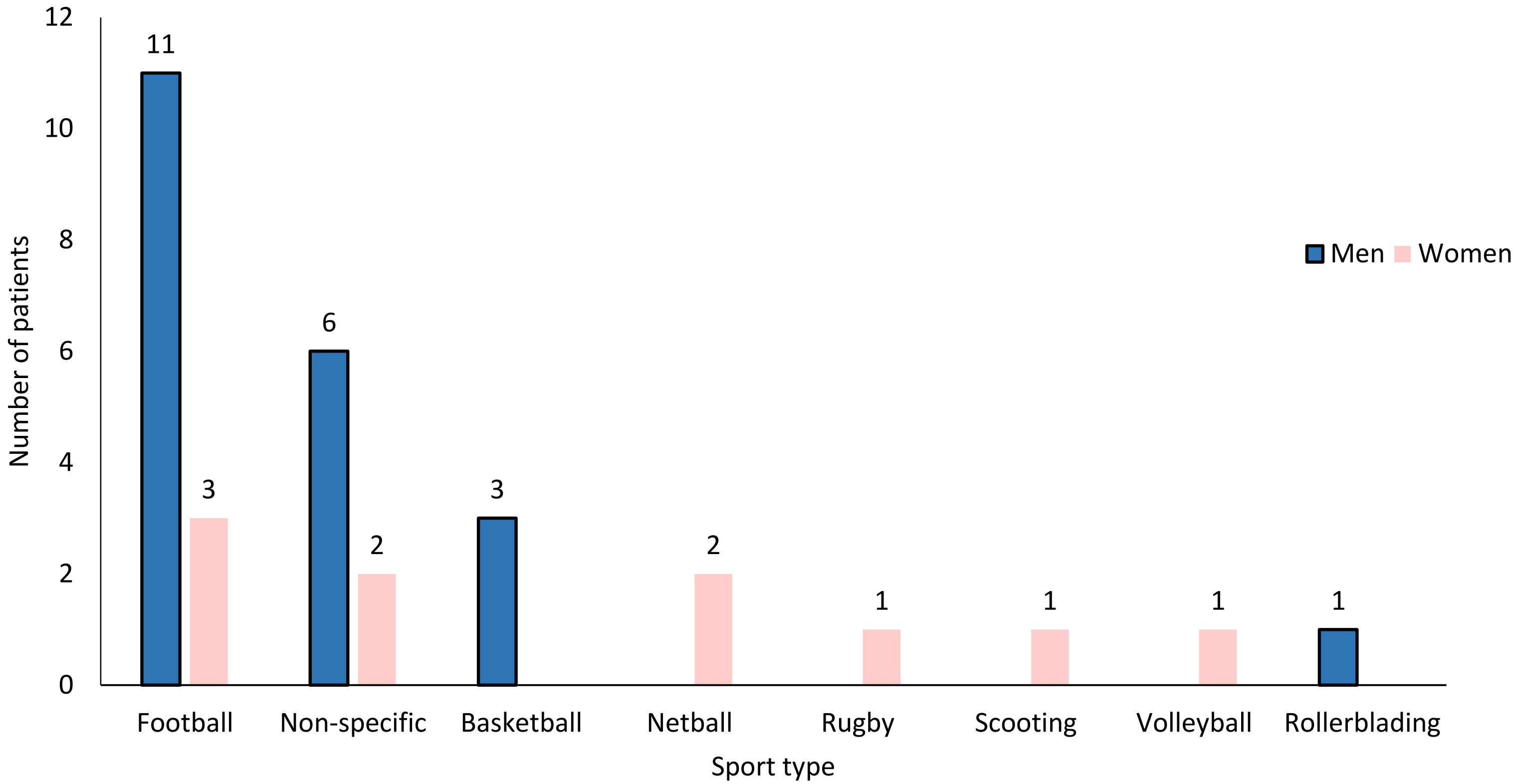


Figure 5-7 Sport type of those patients who reported sport as a cause of injury (n=106).

5.7 Discussion

This is the first study in the UK in a decade and the first in the south of England to illustrate both the demographic and clinical characteristics of patients reporting to a UK emergency department with lateral ankle sprain. It has expanded on the results of a previous study in the UK that determined the prevalence of lateral ankle sprains and severe lateral ankle sprains for a geographical population attending emergency units in the West Midlands of England (Bridgman et al. 2003). Between April 2000 and March 2001, they recorded 5,776 new cases of lateral ankle sprain across four health districts, specifically: Dudley, Sandwell, Walsall, and Wolverhampton. This particular study (Study two) determined the prevalence of new lateral ankle sprain patients (n=909), whilst also describing the demographic and clinical characteristics of those patients. It investigated patients' demographic characteristics, routine ankle radiography referrals, attendance outcome and attendance day, time and month. In addition to this, the common causes of injury and sport type were investigated in order to provide precautionary measures for a similar population. The results of this study informed the methodology of the third study in this thesis.

5.7.1 Prevalence

This study identified 909 cases of patients attending an emergency department due to lateral ankle sprain between May and November 2015. Patients' details were routinely recorded on an online database, "Symphony", and allocated a diagnosis code (Lower limb-ankle and sprain). The descriptive analysis of those cases showed no definite increasing or decreasing trend in the number of patients from spring to winter, as by comparing the number of patients per month, it showed that there were more attendances in May, July and September (141, 157 and 152, respectively), compared to June, August, October and November (123, 109, 127 and 100, respectively). In the UK, two statistical reports, the first by the Health and Social Care Information Centre (Hospital Episode Statistics Analysis 2015) and the second by the House of Commons Library (Carl 2015) provided detailed statistics about patient admissions to emergency departments across England for the financial year 2014/15 (April 2014-March 2015). They documented that 367,093 patients presented with sport injuries (Hospital Episode Statistics Analysis 2015) and 688,000 patients with ligament injury and/or sprain (Carl 2015). However, their results were not comparable to the data from this study, as this study (study two) focused on investigating the epidemiology specific to lateral ankle sprain, whereas those reported presented data for a whole set of injuries such as "sport injuries" and "ligament injury/sprain". In that sense, it is difficult to obtain comparable statistics and reach a conclusion regarding the prevalence of lateral ankle sprain in emergency departments at a national level in the UK. Providing detailed statistics may, therefore, be helpful in terms of devising preventive strategies, as well as establishing the distribution of resources across emergency departments. In this study, a prevalence of 1.7% was recorded for new patients with lateral ankle sprain. From the literature review, there is a lack of evidence to determine the number of patients attending emergency departments with lateral ankle sprain. This information would be helpful to scale the epidemiology, and thus construct relevant prevention programmes.

5.7.2 **Age**

This study included a wide age range from 14 to 92 years old. Over half of lateral ankle sprain injuries (65%) occurred in young patients aged between 14 and 33 years old. The peak prevalence of lateral ankle sprains was found to be between 19-23 years old (22%). Similar results were seen in patients that attended emergency departments in the US (Waterman et al. 2010) and in the UK (Bridgman et al. 2003; Cloke et al. 2009; Cloke et al. 2011) as illustrated in Figure 5-8 and Figure 5-9. They found that the peak prevalence of lateral ankle sprains occurred between fifteen and nineteen years of age (Waterman et al. 2010) and between 15 and 19 (men) and 10 to 14 (women) years of age (Bridgman et al. 2003).

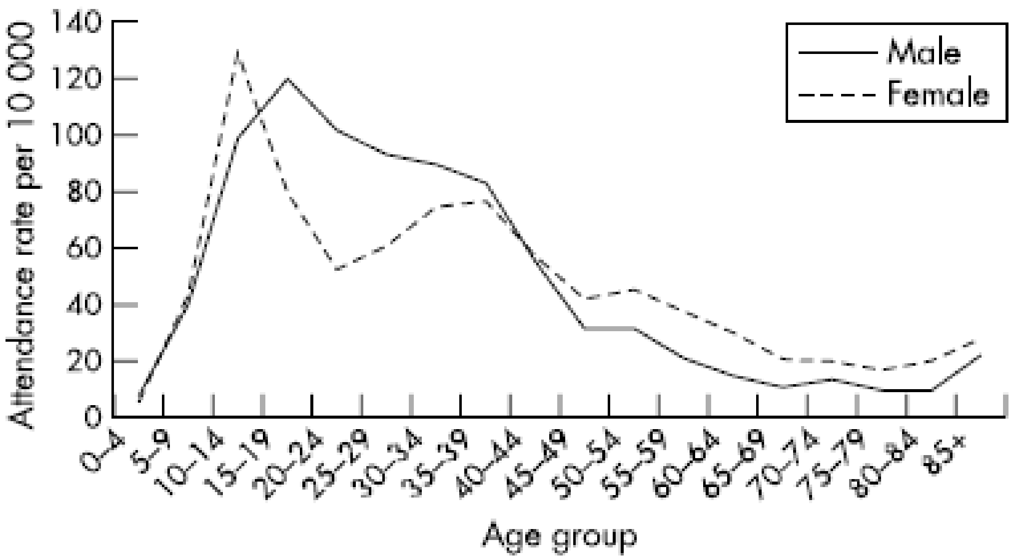


Figure 5-8 Age-sex rates of lateral ankle sprain attendances at A&E units of residents in four West Midlands health districts (1 April 2000 to 31 March 2001. Used with permission from Bridgman et al. (2003)

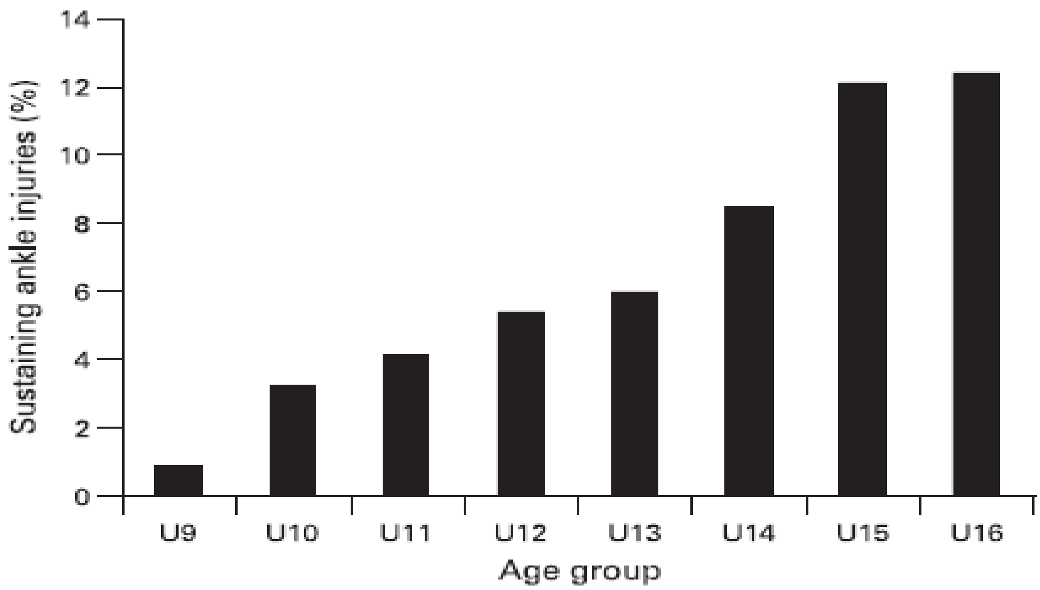


Figure 5-9 Ankle injury prevalence by age group. Used with permission from Cloke et al. (2009).

In this study, it was observed that the prevalence of lateral ankle sprain increases proportionally with age by year in patients between 14 to 23 years old. Similarly in the UK, epidemiological studies showed a proportional increase in the incidence of ankle injuries, including lateral ankle sprain, with age in players at football academies aged between 9 and 18 years old (Cloke et al. 2011) and 9 to 16 years old (Cloke et al. 2009). The distinguishable proportional increase in the incidence of injury in relation with age in young players can be explained by older boys play with more speed, strength and generate more tackling force during sport activities (Price et al. 2004; Caine et al. 2008). The increase in the incidence of lateral ankle sprains in the younger population (14-23 years) requires those who set training programmes, schools' administration, sports medical teams and sport academies to take immediate precautionary measures to reduce the occurrence of this injury. Such measures might be in the form of prevention programmes, appropriate rehabilitation and timely RTP in order to reduce the risk of sport injuries including lateral ankle sprains (Thacker et al. 1999; Hootman et al. 2007; Soomro et al. 2016).

5.7.3 **Sex**

The prevalence of lateral ankle sprain for men and women in this study was relatively equal (49.6% and 50.3%, respectively). Similar percentages (50.3%of men and 49.7% of women) were also noted in patients attending emergency departments in the US (Waterman et al. 2010). The current literature is divided on the role of sex on sport injuries, including lateral ankle sprains. Some studies indicated that women had a higher prevalence of sport injuries such as lateral ankle sprain (Hosea et al. 2000; Beynnon et al. 2005; Leininger et al. 2007) and anterior cruciate ligament tear(Powell and Barber-Foss 2000; Mountcastle et al. 2007; Caplan and Kader 2014). Others found no significant differences between men and women (Lauder et al. 2000; Beynnon et al. 2001; Bridgman et al. 2003; Waterman et al. 2010).

In this study, younger men (14-37 years old) accounted for a higher number of injuries (n=324) compared to women of the same age (n=269). In contrast, among those of older ages (38-92), the number of women with lateral ankle sprain was higher (n=189) compared to men (n=127). This was also the case in another study, in which men (15-20 years old) had a higher incidence of lateral ankle sprain injuries than women of the same age (Waterman et al. 2010). It might be that men at younger ages generate more tackling force especially in contact sports and cause more sport injuries (Price et al. 2004; Caine et al. 2008). In addition, women aged above 30 years had a higher incidence of lateral ankle sprains than men (Waterman et al. 2010). Other studies showed a higher incidence of lateral ankle sprain injury in women after the age of 40 years old, compared with their counterparts of the opposite sex (Holmer et al. 1994; Bridgman et al. 2003). The reason for this could be a fluctuating hormonal cycle in women at older ages, which is associated with joint laxity, thus their ligaments become more susceptible to injury (Heitz et al. 1999).

Across England, about 56% of people aged between 16 and 25 years take part in sports at least once a week (Sports England 2016) (Figure 5-10), and younger men are much more likely to participate in sports than women (41% and 32%, respectively), although this difference declines with age. This could explain the increased prevalence of lateral ankle sprain in younger men compared to women. More research is required to determine the association between age and sex in individuals with lateral ankle sprain, in order to develop appropriate prevention programmes tailored to individual age and/or sex groups.

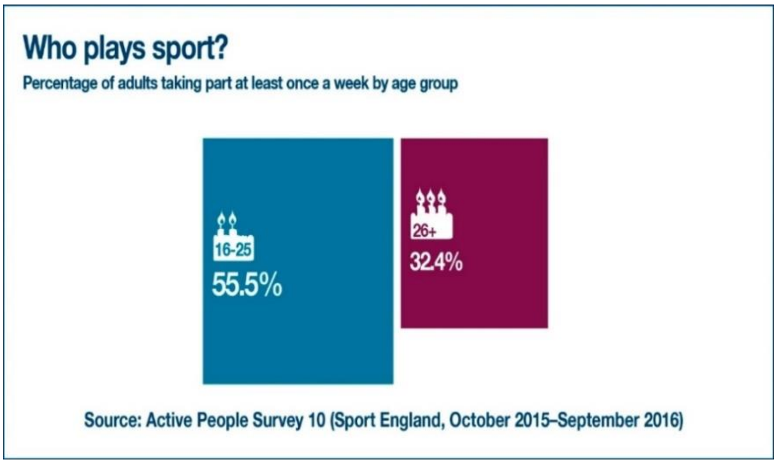


Figure 5-10 The age ratio for people who participate in sports across England. Used with permission from (Sports England 2016).

5.7.4 Radiography referrals

This study documented 808 patients (89%) diagnosed with lateral ankle sprain that were referred to the radiology department for foot and ankle radiographs. This is a substantial number of patients who had radiographs taken compared to those who did not. Others have also noted that high percentage (95%) of ankle radiographs taken for individuals attending an emergency department in Malta with lateral ankle sprain (Borg and Pickard 2008). In their study, two of the patients that were not referred to the radiography department fulfilled the Ottawa Ankle Rules (OAR) criteria for fractures (Figure 5-11 and Table 5-7). Of those who were sent to the radiology department, 19.4% did not fulfil the OAR criteria for ankle fractures and 32.4% did not fulfil the OAR criteria for ankle fractures. These results clearly illustrate an inconsistency in clinical practice, specifically in terms of using OAR as a clinical screening tool in emergency departments. Based on their results, they recommended an implementation strategy for OAR to be used in emergency departments that, in turn, according to their results, may reduce unnecessary radiographs by about 22% (Borg and Pickard 2008).Others also recorded an overall reduction of 28% in inappropriate practice, including failure to follow OAR guidelines (Bairstow et al. 2010).

As part of the routine assessment in emergency departments, OAR are frequently used as a clinical measure to identify those patients who may have an ankle fracture (Stiell et al. 1992). They have been found to be highly sensitive and effective in reducing unnecessary radiography, without missing any significant fractures (Leddy et al. 2002; Wynn-Thomas et al. 2002; Seah and Mani-Babu 2011; Wang et al. 2011). However, others have indicated that the possibility of a fracture occurring following lateral ankle sprain is less than 15% (Bachmann et al. 2003; Chevalier 2003). Despite this fact, most patients are referred for foot and ankle radiographs. A similar trend was observed in this study, which raises the question as to whether individuals are being referred unnecessarily. It would be useful to review all the patient records to find out how many patients had negative results once their radiographs been taken. Unfortunately, that was outside the scope of this study. It is possible that physiotherapy and podiatry clinicians could work together with emergency departments to run an educational programme followed by implementing the OAR during the clinical assessment for lateral ankle sprain patients. In addition, posters of areas of palpation could be put up in the triage and clinical areas of the emergency department to ensure proper use of this tool (Figure 5-11 and Table 5-7). Once a clear understanding of the use of OAR as an important assessment tool within current clinical practice, a patient can be properly diagnosed whether there is a fracture or not. This will in turn enhance the process of return to sports or work or daily living activities by identifying those who require longer recovery time if they have associated ankle or foot fractures.

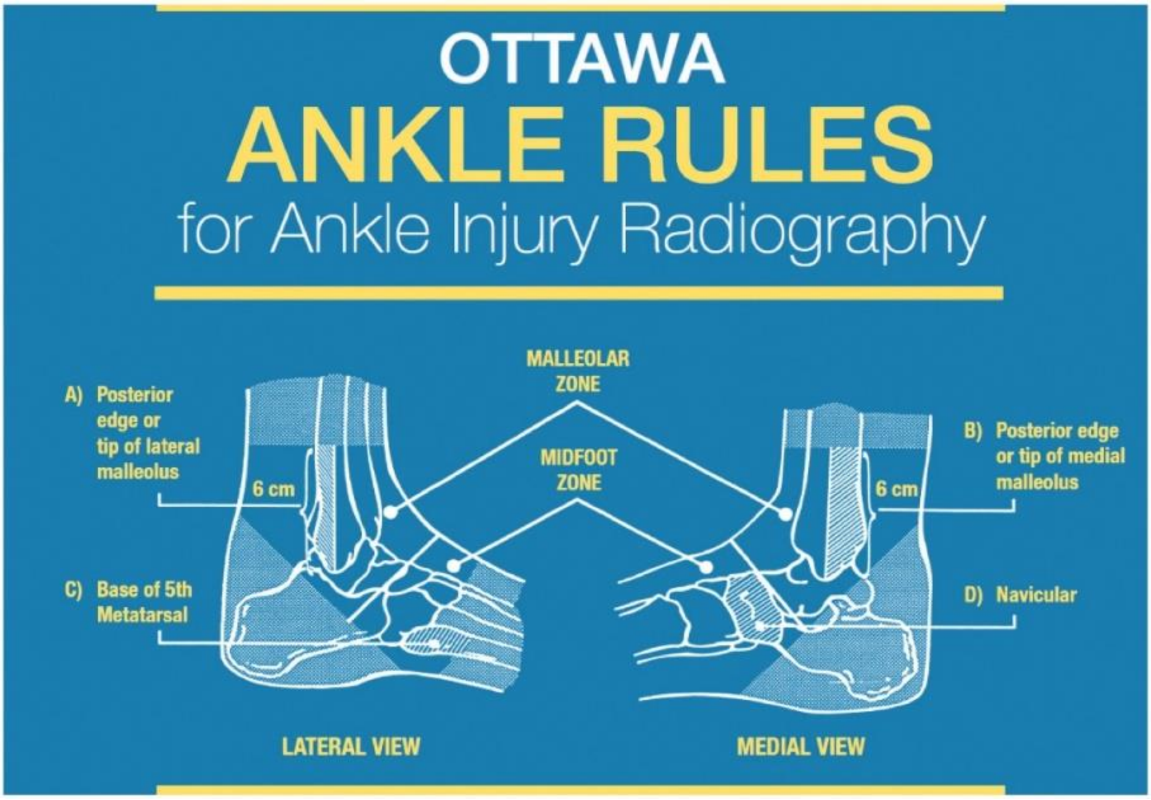


Figure 5-11 OAR: Areas of palpation. Used with permission from http://www.ohri.ca/ (accessed 24th November 2016).

Table 5-7 The Interpretation of Findings from Palpation.

a) An ankle x-ray series is only required if there is any pain in the malleolar zone and any of these findings:	1. Bone tenderness at A or 2. bone tenderness at B or 3. The inability to bear weight both immediately and in the ED
b) A foot x-ray series is only required if there is any pain in midfoot zone and any of these findings:	1. Bone tenderness at C or 2. Bone tenderness at D or 3. The inability to bear weight both immediately and in the ED

Used with permission from http://www.ohri.ca/ (accessed 24th November 2016)

5.7.5 **Attendance outcome**

As is routine practice in the emergency department setting and at the time of discharge, patients are given written discharge instructions that cover self-management and rehabilitation following lateral ankle sprain (Chorley 2005). The advice includes information about patient-oriented rehabilitation such as RICE, range of motion exercises, strengthening exercises, proprioception exercises and/ or medication. About 50% of patients in the study described were sent home with “as needed” follow up referrals. This percentage is relatively similar to that observed in this study, in which 58% of patients were sent home with no follow-up appointments. Instead, the discharged home patient in this study were provided with instruction sheet (Appendix 12) that did not contain any information about return to work/ sport/ activities which in turn may make those patients susceptible to premature return to activities and re-injuries.

To trace the course of recovery following lateral ankle sprain in these patients, a further in depth follow up study would be required, as there is no guaranteed contact with those patients once they have been discharged. Some patients may resume their normal sport, work and/or daily life activities without having fully recovered, despite the fact that evidence has shown that premature RTP maybe a potential factor for causing recurrent injuries such as hamstring injuries (Taylor et al. 1993; Engstrom and Renstrom 1998; Croisier 2004). Indeed, another study indicated that the healing process may actually take longer than clinical findings have previously indicated (Orchard and Best 2002). Furthermore, a history of injury and premature RTP has been suggested as being the strongest predictor of recurrent ankle injury (McKay et al. 2001; van der Wees et al. 2007; Malliaropoulos et al. 2009). Therefore, patients with no follow-up may return to sporting activities despite the fact that the ligament may not have fully recovered. In addition, information about return to work or sport is not given on the take home instruction sheet, consequently, important information is missing and patients may be at risk of re-injury.

5.7.6 **Common cause of injury and sport type**

A subsample of records of 106 patients was manually reviewed to identify a common cause of injury for lateral ankle sprain and the type of sport being played when the injury was sustained. Tripping was reported as the most common cause of injury (29%), whereas sport accounted for 26% of injuries. In this study it was found that there was a high number of patients (26.4%) for whom the cause of injury was not specified, although the mechanism of injury, inversion, is recorded. Although evidence has shown that lateral ankle sprain is a common injury in sports such as football (Woods et al. 2003; Nelson et al. 2007; Cloke et al. 2009), it was not possible to appropriately categorise the type of sport because it had not been documented in about a quarter of all records of the subsample (26%). It is possible that there might be more people who had sustained their injuries during a sports activity. Data from other countries also provides limited information about the cause of injury. For example, in Denmark, a prospective epidemiological study of patients attending an emergency department recorded an incidence of 7 per 1000 persons per year (Holmer et al. 1994), with about 45% of those injuries having been caused during sports activities, 20% during play and 16% during work. In addition, it was also reported that men sustained more injuries than women during sporting activities (54% and 33%, respectively). In terms of sport type, a review of high school injuries showed a higher incidence of lateral ankle sprains in basketball, American football, and women's cross-country running (Garrick 1977). Another study indicated that 50% of all patients included in the study had sprained their ankle when playing football (Duncan and Farr 1988). In addition, basketball was also shown to result in a high frequency of lateral ankle sprains among those records that were included in the subsample analysis. The results, in this study, would be easier to interpret if complete patient information has been recorded. For this reason, it is important to emphasise the importance of keeping complete and accurate records for such patients to promote inter-professional communication and enable accurate interpretation of patients' history and progress. Due to this, the current study recommends that alternative methods for collecting this information including questionnaires and interviews be used with those patients in future in order to obtain more specific information, specifically the cause of injury and type of sport being played at the time of injury.

5.8 Strengths and potential limitations

This is the first study in a decade that has provided descriptive statistics for multiple demographic and clinical factors related to new lateral ankle sprain patients admitted to an emergency department in the UK. Furthermore, it is the first in the UK that has provided combined results of the prevalence and demographic and clinical characteristics of patients with lateral ankle sprain. In addition, it has confirmed important clinical issues in terms of the management of lateral ankle sprain at emergency departments. These issues came to light during the review and analysis of the collected data.

During the subsample review, it was noted that there were letters revealing that 10% of the patients had been identified as having minor fractures after they had been discharged from the emergency department. The effect of this on the current data was not evaluated, as the researchers of this study only looked at 10% of the total patient records. It would have been more appropriate if the number of patients who had been sent to radiology department and did not have foot and/or ankle fractures had been calculated. The only way to investigate both the accuracy of the initial diagnosis and the number of unnecessary radiographs is to review all the records. Unfortunately, this was beyond the scope of the current study and the capacity of the researchers. However, this could be a potential area of research in the future.

The included cases in this study were assigned a diagnosis by combining two elements: the diagnostic area (lower limb-ankle) and the local diagnosis description (sprain). These two elements are diagnosis codes on the online record system. However, some of the cases were not valid lateral ankle sprain and the diagnosis did not correctly match with the written patient notes. This was discovered during the manual review of the clinical notes of the patients in the subsample, in which injuries were recorded as “ruptured right calf”, “pain in big toe” and “fracture distal tip of plantar”. The only method to verify the correct diagnosis is to go through all the patient notes (n=909), which was beyond the scope of this study. Despite this, it was assumed all the other information that was retrieved from the online patient record system is correct and included in the analysis.

These findings may bias the interpretation of these results in terms of the correct prevalence and characteristics of lateral ankle sprain. This is in agreement with a previous review, which stated that quality review of patient records in the emergency department is highly recommended (Bridgman et al. 2003). Indeed, reviewing 10% of the whole sample might not be the best method to make a sound conclusion on those issues. However, due to the ethics agreement and the unavailability of someone from the emergency department with the ability and permission to review all records, this method was taken.

5.9 Recommendations and future research

This study confirmed some important clinical aspects that need to be investigated to improve current practice related to the management of lateral ankle sprain. National statistics reports should include disease-specific statistics that cover both the demographic and clinical characteristics of admitted patients, as this might better identify the population most at risk of this injury. This would also help relevant health care professionals to establish prevention programmes for those individuals, young patients in particular. Preventative measures can then be implemented in order to reduce the number of injuries, thus reduce the burden on health care providers. This, in turn, may reduce expenses at different healthcare settings, including emergency departments.

In addition, clinical assessment tools for lateral ankle sprains such as OAR need to be become common practice, in order to reduce unnecessary radiographic investigations. The current study recorded a high percentage of patients that were referred to the radiology department, which could be decreased if certain educational measures are implemented. For instance, training clinicians working in the emergency department in the use of OAR may help to reduce unnecessary radiographs. Furthermore, a great deal of methods could be adopted such as educational posters, leaflets, presentations and audio-visual means to educate staff. In addition, specialists such as physiotherapists and podiatrists could also help in disseminating clinical guidelines for OAR. Upon successful adaptation of these guidelines, it is possible that the burden of referrals for ankle and foot x-rays could be reduced, thus reducing the related healthcare expenses.

As mentioned previously, this study also discovered that some patients' information was missing from the patient records. Information about the causes of injury and sport types would certainly help those who are interested in measuring the epidemiology of this injury and determining associated risk factors. Another limitation of the current patient record database is that the diagnostic code is misused at times. Lateral ankle sprain injury should be clearly defined to enable nurses and clinicians to clearly diagnose and then document it on the online system. This could be appropriately addressed by ensuring staff understand which ligaments are affected when a patient has sustained lateral ankle sprain, clearly reporting the cause of the injury and providing relevant physical examination, including specific clinical tests. In addition, carrying out regular clinical audits to ensure appropriate documentation of patient notes might identify these issues and lead to the proposal of relevant solutions to rectify them.

Once all the main patient demographic and clinical characteristics are determined, future research should focus more on determining the association between these characteristics and recovery from lateral ankle sprain. Such steps might help develop prevention strategies and clinical recommendations to ensure safe return to daily activities such as playing sports and work. This recommendation was taken into consideration in developing the following investigations of this thesis.

5.10 **Conclusion**

This study recorded 909 new patients who attended the ED with lateral ankle sprain during the study period. Besides the results from descriptive statistics, the study has confirmed some important clinical aspects that need to be investigated to improve current practice in terms of the management of lateral ankle sprain in an emergency department. Firstly, it is important that complete and consistent information about the diagnosis, causes of injury and sport type be collected upon patients’ arrival at an ED, as keeping records that include disease-specific statistics covering both the demographic and clinical characteristics of admitted patients may identify those most at risk of this injury. This would also help clinicians and medical teams at sports clubs to establish prevention programmes for those individuals and identify potential contributing factors that may affect RTP. Secondly, the use of clinical assessment tools for lateral ankle sprains, such as OAR, should become common practice to potentially reduce unnecessary radiographic investigations. Furthermore, future research should focus on investigating the use of OAR to reduce the burden for referrals to the radiography department. Future research could also focus more on determining those at risk of lateral ankle sprain injury, the subsequent economic impact and the most effective management of these injuries.

Thirdly, although the study confirmed the demographic and clinical characteristics of patients included in this study, it was difficult to obtain clear information about sporting activities, as some data was missing from the patient record system. Thus, it was not possible, in this study, to establish a link between the identified demographic and clinical characteristics and sport related factors. Alternative methods for collecting this information such as questionnaire and interviews should be used with those patients who are sent home with no follow up to find out potential factors that may affect RTP. Therefore, the following study (Study three) in this thesis implemented an analytical survey design in order to ascertain this specific information, including clinical and sport characteristics, and determine their relationship with RTP after lateral ankle sprain. Those factors might affect RTP after lateral ankle sprain as they have already been found to affect RTP after other sporting injuries.

Chapter 6: Study three, Factors associated with RTP in athletes with conservatively treated lateral ankle sprain

This study, which forms the third phase of this thesis, investigated the factors associated with RTP among sportspeople with a conservatively treated lateral ankle sprain, thus building on the findings of the first two studies in this thesis. Indeed, previous findings from study one and study two collectively informed the methods of this study. Their main findings showed that there is lack of evidence to support clear clinical guidance for RTP after a lateral ankle sprain, as there was a lack of knowledge regarding the factors influencing RTP. Most demographic, clinical and sport-related factors were not considered in previous observational studies, as the focus was only on investigating the recurrence of the injury (McKeon et al. 2014), functional scales, pain and clinical measures (Cross et al. 2002) and physical impairment and activity limitation (Wilson and Gansneder 2000). The second study in this thesis also showed that over half of the patients attending the ED department for lateral ankle sprain (58%) were sent home with no follow-up treatment. Instead, they were provided with a discharge instruction sheet that did not contain any information about returning to sports, work or other activities. Therefore, it was evident that there was a need to investigate how individuals with lateral ankle sprains treat their injury and make RTP decisions. These two studies confirmed the need to conduct a study to investigate those issues with the focus on factors that may influence RTP (Figure 6-1).

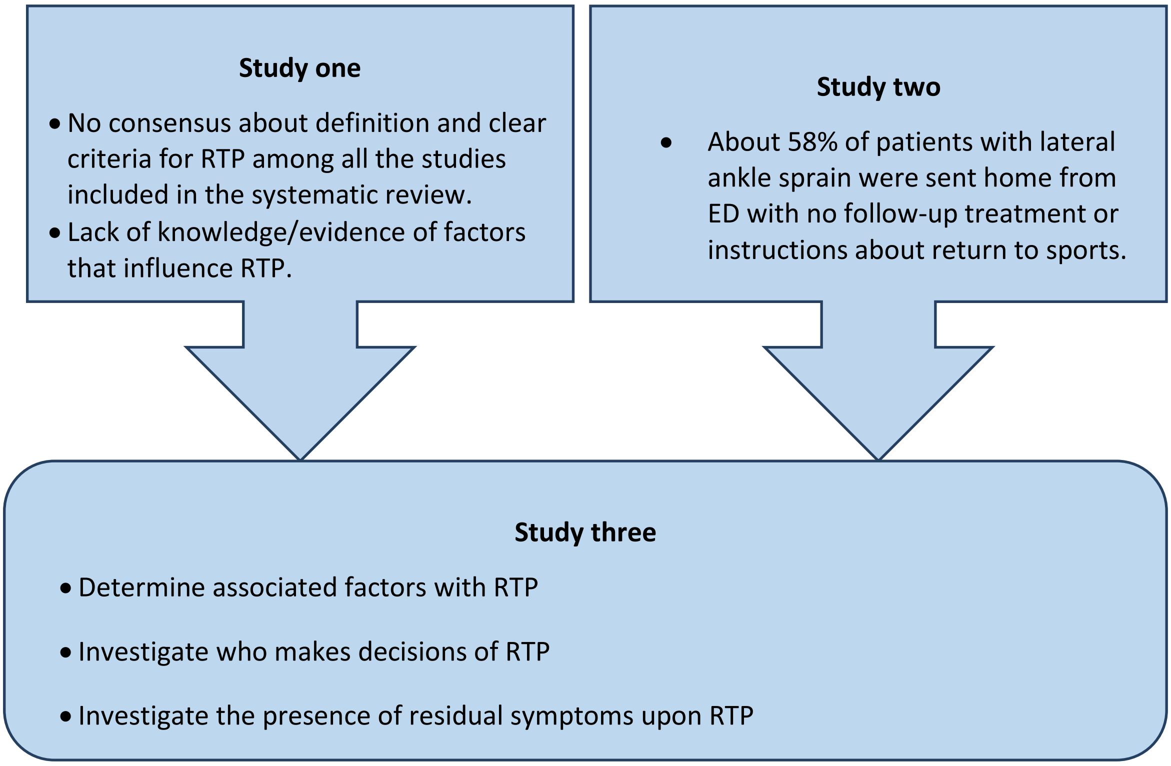


Figure 6-1 The development of the third study from the results of the first and second studies

6.1 **Background**

Lateral ankle sprain is a common injury both among sports and non-sports populations (Bridgman et al. 2003; Waterman et al. 2010; Lambers et al. 2012; Roos et al. 2017) and this was also observed in study two of this thesis (section: 5.6). Evidence has shown that lateral ankle sprain injuries can spontaneously recover with limited treatment options (Wilkerson and Horn-Kingery 1993; Birrer et al. 1999; Aiken et al. 2008). Indeed, ankle strength and the dorsi flexion joint mobility of patients who received standard emergency department care indicated a full recovery within four weeks post injury (Aiken et al. 2008). However, more sensitive measures such as self-assessed ankle function of the Foot and Ankle Outcome Score (FAOS) indicated incomplete recovery and suggested a need for further care beyond the emergency department (Aiken et al. 2008). Moreover, other studies have reported residual symptoms such as pain, joint swelling, joint instability and osteochondral lesions following lateral ankle sprain (Gerber et al. 1998; Hertel 2000; Takao et al. 2003; van Rijn 2008a; van Rijn et al. 2008b; Malliaropoulos et al. 2009; Petersen et al. 2013; Perron et al. 2014). In addition, it has been shown that many patients may experience further long-term effects, including joint degenerative changes such as osteoarthritis (Golditz et al. 2014). Amongst these residual symptoms, pain and joint instability are found to be most prevalent following lateral ankle sprains (Gerber et al. 1998; van Rijn et al. 2008b). A more recent observational study examined residual structural and functional impairments and activity limitations at RTP in athletes with a lateral ankle sprain (McCann et al. 2018). They found that athletes had increased ankle ligamentous laxity and self-reported reduced function, dorsi flexion range of motion, and dynamic postural control at RTP. They further stated that the development of these symptoms was unclear, and thus should be considered in future research.

It is unknown whether early RTP or poor recovery decisions are associated with the occurrence of those residual symptoms (McCann et al. 2018). However, a history of injury and premature RTP have been suggested as being predictors of recurrent ankle injury (McKay et al. 2001; Stasinopoulos 2004; van der Wees et al. 2007; Malliaropoulos et al. 2009).

“When can I return to play?” is a very common question that has been observed by the researcher after sportspeople have sustained sport injuries, including lateral ankle sprains. This question must be answered carefully, so as to avoid the development of residual symptoms and re-sprains. Furthermore, this is also a question commonly asked by other relevant individuals such as parents of the athletes, club medical teams, team managers, physiotherapists and podiatrists. Yet, there are several issues that need to be addressed before an answer to that key question can be formulated, and having a thorough understanding of the different factors that might be associated with RTP is a priority, in order to inform evidence-based RTP recommendations.

However, there is a lack of evidence related to the factors associated with RTP after conservatively treating a lateral ankle sprain (Anderson 2002; van Rijn et al. 2008b; Clanton et al. 2012; Richie and Izadi 2015). As discussed in section 4.5.3 of this thesis, it was not possible to draw a sound conclusion regarding the factors influencing the decision to RTP, because of the heterogeneity of the articles included. In addition, most of the articles did not account for the influence of other confounding factors in their results. For instance, Medina McKeon et al. (2014) only investigated the history of injury as a potential predictive factor for RTP after a lateral ankle sprain. Furthermore, although they collected information about age, sex, referrals and sport participation, they did not include them in the regression analysis. For these reasons, it was important to conduct a study that considered those potential confounding factors in the analysis in order to appropriately investigate their relationship with a RTP decision.

For this study, key variables that might potentially be associated with RTP were considered. They were previously investigated in different populations, including patients with lateral ankle sprains (Wilson and Gansneder 2000; Cross et al. 2002; Whitman et al. 2009; O'Connor et al. 2013; Medina McKeon et al. 2014; Mailuhu et al. 2017), high ankle sprains (Miller et al. 2012;

Mendelsohn et al. 2013; Sman et al. 2014), hamstring strain (Warren et al. 2010; Moen et al. 2014), back pain (Cook et al. 2013) and cruciate ligament sprain (Muaidi et al. 2007; Kamien et al. 2013).

However, the influence of those demographic, clinical and sport related factors on the decision to RTP is not fully understood , which might in turn increase the occurrence of chronic symptoms (Petersen et al. 2013). Consequently, it was evident that a clear understanding of the influence of these factors on the recovery from lateral ankle sprains could inform sound decisions for RTP. Various authors of the narrative reviews have confirmed that athletes, parents, club medical teams and club management require appropriate guidance on return to sporting activities after a lateral ankle sprain, in order to eliminate any disagreement, poor decision-making and to reduce the recurrence of injury (Anderson 2002; Clanton et al. 2012; Richie and Izadi 2015). Therefore, the associated factors that might influence the time that a player needs to RTP after a lateral ankle sprain were investigated by this study (Study three).

6.2 Aims and objectives

6.2.1 Aims

To determine the self-reported factors associated with RTP following conservative treatment of a lateral ankle sprain.

6.2.2 Objectives

The objectives of the study included:

1. Determining the demographic, injury and sport related characteristics of sportspeople with lateral ankle sprain.
2. Investigate self-reported decisions for RTP
3. Investigating self-reported residual symptoms upon RTP
4. Determining the association between patients' demographic characteristics and injury/sports related factors and RTP.

6.3 Methods

6.3.1 Research design

This study employed a retrospective sample survey design. A retrospective sample survey study design is a type of observational study, i.e. the researcher does not carry out any interventions, since the outcome of interest has already occurred in the past. The sample in the retrospective study design refers to a group of people that share a specific disease/injury that are followed back in time to trace the incidence or course of that disease/injury (Song and Chung 2010). In this study, individuals with a lateral ankle sprain injury were asked to provide information about their demographic, injury and sport-related factors (potential associated variables), as well as when they returned to the sporting activity (criterion variable).

A retrospective study design was chosen because it adopted an explanatory purpose to investigate different factors that may influence RTP after a lateral ankle sprain, since inferring causality was not the primary intention at this stage when answering the aims and objectives of this study. In addition, this was the first study that investigated the relationship between various demographic, clinical and sport related factors and RTP in sportspeople who had sustained a lateral ankle sprain, as it was known that those associated factors would be important for increasing our understanding of this topic and to inform future confirmatory studies.

This study was conducted because most of the patients (58%) who presented at the emergency department with a lateral ankle sprain were discharged and sent home with no follow-up treatment, and 26% of patients had sustained their injury during sports (5.6.4). It was clear from these findings that recruiting patients from a secondary care setting (emergency department) would not allow us to capture the range of individuals seen for lateral ankle sprain, as many were not followed up. Similarly, there were those who simply did not go to the ED department, therefore limiting the generalisability of such a sample. The results might have been biased, as it they could only be attributed to severe cases who presented at secondary care, and therefore they did not include individuals who had less severe cases, and thus did not seek medical attention. Therefore, to answer the proposed aims and objectives of this study, participants were recruited from local sport clubs, gyms, university sport teams and private physiotherapy/ sport clinics in order to gain a sample representative of a variety of health care seeking or non-health care seeking sporting individuals.

Conducting a retrospective sample study design has some advantages over other designs, as it is less costly, shorter and the data is readily available (Song and Chung 2010). Other advantages include the fact it is more specific to the aims and objectives of study 3, specifically:

- It allows the observation of a disease when there is a long time between exposure and outcome. This is relevant, because in the case of lateral ankle sprains, as it may take up to 12 months for a severely injured ligament to heal and regain complete strength (Cereatti et al. 2010; Hauser et al. 2013). Therefore, this design was chosen in order to maximise the response rate and cover as wide a range of potential grades of ankle injury as possible, including severe ones.
- It allows multiple potential explanatory variables that might correlate with a criterion variable to be investigated. In this study, twenty potential explanatory variables were included, in order to study their relationship with the primary criterion variable (RTP).

However, some potential disadvantages should be considered when choosing this study design such as the fact data may be incomplete and/or inaccurate, and there may be a recall bias. The researcher (SB) of this study took the following precautions to minimise the occurrence of potential sources of bias:

- Limiting participation to 6 months from the onset of injury to completing the questionnaire in this study. This period of time was chosen, as it has been used in previous retrospective observational studies to reduce recall bias (GomezI et al. 2007; Mohanty et al. 2016). In addition, participants were advised to take adequate time to complete the questionnaire. The questionnaire could be completed online at any time within the specified time and participants could take their time to do so.
- Using a standardised data collection procedure and well-structured questionnaire to survey all of the study participants. The questions in the questionnaire were devised following the findings from study one and two of this thesis and were reviewed by experts in the field, as well as by patient and public involvement (PPI) and an educational psychologist, to ensure the language, literacy and understanding were clear. It was important to take those procedures to maximise the content, and thus gain richer data, and ensure the validity of the study documents.

6.3.2 Study population

A clear definition of the study population is important to enable the researcher to draw an appropriate study sample. The study population is a group of individuals taken from the general population who share some common predetermined characteristics (NCI 2015). In this study (study 3), the targeted study population was determined by four main characteristics: geographic features, sports training, history of lateral ankle sprain injury and age (Table 6-1).

Table 6-1 Study population inclusion criteria.

Geographic features	Individuals living in Wessex.
Sport training	Individuals who practise sport at least once a week. It was important to determine the intensity of sports training and return to sports activities after the injury.
History of lateral ankle sprain injury	Individuals who sustained a lateral ankle sprain within the last six months to minimize recall bias. Lateral ankle sprain is a traumatic injury affecting the lateral capsular ligament complex of the ankle (Kerkhoffs et al. 2012).
Age	Individuals aged 18 and above. The Incidence of lateral ankle sprain injury peaks at the age of 19 years, as shown by the previous study 5.6.1). Similar trends were also observed in the literature (Backous et al. 1988; Bridgman et al. 2003; Waterman et al. 2010).

This list of demographic characteristics was considered the inclusion criteria in this study. Individuals were excluded if they had had concurrent ankle fractures, had had surgical treatment for the sprain and/or had mental health conditions preventing them from responding to the questions. Study participants were recruited from different sports clubs, sports associations and via social media.

6.3.3 Sample and sample size

The sample of the population identified as eligible was targeted during the recruitment and data collection process. It was decided that all of individuals from that population were to be approached and invited to complete the questionnaire. Those who completed the questionnaire within the timeframe of the survey formed the final study sample.

This study employed a linear regression analysis, because the dependent variable (criterion variable) was the number of days from sustaining the lateral ankle sprain injury until RTP. Therefore, the sample size was planned according to the number of explanatory (independent) variables that were included in the multivariable analysis.

There are two approaches that can be taken when deciding on the number of participants in linear regression studies. The first is to include a fixed number of participants in the study, regardless of the number of explanatory variables, whereas the second is to include a number of subjects per variable (SPV). The approach that incorporates a number of participants per explanatory variables appears to be the most commonly used approach among researchers in the literature related to this field (Schmidt 1971; Green 1991; Harrell Jr 2001). Green (1991) found that although 20 SPV are preferable, a minimum number of five is required to perform the multiple analyses. However, others recommended that the minimum number of SPV should be between 10-20 (Schmidt 1971) and 10 SPV (Harrell Jr 2001) to produce robust statistics. Interestingly, a recent study conducted a series of simulations in order to determine the minimum number of SPV needed for multiple linear regression (Austin and Steyerberg 2015). The authors concluded that a minimum number of two SPV is adequate to guarantee an unbiased estimation of the coefficient and adjusted R^2 values. However, they further stated that a higher number of SPV is required to achieve higher statistical power. Therefore, based on these results, a recruitment of 100-200 participants for this study was planned to run the regression analysis.

6.3.4 **Variables**

6.3.4.1 **Explanatory variables**

The potential explanatory variables were identified based on the findings of the literature (Study one, systematic review) and the clinical experience of the researcher. Then, experts from physiotherapy (SB), podiatry (CB and LG) and mechanics (MW) refined the final list of variables. For the regression analysis, four main constructs represented the selected variables: demographic characteristics, sport, history of injury and treatment methods (Table 6-2). In addition, qualitative open-ended questions related to structural, personal and environmental factors were also included to explore other potential influencing factors.

Those variables had been previously investigated in different populations with injuries such as lateral ankle sprains (Wilson and Gansneder 2000; Cross et al. 2002; Whitman et al. 2009; O'Connor et al. 2013; Medina McKeon et al. 2014; Mailuhu et al. 2017), high ankle sprains (Miller et al. 2012; Mendelsohn et al. 2013; Sman et al. 2014), hamstring strain (Warren et al. 2010;

Moen et al. 2014) and cruciate ligament sprain (Muaidi et al. 2007; Kamien et al. 2013). Some explanatory variables were required to be computed in order to produce suitable figures and make it practical for them to be included in the regression analysis. These variables were: the SF36, BMI, primary sport type, injured dominant limb. For instance, the BMI was calculated by dividing the patient's weight in kilograms by their height in metres squared.

Table 6-2 The explanatory variables.

Construct	**No of variable**	**Explanatory variables**	**Integer**
Demographics	Ind.* 1	Age	Years
	Ind. 2	Sex	Men (0). Women (1).
	Ind. 3	Body mass index (BMI)	Kg/m2
Sport	Ind. 4	Primary sport type	Limited or non-contact (0) Contact (1)
	Ind. 5	Average number of sport hours per week	No. of hours
history of injury	Ind. 6	Recurrent injury	Yes (0) No (1)
	Ind. 7	Cause of injury	Sport (0) Non-sport (1)
	Ind. 8	Injured dominant side	Yes (0) No (1)
	Ind. 9	Mechanism of injury	Inversion (0) Plantar flexion (1)
	Ind. 10	Pain severity when non-weight bearing	VAS scale (0-10)
	Ind. 11	Joint swelling	Yes (0) No (1)
	Ind. 12	Restricted AROM of dorsi flexion because of pain	Yes (0) No (1)

Construct	No of variable	Explanatory variables	Integer
	Ind. 13	Restricted AROM of plantar flexion because of pain	Yes (0) No (1)
	Ind. 14	Restricted AROM of eversion because of pain	Yes (0) No (1)
	Ind. 15	Restricted AROM of Inversion because of pain	Yes (0) No (1)
	Ind. 16	Days until pain free walking	Number of days
	Ind. 17	Self-reported chronic instability	Yes, feeling of giving way persisted longer than 12 months (0) No (1)
	Ind. 18	Short Form 36 (SF36) Physical Functioning component	Percentage %
Treatment methods	Ind. 19	Treatment programme	Self-care (0) Professional advice by a clinician, physiotherapist, sports medical team (1)
	Ind. 20	NSAIDs	Yes (0) No (1)

*Ind. = Independent variable

6.3.4.2 **Criterion variable**

The criterion variable for this study was RTP and was defined as "the number of days that have elapsed from the date of injury to the date of the player's return to full participation in team training and availability for match selection" (Fuller et al. 2007).

6.3.5 **Development of data collection tools: advertising poster, questionnaire and participant information sheet (PIS).**

The development of the data collection tools followed systematic steps in order to for them to be ready for data collection.

6.3.5.1 Development of study questionnaire

Through an agreement process, the four experts discussed and agreed on the content of the questions that were found to be appropriate for achieving the study aims and objectives. As a result, six groups of questions were derived based on the proposed list of explanatory variables:

1) Questions related to sport type and intensity

2) Questions related to current and previous injury details

3) Questions related to demographic characteristics

4) Questions related to conservative treatment methods

5) Questions related to the decision to RTP a sporting activity

6) Open-ended questions related to structural, personal and environmental factors.

Sub-questions were then developed from those six main themes. The questions were designed based on the study objectives and the demographic characteristics of the respondent. The age, sex, socio-economic status, geographic characteristics and/ or educational level of the subject were taken into consideration when designing the questions. In addition, both closed-ended (structured) questions and open-ended (unstructured) questions were used in the questionnaire. Closed-ended questions included dichotomous or two-point questions (e.g. Yes or No), multiple choice questions (e.g. A, B, C or D) and scaled questions (e.g. VAS pain scale from 0 to 10), while open-ended questions were used when predefined options or categories could not be included as answers. Open-ended questions were also used to explore any other potential factors influencing RTP. The matrix questions were used to investigate the physical function of the participants (e.g. SF36 Physical Function scale). In addition, there were also contingency questions that only needed to be asked if they were applicable to the participant. For example, if the participant has not yet returned to play then he/ she had to provide reasons why that had not happened up until that point.

6.3.5.2 Pilot testing of data collection tools

All data collection tools were pre-tested and reviewed before starting the process of data collection, since this is an important step in the development process of data collection tools. Patient and Public Involvement (PPI) representatives reviewed the advertising poster, the questionnaire and PIS.

Involving PPI in the research development process is important in order to define, design, conduct and disseminate the research (Involve 2014). Indeed, the quality and relevance of the research is regarded as being greatly improved after active involvement of PPI in the research process (Goodare and Smith 1995; Oliver 1995; Entwistle et al. 1998). Therefore, eight PPI representatives, comprised of patients and their relatives, as well as members of the public, were recruited to review the questionnaire and study documents. Following this, comprehensive feedback related to the questionnaire, PIS (Appendix 17) and the advertisement poster Appendix 16) was received from the eight PPI reviewers (Appendix 13, Appendix 14 and Appendix 15). As a result, some changes were made to the wording of certain parts, as they were regarded as possibly having different interpretations by the respondents of the questionnaire. For example, recommendations included using the terms "Doctor/Nurse' instead of 'clinician" and "and persisted longer than 6 months" instead of "for a period longer than 6 months". The study management team (SB, CB, MW and LG) continuously monitored this process to ensure the questionnaire's usability for potential study participants. When necessary, consensus meetings were conducted to decide on changing any ambiguous or inappropriate wording of the questions.

An educational psychologist (BW) also reviewed the usability of the questionnaire by highlighting any literacy issues and the potential for misunderstandings. The language and the construction of the questions were thoroughly reviewed and feedback was given accordingly.

Once the questions had been developed and agreed on by the members of the study management team, the final version of the questionnaire was drafted and used for the targeted study population (Appendix 18). The time needed to complete the final version of the questionnaire was also established and found to take from 10 to 15 minutes.

6.3.6 **Ethics approval**

Study three received approval from the ethics committee at the University of Southampton through the Ethics and Research Governance Online (ERGO, Reference No 25336). Amendments to the study questionnaire were carried out later in the data collection period, which also required ethics approval (ERGO, Reference No 25336.A1). The amendments included adding open-ended questions to investigate other potential influencing factors.

More information about data management and the code of conduct can be found in section 5.5.

6.3.7 Data collection procedure

To help achieve the highest response rate when recruiting the proposed sample, as many sample sources as possible were targeted. A list of potential recruitment places was made, along with the best method of approaching and contacting them. Subsequently, a number of different places were approached and contacted such as local and professional sports clubs, local universities, sports associations, gyms, private physiotherapy clinics, and sports playgrounds. A wide range of diverse methods for distributing the study questionnaire was carried out based on the available resources. These methods included:

- Social media (Facebook and Twitter)
- Personalised e-mails and online (sport related web pages and forums)
- An advertising poster (displayed on the premises of different sports settings e.g. local gyms, sports clubs, the university)
- Contacting various sports clubs, private physiotherapy clinics, gyms (by phone call)
- Arranging to visit sports clubs, local gyms, the university's sport clubs, private physiotherapy clinics and gyms.
- Sending questionnaire links by SMS
- Personalised questionnaires via social media and mobile phone applications (WhatsApp and Messenger), as this had been found to increase the response rate in completing questionnaires (Edwards et al. 2002).
- QR code: scanning the code took the participant directly to the PIS and online questionnaire.

In the case of non-response from the recruitment places targeted, whether they were approached online or via the poster and given hard copies of the questionnaire, additional attempts to contact and remind them were made. They were reminded at least twice more, making a total of three attempts. Giving participants a second opportunity to respond to the questionnaire was found to be important for increasing the response rate (Edwards et al. 2002). The questionnaire was accompanied by a cover letter, which could be found on the first page of the questionnaire. The cover letter briefly included information about the study, including eligibility criteria and the aims of the study. It also provided electronic links to the PIS for more details about the study. All of the potential participants were instructed to read the enclosed PIS before completing the questionnaire. They were also informed that by completing the questionnaire, they were also providing their consent (implied consent) and agreeing that their data would be used in the analysis. To clarify, implied consent is attained by the implication of a specific action (Aveyard 2002), which in this case was determined by completing the questionnaire in this study.

6.3.8 **Data collection timescale**

The period of participant recruitment and data collection continued for a period of 6 months from June 2017 until December 2017. Subsequently, a second round data collection phase was carried out between January and March 2019. The findings from the first phase showed a need to investigate why participants did not seek professional advice on RTP and why they resumed training with residual symptoms. The reasons why those participants resumed training with symptoms were not clear during the first phase of data collection, therefore open-ended questions were added to the questionnaire to explore those reasons during the second round of data collection. At the end of the data collection period, all of the data from the online questionnaire was transferred to SPSS for data analysis.

6.3.9 **Data Handling**

All the data collected from this study was handled carefully, although participants were not asked any sensitive personal information, that is to say, they were not asked to provide any kind of identifiable personal information such as names, addresses, employment details, hospital numbers and/or telephone numbers. Despite this, all the data was managed and handled according to The Data Protection Act 1998. All of the online questionnaires were stored in a password-protected online repository (Google Forms). The data was then transferred from each individual survey response onto a secured University of Southampton PC. A total of 116 responses were retrieved from the online Google Forms repository. Following this, the data was exported to SPSS software (IBM SPSS Statistics, 24) on the same PC for analysis. At this stage, information from all of the questionnaires was included in the dataset of the SPSS software. Each survey response was given a coded identification number on the SPSS program (e.g. ID-1, ID-2, ID-3, etc).

6.3.10 **Data cleaning**

Before running any statistical analysis, all of the data that had been collected were screened in order to determine if there were any duplicate data entries by running “Identify duplicate cases” on SPSS, in which case they could be deleted if necessary. However, no duplicate data entries were identified, thus all of them were considered valid. Next, the study variables were examined to determine if the data made sense in terms of its distribution and the maximum and minimum values of the study variables. In addition, the appropriate measurement scale of study variables was examined and compared against the raw data. Finally, any false entries of coding and values of the variables were checked and corrected accordingly.

6.3.11 **Handling of missing data**

Missing data analysis was performed to determine if there was any missing data and if there was a pattern to the missing data. There are three types of missing data: missing completely at random, missing at random and missing not at random. Missing completely at random occurs when the missing responses are independent from others and can be characterised by finding only a single variable with data missing. Missing at random indicates that the pattern of missing data depends on other explanatory variables. Missing not at random, also known as non-ignorable nonresponse, is when the value of the variable that is missing is related to the reason it is missing (Dancey et al. 2012).

Several methods can be used to address missing data, such as the deletion of cases, mean substitution, and imputation methods to calculate the value of that missing variable (Dancey et al. 2012). Dealing with missing data and extreme high scores with regard to the number of days from injury to RTP in this study was carried out with the assistance of a statistician (SE) from the University of Southampton. It was agreed that those responses (entire participant cases) be deleted, as the number of those cases (n=9) was small, and therefore unlikely to have an impact on the study results (Dancey et al. 2012). The exclusion of those responses was decided when the criterion variable (RTP) was not reported (n=7) or the criterion variable score was very high (n=2). Seven participants did not mention the date they sustained their injury or the date they resumed training, therefore it was not possible to calculate the number of days (criterion variable). Two participants reported very high RTP scores (335 and 366 days) and these responses were considered potential outliers, because they may not reflect a logical physiological time frame for ligament healing (Hubbard and Hicks-Little 2008; Guillodo et al. 2013). The data related to excluded participants were summarised in Table 6-3.

Table 6-3 Comparison in demographics between participants whose responses were excluded (n=9) and those included in analysis (n=107).

Variables		**n= 9**	**n= 107**
Age (years)		35 ± 16	30.8 ± 11.5
Sex	Men	6 (67%)	60 (56%)
	Women	2 (22%)	47 (44%)

6.4 **Data analyses**

6.4.1 **The choice of research analysis strategy**

This study employed a hypothetico-deductive approach to analyse the data (Figure 6-2)**.** It is a method by which “a cyclic pattern of reasoning and observation is used to generate and test proposed explanations (i.e., hypotheses and/or theories) to derive useful knowledge” (Lawson 2015). In light of the current literature, the hypotheses were that all of the explanatory variables were considered potential factors associated with RTP. Therefore, a series of statistical examinations were conducted to decide whether to accept or reject those hypotheses.

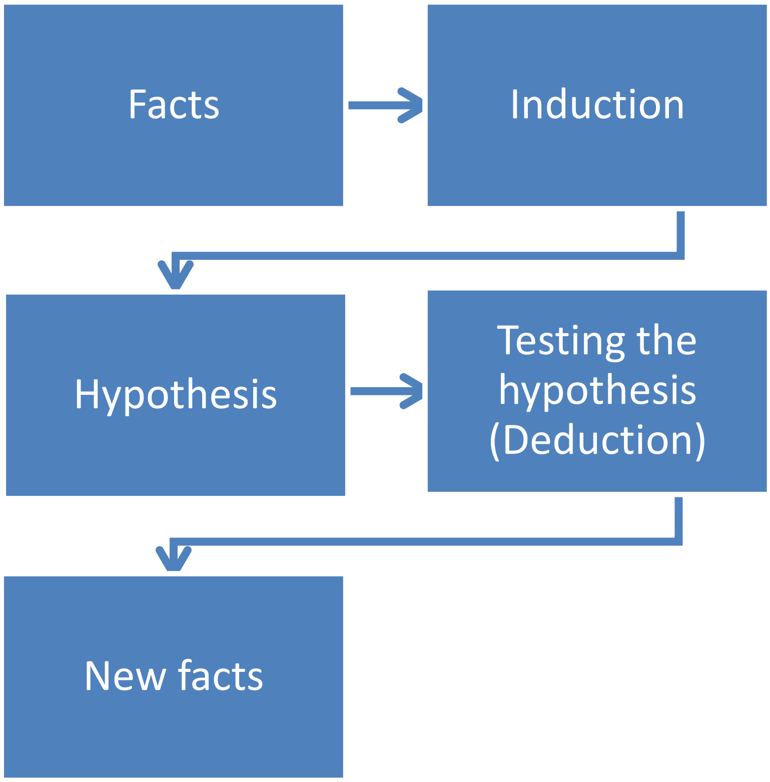


Figure 6-2 Hypothetico-deductive method

6.4.2 **Methods of data analysis**

The following section discusses the statistical methods used in this study (Study three). Both descriptive and inferential statistics were carried out to address the study objectives. All the statistical procedures were carried out by the researcher (SB), however, assistance was sought from a senior medical statistician (SE) from the University of Southampton when required. All of the statistical procedures in this study were carried out using the SPSS Statistics software package (version 24; SPSS Incorporation).

6.4.3 **Descriptive statistics**

The data collected from the online questionnaire provided demographic, sport-related and clinical information that allowed certain descriptive statistics to be drawn (objective number 1 of this study). Descriptive statistics were conducted using measures of central tendency and measures of variability. Measures of central tendency may include the mean, median and mode whenever applicable whereas measures of variability included standard deviation, variance, the minimum and maximum values. Therefore, for continuous variables, such as age, BMI, SF36, means and standard deviations (SD) or the median and interquartile range (IQ) were calculated depending on data distribution. For binary and categorical variables, such as sex, recurrent injury and mechanism of injury, frequencies and percentages were calculated. In addition, the distribution of age and sex across the population in this study was illustrated using a line chart and histogram.

6.4.4 **Inferential statistics**

The inferential statistics were divided into three parts according to the study aims.

1) The relationship between age groups, sex, three most prevalent sport types and RTP.

Age was clustered into four groups: 18-25, 26-35, 36-45 and 46-65. These age groups were similar to those reported in previous literature (Petry 2002; Lenhart et al. 2010). Statistical methods were explored to describe any potential trends in RTP across the different age groups. A nonparametric test (the Kruskal-Wallis test) was chosen to investigate the difference between the four age groups, because of the small and unequal number of participants in each group (Kitchen 2009) and the non-normal distribution of RTP values across these age groups.

In order to investigate the relationship between sex and primary sport types and RTP, a Negative Binomial test was used. The Negative Binomial regression was used in this study because the data did not meet the assumptions for simple linear regression, that is to say, it was not normally distributed, as the variance was more than the mean and there was over dispersion of the data. In addition, the relationship between the three most prevalent sports in this study (football, rugby and running) and RTP was investigated. Football was set as a reference, as it was found to be the most prevalent type of sport in the previous study (Study two), as well as in other studies (Nelson et al. 2007; Cloke et al. 2009; Cloke et al. 2011). In addition, football players were found to have a shorter RTP duration after a hamstring injury (Jacobsen et al. 2016).

2) The relationship between the residual symptoms and RTP. The presence of residual symptoms at RTP was treated as binary variable (yes/ no).

The distribution of participants who sought professional advice from clinicians such as physiotherapists and podiatrists compared to those who decided for themselves was presented. In addition, the statistical relationship between those decisions and residual symptoms were calculated using Chi-Square tests.

3) Regression analysis to determine which variables are best associated with RTP after a lateral ankle sprain.

Regression is type of correlational analysis that is used to estimate the relationship/ association between one or more independent variables and a dependent variable (Dancey et al. 2012). Negative Binomial regression analysis was chosen to determine this relationship between potential associated factors and RTP. It was used because the variance assumption underlying simple linear regression was violated. The violations of statistical assumptions and goodness of fit were also analysed.

The first step of the regression analysis was to conduct a univariable regression analysis to determine which explanatory variables were significant and worth including in further analysis (multivariable analysis). Univariable analysis is a type of correlation analysis in which one explanatory variable is investigated to determine if there is a significant association between an explanatory variable and a criterion variable (Field 2013). This step was repeated until all of the explanatory variables in the study had been examined. Any explanatory variable with a significance level of $p < 0.2$ was selected for inclusion in the multivariable model. A lenient significance level was chosen to minimise the likelihood of overlooking any potential explanatory variables. That significance level had also been used in previous observational studies (Warren et al. 2010; Moen et al. 2014) and it was also decided on during a discussion with a statistician from the University of Southampton (SE).

Once all the significant explanatory variables were determined, they were entered into a multivariable model to determine if there is a relationship between the combined explanatory variables and the criterion variable. The final multivariable model was determined based on the stability of the model and the significance level of the included variables. The stability of the model was determined by the effect size of the included explanatory variables, the goodness of fit (Omnibus Test: AIC and LR CH^2) and the significance level of the whole model. The association effect size of the explanatory variables in each multivariable model was determined using the Incidence Rate Ratio (IRR), with 95% Confidence Intervals (CI).

6.4.4.1 **Control variables**

Two control variables were added to the multivariable regression model to ensure that the coefficients of the selected explanatory variables were not affected by the effect of confounding variables. Those two potential confounding variables were age and sex of the participants. They were added to explore and to endeavour to eliminate the omitted variable bias.

Age has been found to be an important risk factor for many musculoskeletal injuries (Bennell and Crossley 1996; Miranda et al. 2001; Blagojevic et al. 2010). For example, in football, the risk of hamstring strain has been found to increase in older players (Arnason et al. 2004). In addition, it has been reported that the incidence of lateral ankle sprain among players at football academies increases proportionally with age (Chomiak et al. 2000; Cloke et al. 2009; Cloke et al. 2011). Similar results were found in young football players aged 6-17 years old, with the findings showing that the risk of injury doubles from the age of 14 onwards (Backous et al. 1988). In terms of age, more specifically in young adult populations, all of the studies have indicated a sharp increase in the prevalence of lateral ankle sprain for this age group (14 years and above) (Bridgman et al. 2003; Waterman et al. 2010; Al Bimani et al. 2018a). Age was also investigated as a potential explanatory variable for recovery in musculoskeletal injuries such as lateral ankle sprain (O'Connor et al. 2013), ankle fracture (Egol et al. 2006) hamstring strain (Verrall et al. 2006; Moen et al. 2014), ACL injuries (Sandberg et al. 1987; Daniel et al. 1994; Buss et al. 1995; Brophy et al. 2012) and back pain (Cook et al. 2013). Old age was found to be significantly associated with a delay in functional recovery in patients with ankle fracture (Egol et al. 2006). Other studies have also shown similar results, that is to say, older patients with an ankle fracture are less likely to return to baseline functional activities compared to younger patients (Aharonoff et al. 1997; Skovron et al. 1997). In patients with lateral ankle sprain, age was significantly associated with lower functional activity at four weeks and four months (O’Connor et al. 2013). Therefore, this study explored the effect of age as a control factor in the presence of other explanatory variable in the multivariable model analysis.

The sex of sportspeople with lateral ankle sprain is another important factor that can affect the incidence, course of injury and recovery from different musculoskeletal injuries, including lateral ankle sprain. One study showed that in sports that require jumping and speed cutting, women are six times more at risk of sustaining a serious knee injury than men participating in the same sports (Hewett 2000). In Study two of this thesis (5.6.1), it was mentioned that the epidemiological study found that men aged 14-37 years had a higher prevalence of injury than women (Al Bimani et al. 2018a). In contrast, women (38-92 years old) had a higher prevalence of injury than men. Others found that women are more likely to sustain lateral ankle sprains than male patients (Beynnon et al. 2005; Willems et al. 2005; Ericksen and Gribble 2012; Gribble et al. 2012). In patients’ post ACL reconstruction, there was a significant difference in the results between men and women ($p=0.042$), as men returned to higher levels of sport compared to women (Sandon et al. 2015). Therefore, this study explored the effect of a participant’s sex as a control factor in the presence of other explanatory variables in the multivariable analysis.

6.5 Results

A hundred and sixteen participants completed the questionnaire posted online. Of those hundred and sixteen responses, nine were removed, because they were outliers or did not give information about the criterion variable (section6.3.11). Therefore, a total of one hundred and seven responses were analysed to obtain descriptive and inferential statistics.

6.5.1 Descriptive statistics

Descriptive statistics were calculated for all explanatory variables that were included in this study. Participants in this study had a median age of 28 years (IQR 17), ranging from 18 to 65 years with a peak at 19-21 years (35%) (Figure 6-3 and Figure 6-4).

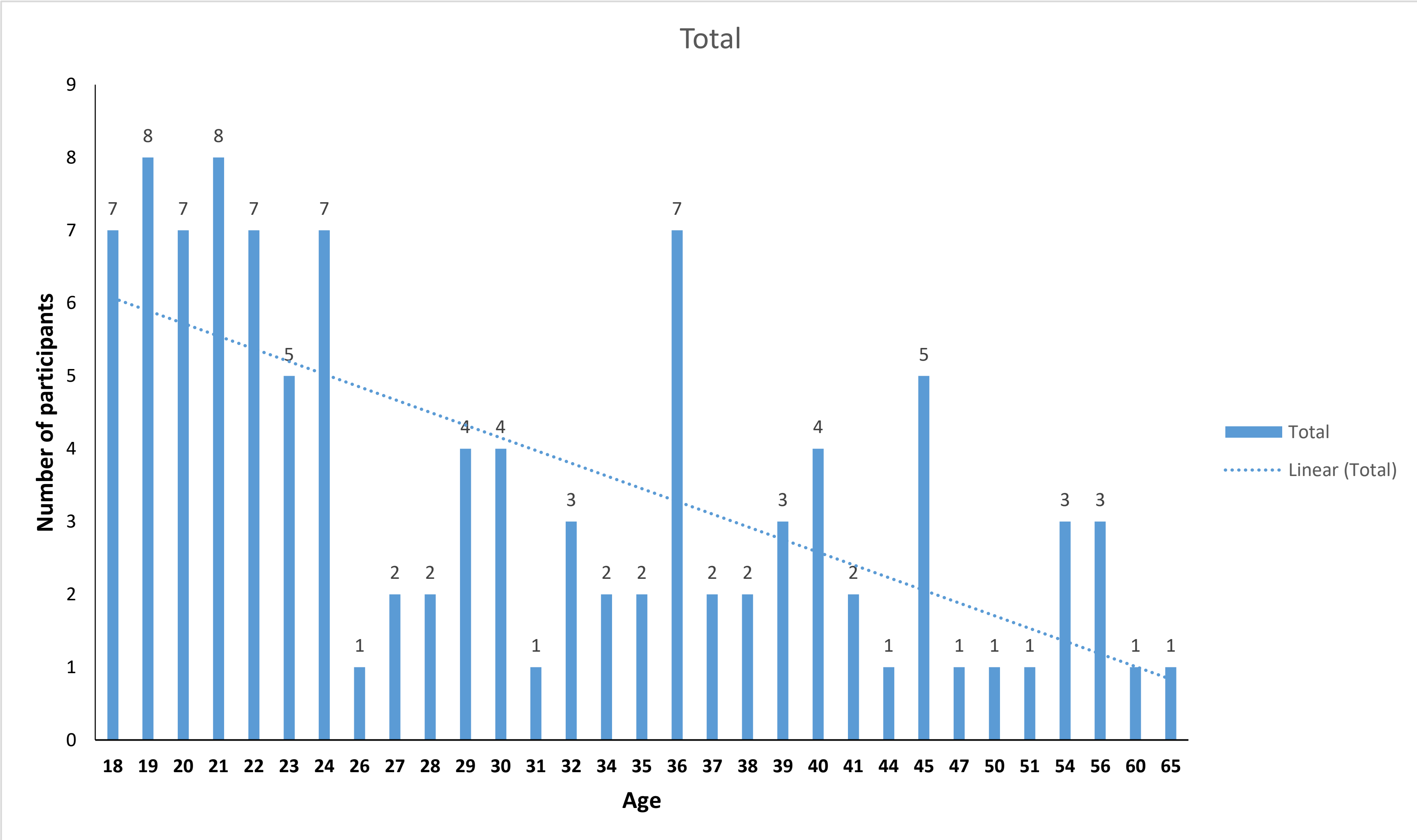


Figure 6-3 Distribution histogram of the age of participants

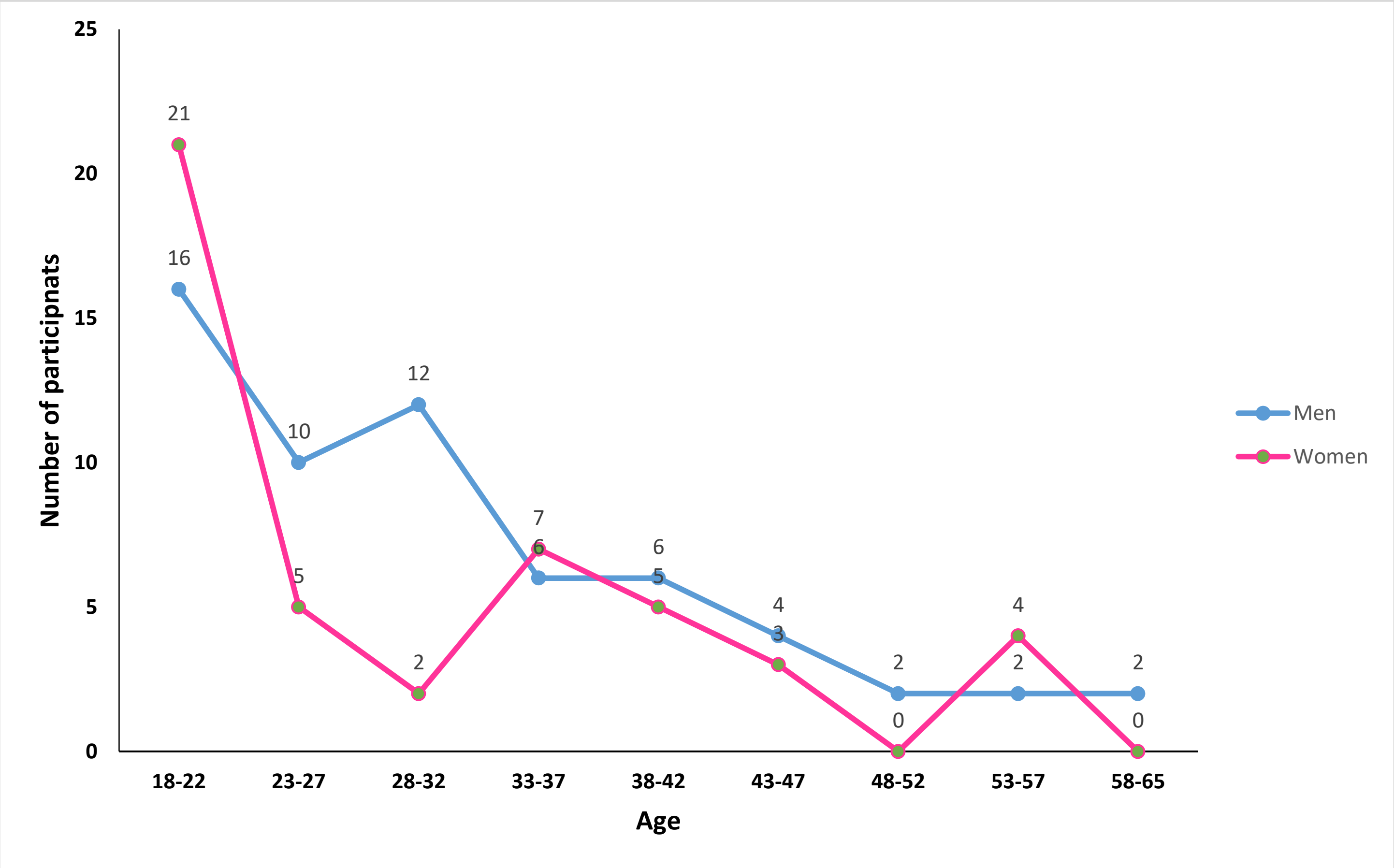


Figure 6-4 Age distribution for each sex

Descriptive statistics of all of the variables are illustrated in Table 6-4. The frequency and distribution of lateral ankle sprain injury are presented as mean and standard deviations for continuous variables and percentiles for categorical variables.

Table 6-4 Descriptive statistics for all explanatory variables.

Variables	**Mean and SD or N and %**
Age	30.8±11.5*
Sex	
Men	60 (56%)
Women	47 (44%)
Body mass index (BMI)	24.9 ± 3.9*
Average number of sport hours per week	8.7 ± 12.8*
Primary sport	
Football	23 (21.5%)
Rugby	17 (15.9%)
Running	15 (14%)
Tennis	7 (6.5%)
Hockey	6 (5.6%)
Basketball	4 (3.7%)
Squash	4 (3.7%)
Cycling	4 (3.7%)
Volleyball	3 (2.8%)
Triathlon	3 (2.8%)
Athletics	3 (2.8%)
Dancing	3 (2.8%)
Equestrian	2 (1.9 %)
Netball	2 (1.9 %)
Korfball	2 (1.9 %)
Weightlifting	1 (0.9 %)
Gym	1 (0.9 %)

Variables	Mean and SD or N and %
Boxing	1 (0.9 %)
Gymnastics	2 (1.9 %)
Climbing	1 (0.9 %)
Tae Kwon-Do	1 (0.9 %)
Walking	1 (0.9 %)
Cheerleading	1 (0.9 %)
Type of sport	
Limited or no contact	55 (51.4%)
Contact	52 (48.6%)
Recurrent injury	
Yes	64 (59.8%)
No	42 (39.3%)
Cause of injury	
Sport	76 (71%)
Non-sport	31 (29%)
Injured dominant side	
Yes	75 (70.1%)
No	31 (29%)
Mechanism of injury	
Inversion	98 (91.6%)
Plantar flexion	6 (5.6%)
Pain severity when non-weight bearing	5.50 ± 1.94
Joint swelling	
Yes	84 (78.5%)
No	22 (20.6%)
Restricted AROM of dorsi flexion because of pain	
Yes	
No	78 (72.9%)

Variables	Mean and SD or N and %
	29 (27.1%)
Restricted AROM of plantar flexion because of pain	
Yes	68 (63.6%)
No	39 (36.4%)
Restricted AROM of eversion because of pain	
Yes	77 (72%)
No	30 (28%)
Restricted AROM of inversion because of pain	
Yes	78 (72.9%)
No	29 (27.1%)
Days until pain free walking	26.5 ± 38.4*
Self-reported chronic instability	
Yes	28 (26.2%)
No	77 (72%)
Short Form 36 (SF36) Physical Functioning component	36.2 ± 25.6
Treatment method	
Self-care	45 (42.1%)
Professional advice	60 (56.1%)
NSAIDs	
Yes	51 (47.7%)
No	52 (48.6%)

N = number of participants. % = percentage of respondents. * denotes mean and SD.

6.5.2 Relationship between age groups, sex and primary sport types and RTP

The scores of RTP were calculated, using the relevant statistics, in order to compare individuals across three variables: age groups, sex (men and women) and the most prevalent type of sport (football, rugby and running). The date of injury was subtracted from the date of resuming sports training using an online day calculator (https://www.timeanddate.com/date/duration.html).

6.5.2.1 Relationship between age groups and RTP

This was carried out in order to determine any relationship between the different age groups and RTP, and in order to analyse that relationship, participants were divided into four groups (Table 6-5). The results showed that participants aged between 26 and 35 years had a longer RTP duration (median= 36 days). In addition, participants aged between 46 and 65 years had the quickest RTP (median= 14 days). However, there was no significant difference between the four age groups in terms of RTP (Kruskal-Wallis Test, p=.387).

Table 6-5 Relationship between age groups and RTP

Age group (years)	N	Min.	Max.	RTP (days) Min.	Max.	Median
18-25	49	18	24	1	191	29
26-35	21	26	35	2	158	36
36-45	26	36	45	1	184	20
46-65	11	47	65	1	67	14

6.5.2.2 Relationship between sex and RTP

The prevalence of injury for men and women in this study was 60 (56%) and 47 (44%), respectively. Furthermore, the test statistics of Negative Binomial showed a significant difference between men and women in relation to RTP duration (p= .047), as illustrated in Table 6-6**.** The count for RTP days is expected to decrease by 32% for men compared to women. There was no violations of statistical assumptions or goodness of fit for these analyses.

Table 6-6 Negative Binomial statistics for men and women

	IRR*	95% CI	P value
Men	0.68	0.460, 0.995	0.047
Women	1		

IRR: Incidence Rate Ratio: a relative difference measure used to compare the incidence rates of events occurring at any given point in time.

6.5.2.3 **Relationship between primary sport types and RTP**

The most prevalent types of sport in this study were chosen in order to investigate their relationship with the RTP (Table 6-7). Those sports types were football (n=23), rugby (n=17) and running (n=15).

Table 6-7 Descriptive statistics of the three sports.

		RTP		
Sport type	**N**	**Minimum**	**Maximum**	**Median**
Football (reference)	23	2	189	34
Rugby	17	1	189	36
Running	15	2	122	15

6.5.2.4 **Relationship between Football and rugby and RTP**

The Negative Binomial regression test statistics showed that football players RTP faster than rugby players (IRR .80), as illustrated in Table 6-8**.** However, this result did not reach a significance (p= .48).

Table 6-8 Negative Binomial regression for football and rugby and RTP.

		95% CI for IRR		
	IRR	Lower	Upper	P value
Football	0.80	0.42	1.50	0.48
Rugby	1			

6.5.2.5 **Relationship between Football and running and RTP**

The Negative Binomial regression test statistics showed that football players take longer to RTP compared to runners (IRR .1.565), as illustrated in Table 6-9 . However, this result did not reach a significance level (p= 0.18).

Table 6-9 Negative Binomial statistics for football and running and RTP.

		95% CI for IRR		
	IRR	Lower	Upper	P value
Football	1.565	0.81	3.03	0.18
Running	1			

6.5.2.6 The presence of residual symptoms at RTP

A hundred and seven participants provided information about their decisions to RTP after their injury. Out of those, eighty-six participants provided complete information about their RTP decision and the residual symptoms. Those who sought professional advice accounted for 16%, whereas 84% of participants decided for themselves (Table 6-10 and Figure 6-5). The majority of participants who had sought professional advice had residual symptoms upon returning to their sporting activities (n= 11, 79%) and three participants (21%) did not have any residual symptoms. Of those who decided for themselves, n=54 (75%) participants had residual symptoms when they resumed sport training, whereas n=18 (25%) did not have any symptoms.

Table 6-10 RTP decisions and the presence of residual symptoms

			Residual symptoms		
			Yes	**No**	**Total**
RTP decision	Patient themselves	Count	54	18	72
		% within RTP decision	75%	25%	100%
		% within residual symptoms	83%	86%	84%
	Professional advice	Count	11	3	14
		% within RTP decision	79%	21%	100%
		% within residual symptoms	17%	14%	16%

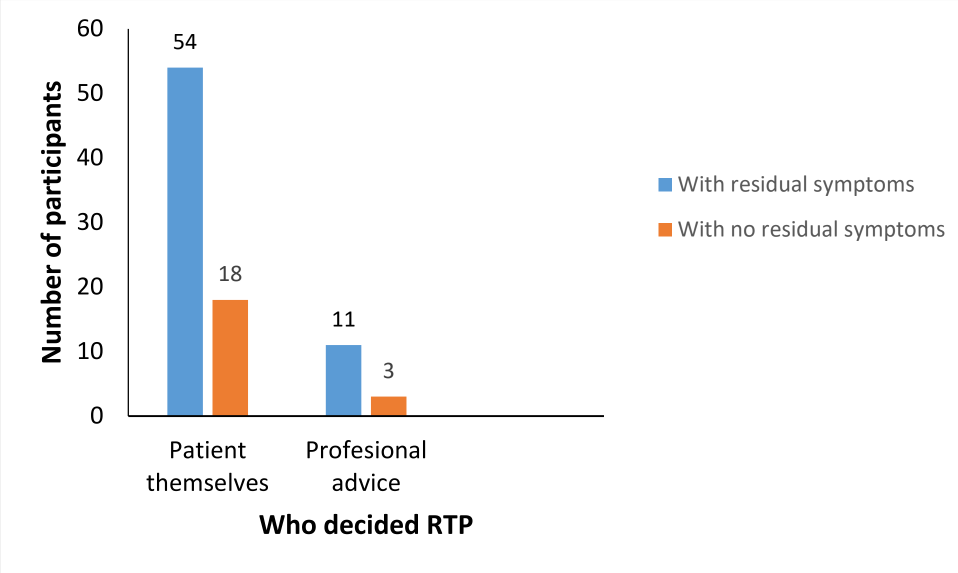


Figure 6-5 RTP decisions and the presence of residual symptoms

However, the Chi-Square test statistics (Fisher's Exact Test) showed no significant difference in the presence of residual symptoms at the time of RTP between those who sought professional advice and those who decided for themselves (p= 0.54), as illustrated in Table 6-11. The Fisher Exact test was used, because there was one cell that had an expected count less than 5 in the two by two table.

Table 6-11 Chi-Square statistics of RTP decisions vs residual symptoms.

	Value	Exact Sig. (1-sided)
Pearson Chi-Square	0.081[a]	
Fisher's Exact Test		0.54
N of Valid Cases	86	

a. 1 cell (25.0%) have expected count less than 5. The minimum expected count is 3.42.

6.5.3 **Regression analyses**

Regression analysis was performed to determine the explanatory variables for RTP after a lateral ankle sprain. However, to perform a regression analysis, the collected data must meet certain assumptions in order to run relevant statistics, for example a linear regression, if the criterion variable is not binary (Dancey et al. 2012). Other assumptions that must be met include:

A linear relationship between the explanatory variable and the criterion variable.

A normally distributed criterion variable.

The removal of outliers or very high scores from the study data is considered.

After performing a normality test (Kolmogorov-Smirnov) and distribution histogram, it appeared that the data of the criterion variable (RTP) was not normally distributed (Figure 6-6 and Table 6-12). The data was positively skewed suggesting that the majority of participants returned to sports between one and fifty days (70%). In data that is distributed normally, the Kolmogorov-Smirnov test should produce a p-value higher than .05 along with a histogram Skewness and Kurtosis approximate to zero. The results of the Kolmogorov-Smirnov test were $p < .001$ and the Skewness and Kurtosis were 1.49 and 1.37, respectively, which were not approximate to zero. Therefore, it was concluded that the data was not normally distributed and regression methods other than simple linear regression were considered.

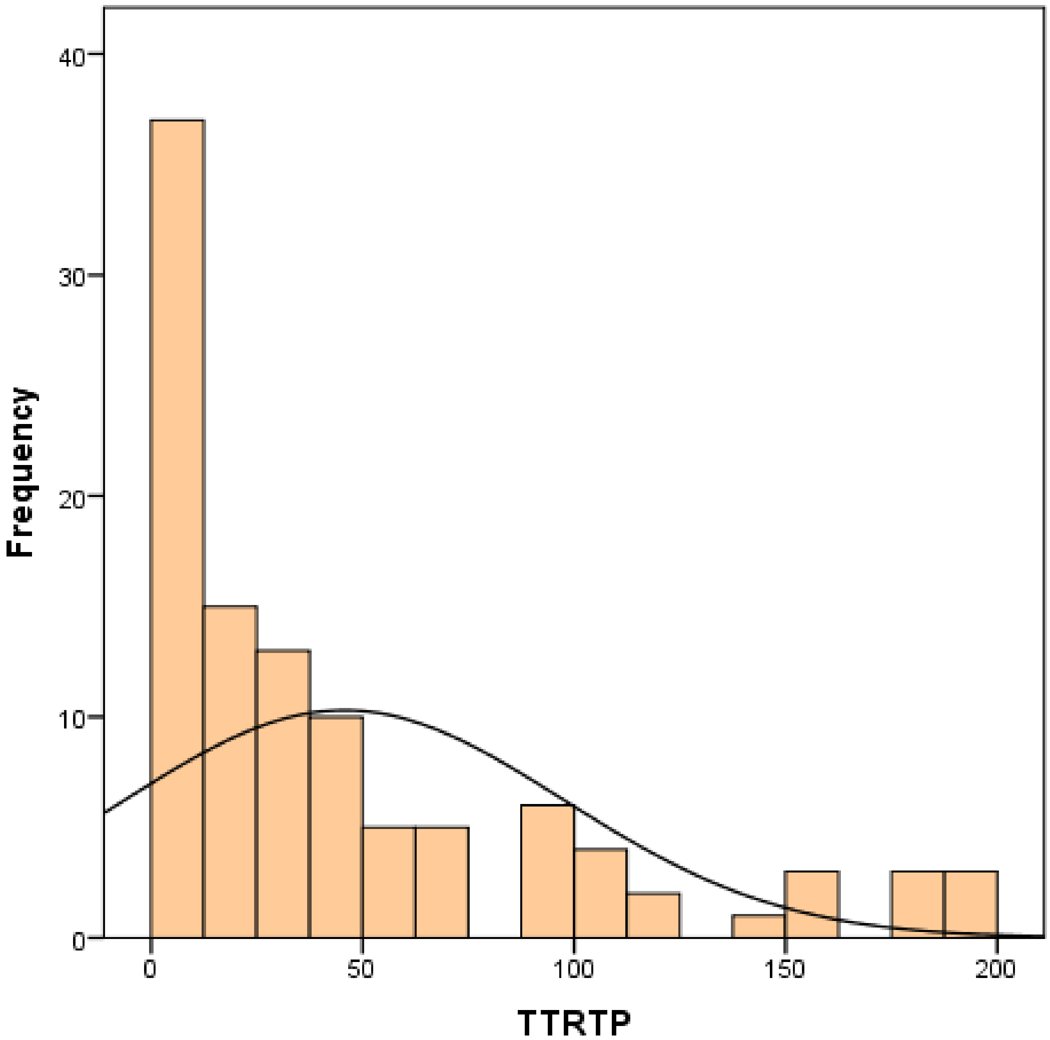


Figure 6-6 RTP distribution histogram

Table 6-12 Kolmogorov-Smirnov[a] test of normality of the RTP.

	Statistic	**df**	**Sig.**
RTP counts	0.19	107	0.000

In addition, the criterion variable in this study was the number of days (count data). Thus, the use of a linear regression was not deemed appropriate for analysing the data. Therefore, generalised linear models (negative binomial regression or Poisson regression) were deemed more appropriate (Hilbe 2011). The choice between Negative Binomial and Poisson regression methods was determined by calculating the mean and variance of the criterion variables (RTP) for each level of the explanatory variables. The results showed that the conditional variance exceeded the conditional mean in all of the explanatory variables. As an example, the mean RTP for men and women was 37.75 and 55.81, respectively, whereas the variance was 2344.80 and 2989.46, respectively (Table 6-13). These results signified that there was an over dispersion of the number of days, thus the variance assumption underlying the Poisson regression was violated. Therefore, the negative binomial regression was used, because it adjusted for the over dispersion.

Table 6-13 Mean and variance of the criterion variable (RTP) for men and women.

	RTP					
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Men	60	1	189	37.75	48.42	2344.80
Women	47	3	191	55.81	54.68	2989.46

6.5.3.1 **Univariable analysis**

The regression analysis phase of this study began by conducting a univariable analysis (Negative Binomial Regression). The statistical association between each explanatory variable and the criterion variable was individually determined. This was conducted in order to decide which explanatory variable would be included in the multivariable model.

The choice of variables that would be included in the multivariable model was based on a modified forward stepwise method. This method involved examining the significance of the relationship between the individual explanatory variables and the criterion variable. Initially, explanatory variables with a statistical power (P-value) of < .2 were considered for further analysis in the multivariable analysis.

1. **Univariable analysis –** Age

The univariable regression analysis showed that the age of participants was not associated with a shorter or longer RTP (IRR 0.99, 95% CI 0.97, 1.01, p=0.22). However, this variable was considered for inclusion in the multivariable analysis as a control variable (6.4.4.1).

2. **Univariable analysis –** Sex

The univariable regression analysis showed that the number of days is expected to decrease at a rate of .63 for men compared to women (IRR .68, 95% CI 0.46, 1.0, p= 0.047). Therefore, this variable was considered for inclusion in the multivariable analysis as a potential associated and control variable. There was no violations of statistical assumptions or goodness of fit for these analyses.

3. **Univariable analysis –** BMI

The univariable regression analysis showed that the number of days is expected to decrease at a rate of .63 with every unit change in BMI (IRR 0.93, 95% CI 0.88, 0.99, p= 0.017). Therefore, this variable was considered for inclusion in the multivariable analysis as a potential associated variable. There was no violations of statistical assumptions or goodness of fit for these analyses.

4. **Univariable analysis –** Average number of sport hours per week

The univariable regression analysis showed that the average number of sport hours per week was not associated with a shorter or longer RTP (IRR 0.98, 95% CI 0.96, 1.01, p= 0.23). Therefore, this variable was not included in the multivariable analysis.

5. **Univariable analysis –** Primary sport type

The univariable regression analysis showed that the primary sport type was not associated with a shorter or longer RTP (IRR 0.83, 95% CI 0.57, 1.22, p= 0.34). Therefore, this variable was not included in the multivariable analysis.

6. **Univariable analysis –** Recurrent injury

The univariable regression analysis showed that recurrence of injury was not associated with a shorter or longer RTP (IRR 0.80, 95% CI 0.54, 1.19, p= 0.27). Therefore, this variable was not included in the multivariable analysis.

7. **Univariable analysis –Cause of injury**

The univariable regression analysis showed that the number of days is expected to decrease at a rate of .64 for participants who had sustained a lateral ankle sprain injury while playing sports compared to participants who did not sustain a lateral ankle sprain injury while playing sports (IRR 0.64, 95% CI 0.42, 0.98, p= 0.04). Therefore, this variable was considered for inclusion in the multivariable analysis as a potential associated variable. There was no violations of statistical assumptions or goodness of fit for these analyses.

8. **Univariable analysis –** Injured dominant side

The univariable regression analysis showed that the injured dominant side was not associated with a shorter or longer RTP (IRR 0.82, 95% CI 0.54, 1.25, p= 0.36). Therefore, this variable was not included in the multivariable analysis.

9. **Univariable analysis –** Mechanism of injury

The univariable regression analysis showed that the number of days is expected to increase at a rate of 2.12 for participants with inversion injury compared to participants with a plantar flexion mechanism (IRR 2.12, 95% CI .91, 4.92, p= 0.08). Therefore, this variable was considered for inclusion in the multivariable analysis as a potential associated variable. There was no violations of statistical assumptions or goodness of fit for these analyses.

10. **Univariable analysis –** Pain severity when non-weight bearing

The univariable regression analysis showed that pain severity was not associated with a shorter or longer RTP (IRR 1.05, 95% CI 0.95, 1.17, p= 0.36). Therefore, this variable was not included in the multivariable analysis.

11. **Univariable analysis –** Joint swelling

The univariable regression analysis showed that joint swelling was not associated with a shorter or longer RTP (IRR 1.25, 95% CI 0.78, 2.01, p= 0.36). Therefore, this variable was not included in the multivariable analysis.

12. **Univariable analysis –** Active dorsi flexion reduced because of pain

The univariable regression analysis showed that the number of days is expected to increase at a rate of 1.60 for participants with restricted dorsi flexion due to pain compared to participants who did not have restricted dorsi flexion due to pain (IRR 1.60, 95% CI 1.04, 2.47, p= 0.032).

Therefore, this variable was considered for inclusion in the multivariable analysis as a potential associated variable. There was no violations of statistical assumptions or goodness of fit for these analyses.

13. **Univariable analysis –** Active plantar flexion reduced because of pain

The univariable regression analysis showed that restricted plantar flexion due to pain was not associated with a shorter or longer RTP (IRR 0.99, 95% CI 0.66, 1.47, p= 0.96). Therefore, this variable was not included in the multivariable analysis.

14. **Univariable analysis –** Active eversion reduced because of pain

The univariable regression analysis showed that restricted active eversion because of pain was not associated with a shorter or longer RTP (IRR 1.10, 95% CI 0.72, 1.69, p= 0.65). Therefore, this variable was not included in the multivariable analysis.

15. **Univariable analysis –** Active inversion reduced because of pain

The univariable regression analysis showed that restricted active dorsi flexion because of pain was not associated with a shorter or longer RTP (IRR 0.96, 95% CI 0.63, 1.48, p= 0.87). Therefore, this variable was not included in the multivariable analysis.

16. **Univariable analysis –** Days until pain free walking

The univariable regression analysis showed that days until pain free walking was not associated with a shorter or longer RTP (IRR 1.00, 95% CI 1.00, 1.01, p= 0.80). Therefore, this variable was not included in the multivariable analysis.

17. **Univariable analysis –** Self-reported chronic instability

The univariable regression analysis showed that the number of days is expected to increase at a rate of 1.35 for participants who had chronic ankle instability compared to those who did not have chronic ankle instability (IRR 1.35, 95% CI 0.87, 2.09, p= 0.18). Therefore, this variable was considered for inclusion in the multivariable analysis as a potential associated variable**.** There was no violations of statistical assumptions or goodness of fit for these analyses.

18. **Univariable analysis –** SF36 Physical function component

The univariable regression analysis showed SF36 was not associated with a shorter or longer RTP (IRR 1.00, 95% CI 0.99, 1.01, p= 0.65). Therefore, this variable was not included in the multivariable analysis.

19. **Univariable analysis –** Treatment programme

The univariable regression analysis showed that the number of days is expected to decrease at a rate of .76 for participants who treated themselves compared to participants who had professional treatment (IRR 0.76, 95% CI 0.52, 1.13, p= 0.17). Therefore, this variable was considered for inclusion in the multivariable analysis as a potential associated variable. There was no violations of statistical assumptions or goodness of fit for these analyses.

20. **Univariable analysis –** NSAIDs

The univariable regression analysis showed that the use of NSAIDs was not associated with a shorter or longer RTP (IRR 1.22, 95% CI 0.82, 1.80, p= 0.33). Therefore, this variable was not included in the multivariable analysis.

A summary of the results of the univariable regression analyses is presented in Table 6-14**.**

Table 6-14 Univariable generalised linear regression (Negative Binomial Regression)

Explanatory variables	**Univariable Coefficient IRR**	**95% CI**	**P-value**
Age	0.99	0.97, 1.01	0.22
Sex	0.68	0.46, 1.0	0.047
BMI	0.93	0.88, 0.99	0.017
Average number of hours per week for overall sport activity	0.98	0.96, 1.01	0.23
Type of sport	0.83	0.57, 1.22	0.34
Recurrent injury	0.80	0.54, 1.19	0.27
Cause of injury**,** Sport vs non-sport	0.64	0.42, 0.98	0.04
Injured dominant side	0.82	0.54, 1.25	0.36
Mechanism of injury	2.12	0.91, 4.92	0.08
Pain severity at non-weight bearing	1.05	0.95, 1.17	0.36
Joint swelling	1.25	0.78, 2.01	0.36

Explanatory variables	Univariable Coefficient IRR	95% CI	P-value
Restricted AROM of dorsi flexion because of pain	1.60	0.91, 4.92	0.032
Restricted AROM of plantar flexion because of pain	0.99	0.66, 1.47	0.96
Restricted AROM of eversion because of pain	1.10	0.72, 1.69	0.65
Restricted AROM of inversion because of pain	0.96	0.63, 1.48	0.87
Days until pain free walking	1.00	1.00, 1.01	0.80
Self-reported chronic instability	1.35	0.87, 2.09	0.18
SF36 Physical function component %	1.00	0.99, 1.01	0.65
Treatment program	0.76	0.52, 1.13	0.17
NSAIDs	1.22	0.82, 1.80	0.33

The chosen variables in the multivariable regression analysis are listed in Table 6-15**.** All of those variables were chosen based on the strength of the IRR and P-values < 0.2. Age and sex were predetermined for inclusion as they were shown to be potential influencers of recovery and RTP after sport injuries.

Table 6-15 The selected explanatory variables for inclusion in the multivariable analysis

Explanatory variable	IRR	P value	Why chosen?
Age	0.99	0.22	Determined in previous observational studies as a potential influencer for RTP/recovery after sport injuries.
Sex	0.68	0.047	Determined in previous observational studies as a potential influencer for RTP/recovery after sport injuries. In addition, it had high effect size (IRR) and p-value < .2 in this study
BMI	0.93	0.017	Had p-value < .2

Explanatory variable	IRR	P value	Why chosen?
Cause of injury	0.64	0.04	Had high effect size (IRR) and p-value < 0.2
Mechanism of injury	2.12	0.08	Had high effect size (IRR) and p-value < 0.2
Restricted AROM of dorsi flexion because of pain	1.60	0.032	Had high effect size (IRR) and p-value < 0.2
Self-reported chronic instability	1.35	0.18	Had high effect size (IRR) and p-value <0 .2
Treatment program	0.76	0.17	Had high effect size (IRR) and p-value < 0.2

6.5.3.2 **Multicollinearity testing**

Multicollinearity exists when there is a strong correlation between two explanatory variables in multivariable models (Field 2013). As the amount of multicollinearity decreases, the multivariable model is less likely to be affected. However, if it increases, the outcome of the model might be affected in three ways:

1. Untrustworthy regression coefficients

The increased multicollinearity may increase the likelihood of the estimations of standard errors of the regression coefficients. That in turn makes the b coefficient in a sample become less trustworthy, thus less likely to represent the population where the sample has been drawn from.

2. Limits the size of R

The size of the correlation between the values of the explanatory variables and the observed values is referred to as R. The inclusion of two highly correlated explanatory variables has an effect on the estimation of the variance in the multivariable model. Adding both highly correlated explanatory variables together in the model is counterproductive, as it leads to the inaccurate calculation of the overall variance.

3. Importance of explanatory variables

Entering two or more highly correlated variables in the multivariable model makes it difficult to determine which one of them is causing a true effect, and therefore, an accurate level of significance of the contribution to the model for each of the variables might not be properly calculated.

For this reason, it was very important to test the multicollinearity between all the explanatory variables before entering them into the multivariable model. One way to check the multicollinearity was by analysing the correlation between the selected variables. If a pair of variables had a high correlation, then one of the pair has to be excluded from the multivariable analysis.

In this study, the correlation analysis between all the selected explanatory variables (age, sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain**,** self-reported chronic instability and treatment programme) was carried out (Table 6-16). There was no significant correlation between each pair of all of these selected explanatory variables.

Table 6-16 Correlation analysis between the selected explanatory variables (Spearman Correlation).

	Age	**Sex**	**BMI**	**Cause of injury**	**Mechanism of injury**	**Restricted active dorsi flexion because of pain**	**Self-reported chronic instability**	**Treatment program**
Age	1	-0.075	0.296	0.039	0.151	0.060	.072	.002
Sex	-0.075	1	-0.117	0.099	-0.137	-0.031	-.323	.122
BMI	0.296	-0.117	1	-0.113	0.260	-0.01	.10	-.01
Cause of injury	0.039	0.099	-0.113	1	-0.057	0.028	.000	.037
Mechanism of injury	0.151	-0.137	0.260	-0.057	1	-0.143	.059	.052
Restricted active dorsi flexion because of pain	0.060	-0.031	-0.011	0.028	-0.143	1	.059	.113
Self-reported chronic instability	0.072	-0.323	0.017	0.000	0.059	0.059	1	.126
Treatment program	0.002	0.122	-0.032	0.037	0.052	0.113	.126	1

In addition, multicollinearity diagnostics were carried out using linear regression analysis to investigate the collinearity effects (tolerance and variance inflation factor, VIF) of all the explanatory variables on each other. The calculation of tolerance and VIF was not assumed to be affected by the presence of the criterion variable (RTP), as it was not included in this analysis (multicollinearity analysis). Instead, it was carried out by considering one explanatory variable (age) at a time as a criterion/dependent variable, while the remaining explanatory variables were considered as independent variables (sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain**,** self-reported chronic instability and treatment programme). This step was repeated until all of the explanatory variables had been tested against each other. A sample model is illustrated in Table 6-17. In this sample model, as well as in all of the other diagnostic models in this study, the results showed a tolerance ranging between approximately 0.84 and 0.99 and the VIF being approximately 1, which indicates that there was no multicollinearity between the selected potential explanatory variables (Field 2013), p.325). Therefore, it was safe to investigate all of them either together or separately in the multivariable model.

Table 6-17 Multicollinearity Diagnostics using Linear Regression.

Model		**Tolerance**	**VIF**
1	Sex	0.84	1.19
	BMI	0.92	1.02
	Cause of injury	0.99	1.07
	Mechanism of injury	0.89	1.13
	Self-reported chronic instability	0.88	1.14
	Restricted active dorsi flexion because of pain	0.97	1.04
	Treatment program	0.94	1.06

Dependent Variable: Age.

6.5.3.3 **Multivariable analysis**

Multivariable regression refers to the analysis of the relationship between a set of two or more explanatory variables and the criterion variable (Field 2013).

The significant explanatory variables that were identified from the univariable analysis (age, sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain**,** self-reported chronic instability and treatment program) were modelled. Additionally, age and sex were also added to the multivariable model to examine their contribution in the presence of the other significant variables. Those two variables were included as they were shown to be important variables in the previous observational studies.

All of the selected explanatory variables were entered into the multivariable model using a modified forward stepwise regression method. The significance (α-level) was set at 0.05, with the intention of maintaining the significance level of the variables at p-value <0 .1 for the most stable model.

During the multivariable analyses, many models were developed that had different combinations of explanatory variables. Those models were identified through a series of multivariable modelling analyses (examples of other multivariable analysis are listed in Appendix 19. They were listed to compare the goodness of fit and the significance of the models, as well as the significant and effect size of each explanatory variable. Two models were presented in order to compare their results and to justify the selection of the final most stable and significant model.

6.5.3.3.1 **Multivariable Model 1:** age, sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain**,** self-reported chronic instability and treatment programme Vs RTP

This example model consisted of all six explanatory variables that were identified through the univariable analyses and the two control variables (age and sex). Regression analysis shows the IRR, as well as the significance values of each variable in the model (Table 6-18). It also provides information about the goodness of fit and the significance of the whole model.

Table 6-18 Regression Coefficients of the First Principle Model of Multivariable Regression Analysis.

Explanatory variable	IRR Exp(B)	95% CI	P-value
Age	1.00	0.98, 1.03	0.81
Sex	0.80	0.51, 1.24	0.31
BMI	0.94	0.88, 1.00	0.03

Explanatory variable	IRR Exp(B)	95% CI	P-value
Cause of injury	0.71	0.45, 1.13	0.15
Mechanism of injury	1.70	0.70, 4.09	0.24
Self-reported chronic instability	1.25	0.78, 2.00	0.35
Restricted AROM of dorsi flexion because of pain	1.71	1.05, 2.79	0.03
Treatment program	0.73	0.47, 1.11	0.14
Goodness of fit of the model	AIC	LR Chi^2	P-value
	942.16	16.79	.032

Within this model, two variables had a good effect size (IRR) and a p value lower than .1; BMI (IRR 0.94, p-value = 0.03) and restricted active dorsi flexion because of pain (IRR 1.71, p-value = .03). The remaining variables had a p value higher than .1: age (p-value = 0.81), sex (p- value = 0.31), cause of injury (p-value .15), mechanism of injury (p-value = 0.24), self-reported chronic instability (p-value = 0.35) and treatment programme (p-value = 0 .14).

6.5.3.3.2 **Multivariable Model 2-**mechanism of injury, restricted active dorsi flexion because of pain and treatment methods Vs RTP

This final model composed of the three explanatory variables: mechanism of injury, restricted active dorsi flexion because of pain and treatment methods. The other five variables (age, sex, BMI, cause of injury and self-reported chronic instability) did not contribute to a better variance in the previous multivariable models (Table 6-19).

Table 6-19 Regression Coefficients of the Second Principle Model of Multivariable Regression Analysis.

Explanatory variable	IRR Exp(B)	95% CI	P-value
Intercept	15.28	5.94, 39.33	0.000
Mechanism of injury	2.38	1.02, 5.57	0.046

Explanatory variable	IRR Exp(B)	95% CI	P-value
Restricted active dorsi flexion because of pain	1.71	1.07, 2.73	0.025
Treatment methods	0.76	0.48, 1.06	0.091
Goodness of fit of the model	AIC	LR Chi2	P-value
	998.516	9.06	0.029

Within this model, three variables had a good effect size (IRR) and a p value of < 0.1, namely mechanism of injury (IRR 2.38, p-value = 0.046), restricted AROM of dorsi flexion because of pain (IRR 1.71, p-value = 0.025) and treatment methods (IRR 0.76, p-value = 0.091). This model was repeatedly compared with other models to check its stability and significance level and it was found the most stable one (goodness of fit AIC 998.516 and the significance of the fitted model p-value = 0.029).

As part of the data analysis process, the study management team (SB, CB, MW and LG) reviewed the outcome of the multivariable analysis and decided that Model 2 is the most stable and significant model among all other multivariable models. A senior statistician from the University of Southampton (SE) was also involved in this process. The decision was based on the individual regression coefficient (Exp IRR) of the investigated variables and the goodness of fit and significance level of the whole model.

Therefore, the contribution of the explanatory variables in the final model (Table 6-19) can be interpreted as follows:

1. The number of days of RTP are expected to increase at a rate of 2.38 for participants with an inversion injury compared to participants with a plantar flexion injury, given that all of the other variables are held constant in the model.

2. The number of days of RTP are expected to increase at a rate of 2.38 for participants with restricted active dorsi flexion because of pain compared to participants with no restricted dorsi flexion, given that all of the other variables are held constant in the model.

3. The number of days of RTP are expected to decrease at a rate of 0 .76 for participants who treated themselves compared to participants who had medical healthcare, given all other variables are held constant in the model.

6.5.3.4 **Summary of regression analysis**

The regression analysis in this study investigated many multivariable models that had different combinations of explanatory variables. Those resulting models differed in terms of type and number of variables that were included or excluded in each model. The variables that had less or more significance and coefficient values were repeatedly included or excluded in order to obtain the most stable model. As a result, Model 2 was found to be a better model. It was then selected as the focus for discussion in this study.

6.5.4 **Other factors that might influenced RTP (open-ended questions)**

Ten participants (9%) provided answers to open-ended questions (Appendix 20). A summary of potential influencing factors is illustrated in Figure 6-7. The data derived from those questions was analysed using NVivo software 12 (Windows). The responses were entered into the NVivo software according to the order of corresponding questions. Thematic analysis procedures were followed, which was first initiated by reading through the responses to the open-ended questions to achieve an overview of the content. Then, the data was grouped into units of meaning that are regarded as codes in the NVivo software. The resultant codes represent specific units of ideas, statements, phrases or words that share a common meaning. For example, the emerging code "support and relationship" was informed by several statements such as "Supports and relationships", "my parents supported me and so did my coaches to take it easy" and "team cohesion and relationships". Then the emerging codes were linked to one of the three main components of the classification of the International Classification of Function (ICF).

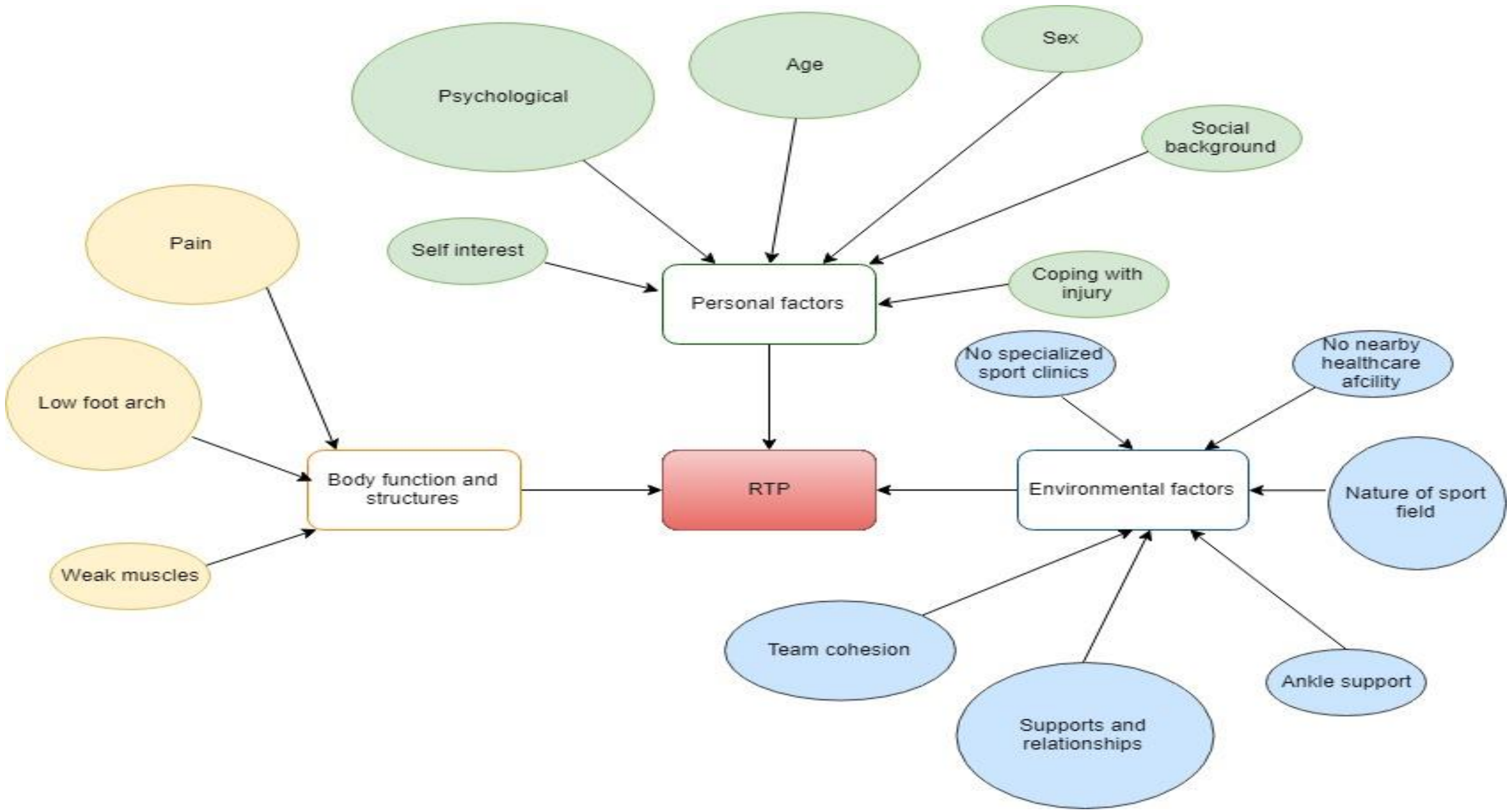


Figure 6-7 Other potential influencing factors from open ended questions

Those questions were asked to explore other potential influencing factors and, after analysing them, they seemed to be related to making decisions for RTP. Thus, they provided an insight into what might be contributing to shorter or longer RTP. They were found worthy to be explored in depth for their relationship with RTP, and therefore they were used to inform the methods of a following qualitative study to investigate them further. In particular, the main and prompting questions of the qualitative study (0) were informed by those responses.

6.6 Discussion

This study was conducted to determine the associated factors for RTP after a conservatively treated lateral ankle sprain. Sportspeople who had sustained a lateral ankle sprain were surveyed in order to understand the cause of the lateral ankle sprain and their decisions for RTP after this injury. This study is the first known study to investigate the relationship between demographic, sport-related and clinical factors and RTP in a population with a lateral ankle sprain. The potential associated factors investigated in this study are those that can be instantly collected on the sports field, when a quick decision on RTP is required by everyone such as coaches, athletes and parents. They can also be identified in clinical settings such as in emergency departments, where a larger numbers of patients do not allow adequate time for other clinical tests and lengthy self-report questionnaires.

Inferential statistics were conducted to better understand the characteristics of the participants, as well as the relationship with RTP. They included information about age, sex of participants and primary sport types.

6.6.1 Age

This study included participants with a wide age range: 18 to 65 years. However, most of lateral ankle sprain injuries occurred in those individuals aged 18 to 36 years (73%). These results were higher than those calculated in the second study (5.6.1), in which 55% occurred in young patients with a similar age. This could perhaps be due to the difference between the two populations in these two studies. Study two recruited patients (general population) from an emergency department, whereas this study (Study three) focused on a sports population. Across England, 3.83 million young people aged between 16 and 25 years old take part in sports at least once a week (Sports England 2016). Similar results were found in previous studies, that is to say that lateral ankle sprain is more prevalent in the younger population (Bridgman et al. 2003; Cloke et al. 2009; Waterman et al. 2010; Cloke et al. 2011). Holmer et al. (1994) noted a higher incidence of lateral ankle sprain in men aged less than 40 years old, whereas women (over the age of 40) sustained more injuries compared to men ($p < 0.01$). The frequency of injury in this study was found to increase with age in participants aged 18 to 22 years old (35%). This is again in agreement with the results found in Study two of this thesis (5.6.1), as well as those observed in other epidemiological studies (Holmer et al. 1994; Bridgman et al. 2003; Waterman et al. 2010).

Aging was found to be accompanied with many physiological changes such as decreased water and collagen content in the ligament, a slower healing process due to decreased active fibroblast cells and decreased elastic properties, which may, in turn, predispose an individual to ligament injuries (Woo et al. 1991; Cereatti et al. 2010). Older patients are reported as having a delay in returning to baseline functional activities compared to younger patients with an ankle fracture (Egol et al. 2006) and hip fractures (Aharonoff et al. 1997; Skovron et al. 1997). O'Connor et al. (2013) found that a higher age was associated with lower function at four weeks post injury ($p< 0.01$; adjusted R square=0.34) and at four months ($p< 0.01$; adjusted R square=0.20) after a lateral ankle sprain. However, in this study, there was no significant difference between the four age groups: 18-25, 26-35, 36-45 and 46-65 ($p= 0.387$), although older participants (46-65 years) seemed to have a quicker RTP (median= 14 days). Therefore, it can be speculated that the fourth age group (46-60 years) had a shorter RTP because they were practising less intense types of sport that involve a smaller risk of sports collision, twisting and jumping and therefore participants thought it was easier for them to resume those sporting activities. Another reason for this observation could be that this group was comprised of very few participants (n=11) compared to those in the other three groups (n=49, 21 and 26, respectively). Therefore, these results should be treated with caution, as larger samples are required to produce more statistical power.

6.6.2 **Sex**

This study showed a higher prevalence of injury among men (56%) compared to women (44%). However, previous cross-sectional studies have showed a more equal distribution of injury between men and women. For example, 49.6% of men and 50.3% of women were calculated to have experienced a lateral ankle sprain in Study two of this thesis (5.6.2). Another epidemiological study conducted in the US investigated the prevalence of lateral ankle sprain in an emergency department and calculated similar percentages of 50.3% for men and 49.7% for women (Waterman et al. 2010). The literature is divided on the influence of sex on the prevalence of and recovery from sport injuries. Some researchers advocate that women are more prone to injuries such as lateral ankle sprain (Hosea et al. 2000; Beynnon et al. 2005; Leininger et al. 2007; Vuurberg et al. 2018) and anterior cruciate ligament tear (Powell and Barber-Foss 2000;

Mountcastle et al. 2007; Caplan and Kader 2014). In contrast, Holmer et al. (1994) found that men sustained more injuries than women during sporting activities (54% and 33%, respectively). Others found no significant differences between men and women (Lauder et al. 2000; Beynnon et al. 2001; Bridgman et al. 2003; Waterman et al. 2010; Al Bimani et al. 2018a). Is not clear whether the intensity of sports determines the risk of injury, or perhaps men play more vigorous sports compared to women. However, several intrinsic factors have been suggested to explain the increased incidence of ACL injury among women in sports. These factors might be lower limb alignment (Hutchinson and Ireland 1995), intercondylar notch shape (LaPrade and Burnett 1994; Shelbourne et al. 1997), joint laxity (Jones 1980), hormonal effects (Lutter and Lee 1993; Wojtys et al. 1998), ligament size (Hutchinson and Ireland 1995; Shelbourne et al. 1997), and body weight (Goldberg et al. 1984).

In terms of lateral ankle sprain, there is a lack of evidence to show the outcome of conservative treatment following lateral ankle sprains on different sexes (men and women). It is currently unclear whether the sex of patients affects the course of recovery from lateral ankle sprain. Furthermore, there is limited evidence as to whether or not those different factors have a direct influence on decision-making for recovery and time to return-to-sport. The results of this study showed a significant difference ($p= 0.047$) between time to RTP for men compared to women (95% CI 0.460, 0.995), as men were found to RTP faster than women. Other authors have also reported differences in sex being associated with recovery time across different types of sport injuries. For example, in one study, significant results ($p=0.042$) showed that men returned to a higher sport level than women after ACL reconstruction (Sandon et al. 2015). Furthermore, female Malaysian athletes were found to take more than six weeks to return to sporting activities ($p < 0.05$) compared to men after a hamstring strain injury (Mohamad Shariff et al. 2013).

In this current study, the sex of participants was intended to be included in the multivariable analysis as a control variable, whether it was found to be significant or not in the univariable analysis. However, it was found to be a significant an associated variable in the univariable analysis and was included in the multivariable modelling to investigate its effect on the presence of other significant associated factors. In the multivariable analysis, the sex of participants did not contribute to a stable model; therefore, it was removed from the final multivariable model. Although the sex of participants did not contribute to a better multivariable model, it still showed a significant relationship with RTP independently from other variables (univariable analysis). Therefore, it is recommended that it is included in future studies as a potential factor associated with lateral ankle sprain.

6.6.3 **Primary sport**

In general, lateral ankle sprain is a very prevalent injury in sports (Fong et al. 2007; Doherty et al. 2014), including those sport types that were identified in this current study. Individuals who play sports such as squash (Berson et al. 1981), football (Brynhildsen et al. 1990a), Australian football (Orchard et al. 1998), rugby (Gerrard et al. 1994), hockey (Murtaugh 2001), and volleyball (Verhagen et al. 2004) were more at risk of sustaining a lateral ankle sprain. This could be explained by the fact that these types of sport require running, turning and jumping, which exert a greater pressure on lower limb joints, particularly the ankle. This could also be related to the greater likelihood of collisions while playing these sports, which, in turn, may increase the risk of injury (McKay et al. 2001). For instance, football players were found to have a unique mechanism of injury when a hit is directed at the medial side of the ankle, forcing the player to bear weight on an inverted foot and thus straining the lateral ligament (Andersen et al. 2004). Precautionary measures should be considered to protect ankle ligaments, especially the lateral ligament, in those sports, in order to minimise the risk of injury. Ankle supports and taping could be also applied to protect the recovering ligament upon RTP after this injury.

In this study, the most prevalent sports were football (22%), rugby (16%) and running (14%). Although running had the shortest median for RTP (15 days) compared to football (median, 34 days) and rugby (median, 36 days), the Negative Binomial statistics showed no significant difference between football and rugby ($p= 0.48$) or between football and running ($p= .18$). The relationship between all of the types of sport in this study and RTP could not be calculated due to the wide range of sports (twenty-three reported sport types). Thus, only three sports were analysed, however, this resulted in only a small number of participants making up part of the sample, as there were few participants in each group. For this reason, future research that focuses on specific sport populations with bigger samples is warranted. By doing so, better comparisons of RTP might be found for individuals that share similar sport attributes. In addition, considering other factors such as level and nature of sport, as well as potential environmental factors such as the nature of the playing court, indoor vs outdoor, natural grass vs artificial turf, shoe type, and presence or absence of a medical team is recommended to inform better RTP decisions (Creighton et al. 2010; Kenow 2014). Those factors were considered when the questions for the following qualitative study (Study four) were constructed.

6.6.4 Decisions for RTP and the presence of residual symptoms

This study confirmed an important issue about recovery from a lateral ankle sprain. The majority of participants (84%) in this the study decided for themselves when to resume their sporting activities. Most of those participants resumed their sports despite having residual symptoms such as pain, joint swelling and restricted range of joint motion. These results may indicate that players were not aware of clinical recommendations to make a safe decision to RTP after a lateral ankle sprain. In fact, currently, there are no clear evidence-based guidance for safe RTP after lateral ankle sprain (4.5.3). A recent systematic review found no previous studies that used a criteria-based RTP decision making process for sportspeople who had suffered a lateral ankle sprain injury (Tassignon et al. 2019). However, they emphasised the use of return to play/ sport/ work as an important criterion measure after a lateral ankle sprain injury and consideration of different factors to inform safer RTP after a lateral ankle sprain. Indeed, the unavailability of clear clinical recommendations for RTP creates confusion and players may decide on a premature RTP, and thus continue to have residual symptoms afterwards. It was found that during the first three months, 65% of participants suffered from joint instability and 24% reported at least one restrain after a lateral ankle sprain (van Middelkoop et al. 2012). They further found that re-sprains and pain at rest at the follow-up, three months after the initial injury, were also related to incomplete recovery seen at the twelve-month follow-up. The development of re-injuries, chronic pain, joint swelling, restricted range of motion and instability may arise because of making a premature decision to RTP. A retrospective cohort study calculated an incidence of 18% of recurrent injuries and 46% residual pain, 25% of anterior ankle impingement and 82% tibiotalar osteophyte bone formation in the long-term (Kemler et al. 2016). Furthermore, Gerber et al. (1998) found that 55% of those who returned to sports activities within six weeks had symptoms such as pain, loss of function and a decrease in the lateral hop test. The same authors found that when all of the participants returned to sports within six months, 40% still complained of the same residual symptoms. Other authors have calculated even shorter timeframes for RTP, in which 70% of participants returned to sporting activities within three days after a lateral ankle sprain (McKeon et al. 2014). These short recovery durations conflict with previous physiological studies that recommend an average ligament tissue healing time of six to twelve weeks, in order to allow for scar tissue to mature to full strength (Hubbard and Hicks-Little 2008).

Making a safe decision to RTP is a multifactorial process, which involves both the clinician and sportsperson making a timely and correct decision. Many factors need to be considered in order to reach a sound decision regarding RTP. The evaluation of the individual’s health status and participation risk are very important steps that must be integrated into the process of making a safe decision to RTP (Creighton et al. 2010; Ardern et al. 2016). Knowing the demographic, personal and clinical factors, as well as having knowledge of the ligament healing process might facilitate better decision-making regarding the recovery after this injury.

A decision-based model for RTP was proposed by Creighton et al. (2010), who highlighted the factors that should be considered when making decisions for safe RTP (4.1). In their model, they proposed three steps: the evaluation of health status, the evaluation of participation risk and decision modification. These three steps are more applicable for those who play team sports professionally and have a clinician that is responsible for making RTP decisions for the players. However, individuals who practice sports at a recreational level also need simple, yet evidence-based RTP recommendations. Studies have shown that approximately 57% of individuals did not receive any professional treatment following their lateral ankle sprain injury (McKay et al. 2001). Furthermore, a very similar percentage was calculated in study two of this thesis (5.6.4), which indicated that 58% were sent home from hospital with no follow up or information about RTP. In this study, 84% of participants decided a RTP timeframe for themselves without seeking any professional advice, since they may not have had any clear guidance on when to safely RTP. Indeed, it could be that they are actually unaware of any existing treatment and RTP recommendations. Therefore, a follow-up study needs to be conducted to explore why those people did not seek any professional assistance. Furthermore, exploring behavioural factors is also important to help understand the reasons for not seeking professional advice for RTP. By doing so, it could be possible to minimise residual symptoms that occur after RTP, thus minimising the burden on healthcare services. Another explanation for this could be that those participants were actually given RTP recommendations, but they simply chose not to follow them. In addition, it has been reported that at least 40% of athletes failed to comply with the RTP recommendations after sport concussions (Cancelliere et al. 2013). This could be a reason why most participants in this study did not seek professional treatment, and therefore had residual symptoms at time when they resumed their sports training.

6.6.5 **Factors associated with RTP**

The unadjusted analysis in this study showed that age, sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain**,** self-reported chronic instability and treatment programme were associated with time to RTP. As a result, all of these variables were examined in the multivariable modelling. The fully adjusted multivariable regression results showed that mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment programme were stronger factors associated with RTP, as they contributed to the most stable multivariable model.

6.6.5.1 Mechanism of injury

The mechanism of injury for lateral ankle sprain has been widely investigated in previous literature, since determining the most common mechanism of injury might be helpful to inform appropriate preventative and treatment methods (Anderson 2002; Kristianslund et al. 2011). Previous kinematic studies have shown that a joint forced into an inversion movement is the typical mechanism of injury for lateral ankle sprain injuries (Andersen et al. 2004; Dubin et al. 2011; Kristianslund et al. 2011). Other studies have recorded a mechanism injury that involved a combined movement of inversion, internal rotation and plantar flexion (Wei et al. 2015). Therefore, the mechanism of injury in this study was dichotomised into inversion and plantar flexion mechanisms.

In this study, about 92% of participants sustained an inversion mechanism compared to plantar flexion. This is in agreement with the findings of previous studies, which state that inversion is the most common mechanism of injury for lateral ankle sprains (Andersen et al. 2004; Dubin et al. 2011; Kristianslund et al. 2011). It was also noted in the second study in this thesis that 98% of patients attending an emergency department (n=106) had sustained an inversion injury (5.6.6). These results indicate that this is the most common mechanism of injury for an ankle sprain. Therefore, prevention strategies including protecting against excessive inversion movement might help reduce the incidence and reoccurrence of this injury, especially in those who have had previous ankle injuries.

The results of the multivariable regression model in this study showed that the mechanism of injury was associated with time to RTP after a lateral ankle sprain injury (p=0.046). The counts of RTP are expected to increase by a rate of 2.38 for participants with an inversion mechanism of injury compared to those with a plantar flexion mechanism, while holding all other variables in the model constant. In an inversion injury, the anterior talofibular and calceneofibular ligaments are often injured, whereas only the anterior talofibular ligament is often injured in a plantar flexion injury (Bennett 1994). The involvement of more than one ligament in an inversion injury might be the reason for having a longer recovery time, thus a larger rate for RTP.

Regarding lateral ankle sprain, there has been a lack of studies investigating the relationship between the mechanism of injury and RTP, thus it was not possible to compare the results in this study with those from previous ones. To the best of the researcher’s knowledge, only one study has investigated the relationship between the mechanism of injury and recovery from a lateral ankle sprain (O'Connor et al. 2013). They found that a non-inversion mechanism of injury correlated with lower functional recovery (Karlson score) at four months ($p<0.01$; adjusted R square=0.20).

The regression results of the relationship between the mechanism of injury and the time to RTP in this study were accompanied with a wide confidence interval (95% CI 1.02– 5.57). That wide CI might be due to the vast majority of participants having an inversion mechanism compared to a plantar mechanism (inversion, 92% and plantar flexion, 8%). It could also be due to the low sample size. This variable had a p value of .08 in the univariable analysis and a wide CI 0.91 – 4.92. Although it maintained a conditional p value below .1 in the multivariable model, the CI continued to increase. Therefore, the increased CI could be related to the sample size and sample distribution in both groups, rather than the influence of other associated variables in the multivariable model. Consequently, future studies should consider larger samples that include an adequate number of participants in each group to provide results with more statistical power.

6.6.5.2 **Restricted dorsi flexion because of pain**

Full active range of motion is important when carrying out daily life activities. Furthermore, a limited range of either movements, dorsiflexion or plantar flexion, may result in the disturbance of normal biomechanics and the stability of the joint (Brockett and Chapman 2016). Evidence is divided on the risk of having a restricted range of motion of ankle joint. However, one systematic review that investigated the relationship between lateral ankle sprain and reduced range of motion of the ankle joint found that ankle dorsi flexion is a strongly associated factor with future lateral ankle sprain (de Noronha et al. 2006). In their review, they found that people who have an inflexible ankle joint (34^{o} of dorsi flexion) are five times more likely to be at risk of a lateral ankle sprain compared with people who have average flexibility (45^{o}). Others concluded that the range of motion (dorsiflexion and plantar flexion) are not related to tan increased risk of sustaining a lateral ankle sprain among collegiate soccer, lacrosse, and field hockey athletes (Beynnon et al. 2001) and modern ballet dancers (Wiesler et al. 1996).

In this study, it was found that restricted active range of dorsi flexion due to pain was associated with time to RTP ($p=.025$). In the multivariable model, the counts of RTP (number of days) are expected to increase by 1.71 for participants with dorsi flexion movement restriction compared to those with no restricted movement. In relation to the previous literature, Wilson and Gansneder (2000) found combined ankle joint swelling and loss of ROM to be prognostic factors for time to RTP ($R^2 = 0.342$, $p=0.023$).

In this study, participants reported a reduced range of motion, without clinically recording how much range was available, that is to say, it is not clear whether there was a minor or major restriction in their range of motion after the injury. It might be speculated that the range of joint motion was minimally restricted, therefore they returned to sport earlier than other participants. In addition, the restricted range of motion in this study was defined by the presence of pain during the movement. Therefore, the pain might not have been strong enough to prevent them from practising their sport. In physiotherapy clinical practice (from the researcher's experience), some patients are allowed to resume their sporting activities if the pain they are experiencing and joint restriction are minimal. Participants might also have thought that their symptoms would get better when they played their sports, despite the severity of their injury. These factors should be considered for thorough investigation in order to understand the course of recovery from this injury. That was also considered when main and prompting questions were constructed for the following qualitative study (Study four).

6.6.5.3 **Treatment programme**

Evidence based and carefully structured treatment is essential after a lateral ankle sprain injury (Vuurberg et al. 2018). Indeed, appropriate diagnosis, assessment, treatment and prevention of reoccurrence of injury is of paramount importance in the management of lateral ankle sprain (Kerkhoffs et al. 2012; Vuurberg et al. 2018). After appropriate treatment, sportspeople with lateral ankle sprain may have a shorter recovery time and safe RTP, and thus have less residual symptom after their injury (Vuurberg et al. 2018). They concluded that a course of conservative treatment composed of functional support for a period of four to six weeks, exercise therapy consisting of neuromuscular and proprioceptive exercises and manual join mobilisation techniques and NSAIDs is recommended. Following such evidence-based treatment programmes may help resolve symptoms that are associated with lateral ankle sprain such as pain, restricted movement, joint swelling and instability.

In this study, 42% of the study participants treated themselves without seeking any medical assistance. Out of those who sought medical assistance (58%), only 27% were treated by a physiotherapist, whereas the others were seen by GPs, nurses, ED clinicians and paramedics. Interestingly, those who did not seek professional treatment had a shorter time to RTP (IRR 0.76, $p = 0.17$). They might have decided on a premature RTP, as they did not receive an appropriate treatment programme or guidance on RTP. Indeed, evidence has showed that patients with lateral ankle sprain who received supervised treatment had better outcomes than those patients who received home programmes (van Rijn et al. 2010a; Feger et al. 2015; Vuurberg et al. 2018).

Moreover, participants who received additional supervised exercises had a better recovery and return to sports than those participants who only received conventional treatment (van Rijn et al. 2010a). Similarly, Feger et al. (2015) concluded that supervised treatment programmes are superior to home exercise in terms of reducing pain and joint instability and improving strength and joint position sense (proprioception). Future research is warranted to investigate the reasons behind not having proper rehabilitation programs that leads to sportspeople making their own RTP decisions.

6.7 Strength and potential limitations

6.7.1 Strengths

This study is the first to investigate if demographic, sport and injury related factors are collectively associated with RTP after a lateral ankle sprain. Those factors had not been previously investigated in populations with lateral ankle sprains. The focus on lateral ankle sprains, however, was on the recurrence of injury (McKeon et al. 2014), functional scales, pain and clinical measures (Cross et al. 2002) and physical impairment and activity limitation (Wilson and Gansneder 2000). The variables that were included in this study might be considered potential confounders for recovery after the injury, therefore it was inevitable that all of them were considered in the analysis.

The study questionnaire was developed according to systematic and scientific procedures. The involvement of experts (SB, CB, MW and LG) in the field of the foot and ankle in the construction stage ensured the validity of the questions of this study. In addition, the contribution from the Patient and Public Involvement (PPI) review panel and a psychology teacher was very valuable in terms of selecting the appropriate language and structure for the questionnaire.

It was not stated in previous studies why they employed linear regression over other regression methods. The criterion variable in those studies was time to RTP, which was the number of days from injury until RTP (count data). They considered the criterion variable as a continuous variable. In addition, the number of days is better treated as count data, as there are no decimals or negative numbers. Furthermore, count data is better analysed using generalised regression methods (Poisson or Binomial Negative regression) rather than linear regression (Hilbe 2011). It was also not clear if their choice of statistical analysis method met the assumptions for being the most appropriate regression method. It was also not mentioned if they tested the linearity of data to ascertain whether it was normally distributed or not. Using linear regression is appropriate when analysing a normally distributed criterion variable that can be determined using scatter plots or statistical tests such as the Kolmogorov-Smirnov test of normality. Only one study stated that the data was normally distributed using Lilliefors test, $\alpha = 0.005$ (Wilson and Gansneder 2000).

Multicollinearity diagnostics were conducted to investigate if two or more associated variables were moderately or highly correlated in the regression modelling. However, it was not clear if this was conducted in previous observational studies prior to building the final multivariable model.

Finally, the inclusion of a potential associated variable in the multivariable modelling was based on both statistical power and clinical relevance. A joint decision was taken by the research team, which consisted of clinical and academic members (the researcher, the supervisors and a health sciences statistician). The same team discussed and decided on the most stable model in the multivariable analysis.

6.7.2 **Potential limitations**

The sample size of this study was determined using a rule of thumb according to the recommendations from the literature. According to Green (1991), the minimum required number of participants per variable should be five. Although the number of participants in this study (n=107) satisfied the minimum requirement for regression analysis, the sample size could still be considered a potential limitation in this study. The distribution of participants in some associated variables' dichotomised groups was affected. For example, there were only six participants in the plantar flexion group compared to 98 participants (92%) in the other group (inversion injury). That might have affected the power of the results and resulted in a wide CI in both the univariable and multivariable analyses. Consequently, future studies should aim to recruit larger samples in order to produce results with more statistical power.

Recall bias is a common limitation in retrospective observational studies (Mann 2003). Recall bias is defined as the inability to correctly recall information of past exposure (Tripepi et al. 2008). In order to minimise this, participants in this study were instructed to complete the questionnaire only if they had sustained their lateral ankle sprain in the previous six months. Another method used to minimise recall bias in this study was to carefully construct the questionnaire in order to maximise accuracy and completeness. Despite that, some participants did not provide answers to some of the questions, particularly those investigating the specific history of the injury, such as the date and frequency of previous injuries.

6.8 **Conclusion**

In conclusion, three factors were found to have a strong association with RTP: mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment methods. Results showed that participants who had an inversion injury had longer RTP than participants with a plantar flexion injury. They also showed that participants with restricted ankle dorsiflexion movement because of pain made the decision to RTP later than participants with no restricted ankle joint movement. In addition, participants who treated themselves decided to RTP more quickly than participants who received medical advice and treatment. It was also found that the majority of participants in this study returned to sports despite having residual symptoms such as pain, swelling and restricted ankle joint motion. Furthermore, it was not clear why those participants decided to return to their sporting activity with residual symptoms. These issues were explored in depth in the following qualitative study of this thesis (Study four), with the aim of investigating the experiences and factors that affected sportspeople's decision to RTP after their lateral ankle sprain.

Chapter 7: Study four, Experiences of sportspeople with conservatively treated lateral ankle sprain on RTP: a qualitative study

7.1 Background

This study forms the last phase of this thesis. It was conducted to explore factors influencing RTP in more depth and the decisions for RTP (RTP) from the perspective of sports individuals who had a lateral ankle sprain. Following the previous three investigations in this thesis, a deeper approach was required to understand the experiences of returning to playing sports for individuals who had lateral ankle sprain. Initially, the systematic review (Study one) found that none of the studies included had investigated behavioural factors as factors influencing RTP. However, investigating those factors might help understand the current practice for self-reported RTP. Following that, it was calculated, in the epidemiological study (Study two), that 58% of patients attending the emergency department with lateral ankle sprain were sent home with no follow up treatment or instruction for RTP. At that time, there was no evidence explaining how those patients should treat their injuries and how they could make own decision regarding RTP. Then, potential demographic, clinical and sport-related factors were investigated, to understand their relationship with RTP (Study three). However, it was spotted that about 76% of participants had residual symptoms upon RTP as a result of their lateral ankle sprain injury (section 6.5.2.6). In addition, about 84% of participants made their own decision regarding RTP after their injury. Therefore, the reason why this study was conducted was to investigate the perspectives of sports people with lateral ankle sprains and find out how those individuals made their own RTP decisions and why they returned to play with symptoms (6.5.2.6).

It was not clear why those participants resumed their sporting activities, despite having residing symptoms such as pain, joint swelling and restricted range of motion. Previous studies have also shown that those individuals with a lateral ankle sprain had at least one residual symptom six months to four years after sustaining a lateral ankle sprain injury (Braun 1999; Anandacoomarasamy and Barnsley 2005). It was also indicated that 65% of participants reported ankle instability and 24% reported at least one ankle sprain during the 3 months follow-up after sustaining an ankle sprain (van Middelkoop et al. 2012). In addition, in this thesis (Study three), 55% still complained of ankle instability and 24% considered themselves as not having completely recovered from their injury, despite returning to play. The reasons for this were not fully understood in either case, whether participants sought medical consultations or did not (6.5.2.6). In the previous study (Study three), it was hypothesised that this was due to the majority (84%) of participants making their own decisions for RTP even when experiencing symptoms, and thus further investigation of this was warranted. However, there is a notable lack of qualitative evidence that has investigated the factors affecting RTP following an ankle sprain among sports people. Potentially, there could be some obscure factors, unknown to us yet, that determine how short or long the time period is before RTP after an injury. Exploring those factors further is important, in order to understand the course of recovery after a lateral ankle sprain injury, as well as various factors affecting RTP.

Indeed, a variety of factors that explain the decisions made by individuals for RTP might exist. For example, psychological factors, such as readiness, coping mechanisms, the influence of family members, teammates and coaches, as well as conflicts of interest, fear of litigation and career development were found to be important factors considered in other sports population (Herring et al. 2002; Bauman 2005; Glazer 2009), shoulder instability (McCarty et al. 2004) and following ACL reconstruction surgery (Langford et al. 2009). Therefore, there is evidence to support the view that a prior evaluation of an athlete's psychological readiness or level of confidence is important. This can be attained by investigating the existence of different psychological factors, in order to inform safe RTP and avoid recurrence of the injury. Creighton et al. (2010) proposed a decision-making model for RTP that included evaluating psychological factors to determine athletes' recovery from an injury (4.1). In their model, they highlighted the importance of evaluating the psychological status of the athlete, pressure from the athlete, pressure on the athlete (e.g. from coach, team manager, family) and fear of litigation. However, it is important to note that those factors were not investigated in terms of their relationship with RTP in all of the articles that were included in the systematic review (4.5.2).

Other factors such as structural and functional impairments, as well as personal and environmental factors also need to be considered as part of an in-depth investigation. Although those factors were partly captured in the cross-sectional survey (6.5.3), it was not clear why and how those factors influenced RTP. Understanding the significance of those factors more clearly would improve our understanding of the course of recovery for someone with a lateral ankle sprain injury and help to inform which factors affect decision making regarding RTP.

Therefore, the final investigation of this thesis involved an exploration of the following research questions:

"What are the experiences and factors that affected sportspeople's decision to RTP after a conservatively treated lateral ankle sprain."

Hence, this final thesis chapter involved a qualitative investigation to expand the knowledge and acquire a deeper understanding of the three preceding quantitative investigations.

7.2 **Research aims**

The study aimed to explore the experiences and factors that affected sportspeople's decision to RTP after a conservatively treated lateral ankle sprain.

7.3 **Research objectives**

1. To explore, in more depth, sportspeople's personal experience of making return-to-play decisions.
2. To identify common themes that represent influencing factors for RTP.

7.4 **Methods**

7.4.1 **Study design**

This study employed an inductive qualitative research approach that started with observations, and which eventually led to constructing new theories/ knowledge (Goddard and Melville 2004). Qualitative research is generally referred to as a type of research that investigates a particular topic and produce results that cannot be quantified by regular numeric statistical methods (Strauss and Corbin 1990). It is usually used to overcome the limitations that usually result from deductive quantitative research (Burney 2008). According to Ritchie and Lewis (2003), "qualitative research provides a unique tool for studying what lies behind, or underpins, a decision, attitude, behaviour or other phenomena" (p. 28). In addition, qualitative methods add great value when people's behaviours need to be understood in a particular context. This was exactly the case in this thesis, as it was not possible to ascertain and understand all the possible factors and their influence on RTP in the previous quantitative study (study three). Study three of this thesis showed interesting and unexpected results regarding the number of participants who made their own RTP decisions and resumed training even when experiencing residual symptoms. The results of that study (Study three) showed that most participants (76%) returned to playing sports despite having residual symptoms (6.5.2.6), which led to the question why those participants returned to playing sports despite having symptoms, thus study four was proposed to investigate these issues in depth.

In inductive qualitative research, no theories or hypothesis are utilised at the beginning of the research, as the research approach is flexible in terms of changing the directions of data collection (Bernard 2011). The interpretation of the collected data mainly depends on its nature/ richness and the relationship between the researcher and the targeted study participants. The researcher plays an important role in reflecting and interpreting the data to produce valid results/ themes. This can be attained by gaining an in-depth understanding of words, opinions and experiences of the study participants, rather than on the superficial identification of the occurrences of emerging themes.

In health and rehabilitation research, inductive qualitative research has been increasingly recognised as an important research method used to explore new knowledge and theories (Mays and Pope 2000; Ohman 2005). Furthermore, It has been shown that this approach provides a comprehensive and in depth understanding of a particular topic of interest that has not been investigated before (Bowling 2014). In addition, it allows for participants' experiences to be deeply explored and determined when using this approach, which is not always possible when solely conducting quantitative methods. Moreover, using one research approach might not be adequate to answer all of the research questions around a particular topic (Creswell and Plano Clark 2007). Therefore, the qualitative research approach has been recommended to compliment the results from deductive (quantitative) research designs (Creswell and Plano Clark 2007; Burney 2008). This approach, in particular, the inductive qualitative research, is better used when some observations are largely exploratory in nature (Yilmaz 2013). The reality of qualitative research is that it is socially constructed and dynamic, hence the need to describe the phenomena of interest from the perspectives of the people who are affected by it, which in this thesis is lateral ankle sprain.

An inductive study design was used as to generate a new theory/ knowledge about other factors influencing RTP after a lateral ankle sprain. Those factors such as behavioural ones were not identified in the studies that were included in the systematic review (Chapter 1:) (Al Bimani et al. 2018b). Using this approach, the researcher was able to deeply explore those factors by asking participants broad, in-depth questions to achieve a clearer understanding of the issue. Therefore, individual interviews were conducted to explore the experiences of participants who had sustained a lateral ankle sprain injury. The interview took the form of a qualitative interview, which is a type of research framework that investigates and records the practices and standards of a particular population (Oakley 1998). Qualitative interviews are also used to challenge, reinforce and reconstruct those practices and standards to inform better clinical practice.

7.4.2 **Role of the researcher**

The researcher (SB) was responsible for developing and constructing this study in consultation with experts in the field, including the supervisory team (CB, MW and LG) and others (PPI group), as well as from reading the relevant literature. The research and interview questions were regularly reviewed by those experts, in order to ensure their language and usability was appropriate for the study participants targeted. The researcher's previous knowledge and research skills also guided and facilitated this process. In addition, the researcher attended some courses concerned with qualitative study design and data analysis at the University of Southampton. The researcher attended three courses: 1) Introduction to qualitative data analysis; 2) Doing well at interviews; 3) Using Nvivo to manage and analyse qualitative and mixed data (2 days).

The researcher was also responsible for the recruitment of the study participants for both the pilot study and the main study. Recruiting study participants was done according to the eligibility criteria, which is discussed later in this section. The recruitment process was initialised by contacting sportspeople who had sustained a lateral ankle sprain in the past via online advertisements, posters, e-mails and through contacts at sport clubs and associations.

During the interviews, the researcher played a core role in directing and controlling the interviews and the amount of data collected at the end, with the guidance of the interview guide. Indeed, in qualitative research, the researcher is considered as an instrument of data collection (Denzin and Lincoln 2003). In other words, the data collected is merely mediated by the researcher's "human instrument" rather than by quantified numerical data such as questionnaires and other means of quantitative research. In addition, the researcher prompted and included additional questions during the interviews to gain further in-depth knowledge. The questions asked were largely influenced by the researcher's own experience, communication skills, views, assumptions and expectations (Greenbank 2003). In order to collect good qualitative data, the researcher asked planned interview questions that were supplemented by prompting questions. It was the researcher's responsibility to listen, think and then ask further prompting questions as and when was necessary. By conducting the interviews in this way, it allowed the researcher to extract deeper levels of knowledge about the topic.

After the data collection phase, the researcher was responsible for transcribing and analysing the interviews. The analysis was conducted using Nvivo software, which was installed on a computer on the premises of the University of Southampton. The data analysis, however, was conducted with the assistance of regular discussions between the researcher and the research advisory team (CB, MW and LG).

7.4.3 Planning the interviews

Conducting qualitative research, particularly when carrying out individual interviews, requires methodical and orderly planning (Silverman 2017). Consequently, the researcher carefully planned and selected the interview questions, in order to attain a rich source of data to answer the proposed study objectives. The interview questions were developed based on the study aims and objectives. Additionally, participants were prompted throughout the interview, in case they did not comprehend the main questions. Other considerations such as conducting PPI, pilot study and constructing appropriate eligibility criteria were equally important to ensure the qualitative research was well-designed and well-executed (Figure 7-1).

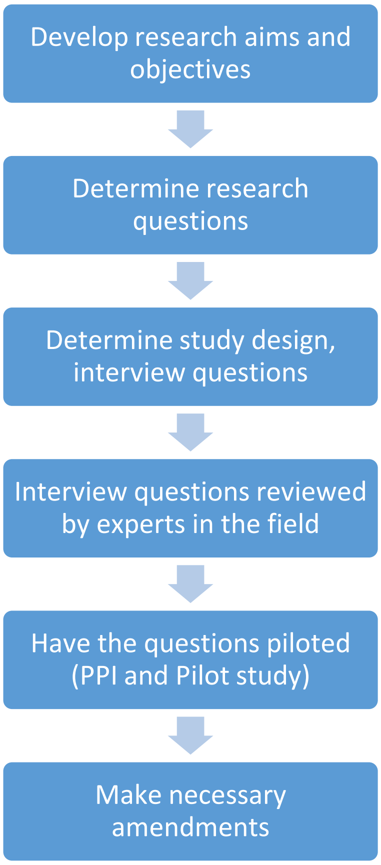


Figure 7-1 Process of developing and reviewing research questions

7.4.4 **Interview questions/ guide**

The interview questions in this study were derived following a review of the literature research regarding the factors related to returning to playing sports following a conservatively treated lateral ankle sprain (Study one), an investigation of the characteristics of patients presenting at the emergency departments with lateral ankle sprain (Study two) and a survey of factors affecting RTP following a conservatively treated lateral ankle sprain (Study 3). Based on the integration and analysis of the findings within these three quantitative investigations, four open ended questions were formulated, and an interview guide was prepared (Appendix 22) to explore the experiences of individuals returning to play their sport following a conservatively treated lateral ankle sprain in more depth. Constructing the interview questions was an important stage in the interview design, as careful development and construction of these would ensure more effective data collection and produce more in-depth information around the research topic. According to McNamara (2009), the wording of effective interview questions should be developed according to the following elements. The following procedures were carried out to create the interview questions/ guide in this current study (Study four):

1. Questions should be open-ended: participants should be given the freedom to construct and say their own answers. The main interview questions should be openly asked, yet specific, in order to gain answers relevant to the research topic.

2. Questions should be as natural as possible: the questions should be asked in a way that allows participants to express their own opinions and experiences without their answers being influenced by the questions (e.g. evocative, judgmental questions).

3. The appropriate wording of questions should be adopted: questions should reflect the purpose and predetermined research aims and objectives. Attention should also be paid to participants’ culture and language, in order to obtain more informative data.

4. Use of the word “Why” should be avoided when asking interview questions: using “Why” when asking questions in interviews may cause participants to think that the interviewer is being dominant or asking for justification for participant’s own decisions.

The interview was guided by in-depth semi-structured questions. In semi-structured interview research, the interview is not dictated by the questions, but rather guided by them (Smith and Osborn 2009). Furthermore, this allows for there to be moments when the researcher can establish good rapport with the participant and encourage him/ her to speak freely and openly. This was indeed implemented during the interview, specifically in cases when the researcher felt that the participant was not disclosing adequate, relevant information or when the participant was not comfortable with the order of the questions.

In semi-structured interviews, the order of the questions is of less importance, since the responses to the questions should guide what the next question is, and so on, until all of the main aspects of the research questions are addressed. The researcher ensured he did not interrupt or ask a new question until the participant had stopped responding adequately to the current question. Following such an approach improves the relationship/ rapport between the researcher and the participants, and also allows for more flexibility when obtaining in-depth and rich data (Smith and Osborn 2009).

An interview schedule of this study was developed to serve as guidance to ensure the main issues of interest related to the study research questions were well addressed, since it is considered to be a tool that ensure that all aspects of the study objectives are covered during an interview (Patton 2002). It is also allows for participants to answer the questions in an unconstrained manner. Furthermore, they can express anything they wish to at any time, without having the researcher stop them. The researcher also maintained a balance between what the participants wanted to express and the interview guide, so that the maximum amount of data possible was obtained.

Following the recommendations above, the interview questions were developed and constructed. The main research questions were developed based on the study aims and objectives, and were also informed by the International Classification of Function (ICF) framework: 1) body functions and structure; 2) personal factors and; 3) environmental factors (Figure 7-2).

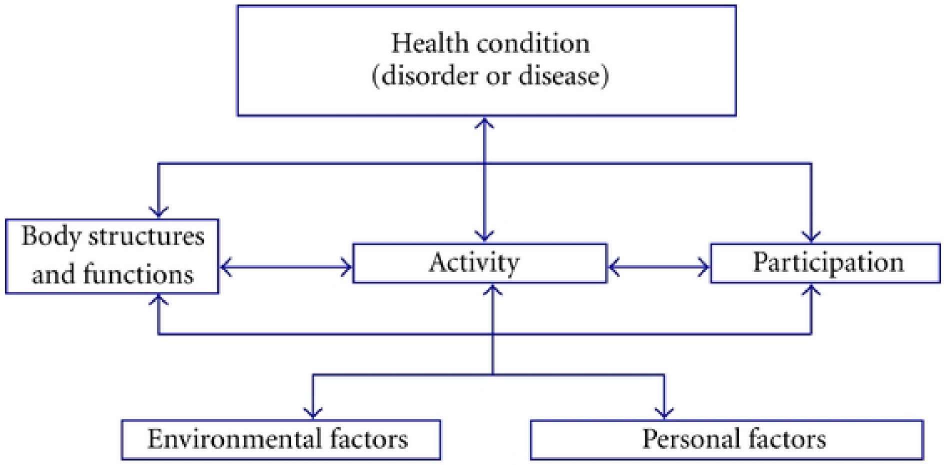


Figure 7-2 International Classification of Functioning, Disability and Health (ICF)

The International Classification of Functioning, Disability and Health, commonly known as ICF, is a framework used to describe health and health related states (World Health Organization 2001). This framework provides a standard and common language for describing the level of functions and factors associated with a person with a particular health condition. It has been widely used to categorise and classify the level of health and functions for various injuries such as musculoskeletal conditions (Scheuringer et al. 2005), stroke (Geyh et al. 2004), osteoarthritis (Dreinhöfer et al. 2004) and rheumatoid arthritis (Dreinhöfer et al. 2004). Therefore, this framework was adopted to inform the construction of the interview questions in this study.

The literature review and results in this thesis (Chapter 4, systematic review) confirmed that there is lack of evidence regarding the various factors influencing RTP after an ankle sprain, especially in terms of behavioural factors. In addition, other personal, structural and environmental factors were also shown to have been underexplored. The interview questions in this study were constructed based on the clinical experience of the researcher and discussions with relevant experts in the field. They were constructed and reviewed following discussions between experts in physiotherapy (SB), podiatry (CB and LG) and mechanics (MW). All of the questions were open-ended and semi-structured. They were divided into two groups: 1) main questions and 2) prompting/ follow-up questions. The four main questions were:

1. Can you tell me about your experience of returning to playing sports after your injury?
2. Can you tell me about how things in your feet affected your return to playing sports?

3. Can you tell me about things related to you as a person that you think influenced your return to playing sports?
4. Can you tell me about things around you that you think influenced your return to playing sports?

The main questions were meant to achieve the aims and objectives of this study, whereas the prompting questions were used to encourage the participants to be as informative as possible when giving their responses (semi-structured interview). The questions had already been discussed with a group of people (PPI) who had the same characteristics of the targeted study population. The PPI group were asked to review the questions in terms of language and understanding and provide suggestions for any amendments.

7.4.5 **PPI sessions**

The patient and public involvement (PPI) in research allows participants to have their say about research that will be conducted among them (Invovle 2019). Their involvement includes reviewing the research design and the process used for data collection. In addition, they also have a say in how the results are disseminated and implemented upon the completion of the research.

For this study, two athletes with similar characteristics of the study population targeted were contacted to review the study design and interview questions. Both athletes had previously sustained a lateral ankle sprain and had already returned to playing their sports. They were regarded as contributors to ensure a better research process and they were not recruited as research participants. They were contacted and invited to participate via social media (WhatsApp) and they agreed to review the study design and study documents. The study documents (study design, interview questions and participant information sheet, PPI) were sent to them by email. They were asked to review those documents in terms of ease of understanding and language. As a result of the PPI review and feedback, modifications were made to the study protocol. Some questions were revised and rephrased in order to make them simple and easily understood. Amendments were also made to the patient information sheet (PIS).

7.4.6 **Pilot study**

Conducting a pilot study is an important aspect of developing the research skills of a novice researcher that is new to the qualitative paradigm (Kim 2010). A pilot study is also referred to as a feasibility study or a small scale preliminary study of the main study (Prescott and Soeken 1989). It is undertaken to evaluate the process used to conduct the main study in terms of study design, participants' recruitment and data collection. In addition, conducting pilot studies helps to build rapport with participants and improve researcher's interviewing skills. Another reason for conducting a pilot study is to improve the planned methods and make any necessary changes and amendments prior to conducting the full-scale research project. It is also an essential stage that provides the opportunity to make amendments to the main study. Additionally, a pilot study equips the researcher with relevant skills and the confidence, which are necessary when conducting qualitative research (Hennink 2007). For those reasons, a pilot study was conducted, however, the data obtained from was not included in the analysis of the main study data, as the data collected was only used to amend the interview questions, improve the researcher's interviewing skills and develop his confidence.

7.4.6.1 **Study sample- Pilot study**

The sample for the pilot study was comprised of two athletes who had a history of lateral ankle sprain (1 man and 1 woman). They were chosen via purposive sampling according to predetermined inclusion criteria, which resembled the same inclusion criteria used for the main study (Table 7-1).

Table 7-1 Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
• Men and women aged 18 years and above	• Had ankle fracture along with ankle sprain
• Had history of a lateral ankle sprain and retuned to playing sports. Lateral ankle sprain was a traumatic injury affecting lateral capsular ligament complex of the ankle joint (Kerkhoffs et al. 2012).	• Had surgical treatment for the ankle sprain
• Lives in Wessex	• Individuals with cognitive impairment

• Practices sports at least once a week	• Individuals with verbal communication problems
• Speaks English	

7.4.6.2 **Participants' recruitment- Pilot study**

Participants of the pilot study were recruited from local university teams (University of Southampton), as the researcher had contact with some sportspeople who had a history of ankle sprain. Joseph et al. (2016) put forward a number of key recruitment techniques for pilot studies including leverage existing social networks and personal contacts. Therefore, the researcher approached and invited potential participants who met the inclusion criteria to participate in the pilot study. Subsequently, a recruitment pack including an invitation letter containing brief information about the study was handed to those who were interested in participating at that stage. The invitation letter provided the participants with an overall description of the study aims and objectives, as well as with the research process (Appendix 23). In addition, it included a statement explaining that any data they provided would remain confidential and that their privacy would also be protected. In addition, they were also provided with necessary documents such as participant information sheet (Appendix 24) and consent form (Appendix 25). The participants who agreed to take part were asked to contact the researcher via email or on a work landline during office working hours (9 am-5 pm). The researcher's contact details were clearly stated in the invitation letter and on the patient information sheet (PIS). For the purpose of this pilot study, the first two participants who agreed to participate were recruited and interviewed.

7.4.6.3 **Data collection- pilot study**

To examine the usability of the interview guide/ questions, a pilot study was conducted. The interviews were conducted immediately after ethics approval was received from the University of Southampton. The interviews took place in a quiet room in the School of Health Sciences at the University of Southampton. The room was chosen carefully to ensure that the participants were in a comfortable environment, in which they could openly answer the research questions. The participants were seated in an appropriate place so that they were in a clear view of the researcher. Once the participant had been properly seated, the researcher greeted the participant and thanked him/her for attending the interview session. He, the researcher, also introduced himself to the participant and briefly stated the main aims and process of the study. The researcher also mentioned the interview was unlikely to take more than an hour, unless the participant chose to say more. According to Jacob and Ferguson (2012), interviews should not exceed 90 minutes, in order to respect any other commitments the participants may have and to prevent any discomfort. The researcher also clearly stated that the data collected from the pilot study would only be used to review the interview questions and make necessary amendments. The entire discussion, including the introductory statements and the actual interviews, was in English. The interviews were recorded using a digital IC recorder for the purpose of transcription and data analysis.

Before starting to ask questions, the researcher ensured that the participant had agreed to participate and had signed the informed consent form. The consent form was collected and kept securely in a research folder, which in turn was later kept locked up in the researcher's desk.

Before the start of the interviews, the researcher had a brief social conversation with each participant to build rapport and to create a non-stressful environment. Jacob and Ferguson (2012) highlighted that having social conversations before formal research interviews is essential to build good rapport and facilitate better responses. Subsequently, the researcher started to ask the main questions, as well as any probing questions whenever necessary. During the interview, the researcher had a predetermined interview guide to trace and ensure all aspects of the main and sub questions were answered.

At the end of the interview, the researcher thanked the participants once again for attending the pilot interview session. The participants were informed how to contact the researcher, in case they had any queries about the data collected.

7.4.6.4 **Outcome of the pilot study**

The pilot study was a helpful exercise that helped to inform the main study in terms of:

1. Amending how the objectives of the study were devised.
2. Restructuring interview questions and making them more open rather than guided. The first draft of interview questions can be found in Appendix 21.

   The researcher (SB) gained more confidence when conducting interviews.
3. The researcher gained interviewing skills, in terms of asking follow-up and prompting questions.

7.4.7 Study participants-main study

The study participants in the main study were sportspeople living in Wessex with a history of lateral ankle sprain in the previous six months leading up to the interviews. Detailed information about the inclusion and exclusion criteria for this study can be found in Table 7-1. Those participants had similar characteristics to the population that was recruited in a previous study for this thesis (Study three). Choosing a similar population for this study was essential, in order to further explore issues that had arisen during the previous study (6.5.2.6), as well as to allow the results from both of the two studies to be compared.

7.4.8 Recruitment of participants-main study

Recruitment of participants and data collection in this study took place between March and June 2019. Study participants were identified by the researcher based on predetermined sources. Those sources included, but were not limited to, the following:

1. The researcher's personal contacts: social relationships and personal contacts are considered helpful in recruiting appropriate participants for a particular research (Joseph et al. 2016). The researcher was a student at a university that contained many students who play sports, and therefore could be eligible to participant in this study. The researcher was a regular sportsperson who plays football every week and occasionally plays badminton. He also played in local university football tournaments with a group of students from the university. Some students already had a history of lateral ankle sprain and often consulted the researcher about how to manage their injuries. Those students were approached and, if they met the inclusion criteria, were invited to participate in the study.

2. Inviting participants from study three in this thesis: an invitation statement was added at the end of the questionnaire for the third study in this thesis. The invitation statement read "If you would like to have the opportunity to participate in a follow up study (one-time individual interview) on how other factors affect return to playing sports after lateral ankle sprain then please enter your e mail address here". Any participant who had left their e-mail address was contacted, and the research pack was emailed to him/her accordingly. Participants were instructed to contact the researcher if they had consented to participate and an appointment for the interview was made.

3. Social media: social media can be defined as interactive web-based platforms that facilitate the creation and share of information ideas, opinions with other users (Wikipedia 2019). There are a great deal of social media platforms, however, only Facebook, Twitter and WhatsApp were used to recruit participants for this study, as these three are considered the most popular networking services in the UK (Social Media 2019).

4. Emails: individual emails were sent to some sport clubs and sport associations, in order to find potential participants for this study. A complete study pack was attached to every e-mail with clear instructions on how to contact the researcher for participation in this study.

5. Recommendation from interviewees: on the day of the interview for this study, the interviewees were also asked to nominate other people who had the same injury and might be interested in participating in the study. This is called snowball sampling, and is considered an effective method for sampling, as a participant can suggest another participant who may be interested in participating, who in turn, can suggest a third participant and so on (Vogt 1999; Atkinson and Flint 2001). As a result, two participants were recruited using this method.

7.4.9 **Sample size-main study**

Despite the growing literature on research methods, the logic of sampling within the qualitative paradigm differs depending on the sample size (Francis et al. 2010; Mason 2010). Challenges exist when sample size is to be determined for non-probabilistic samples (purposive sampling), such as those used for qualitative research (Galvin 2015). Determining the adequacy of a sample size in qualitative research has always been based on data saturation or thematic saturation (Corbin and A. 1990; O'Reilly and Parker 2012). Data saturation is the point in data collection when extra data from more participants adds no extra value to the emerging themes, i.e. no more themes are identified. At that point, the sample size of a particular study can be considered adequate and no more participants are needed.

In order to determine data saturation, researchers conduct a series of interviews to achieve the appropriate sample size for qualitative research. Guest et al. (2006) conducted a study to determine the number of interviews needed to reach data saturation by monitoring the production of new themes and metathemes. They defined data saturation as the point when a new interview produces little or no new information/ themes to the data collection and analysis.

As a result, they concluded that data saturation occurred within the first twelve interviews and basic elements for metathemes were identified by end of the first six interviews. Others have argued that five to six participants are adequate when the purpose of the study is to explore the perceptions and experiences of a group of people who share similar characteristics, i.e. a homogenous sample (Smith and Osborn 2009). In this current study (study four), a homogenous sample was recruited with the aim of gaining an in-depth interaction with each participant. Therefore, a sample of six to ten participants was decided appropriate in order to achieve the proposed aims and objectives of this current study. The researcher, however, decided to try to recruit ten participants to gain maximum data from the interviews. Indeed, a similar sample size was used in a previous study to investigate athletic trainers' experiences regarding making RTP decisions (Kenow 2014).

7.4.10 **Sampling strategy-main study**

Potential study participants were selected using a purposive (homogeneity type) sampling method. Purposeful sampling is a type of non-probability sampling method used to recruit information-rich participants that answer research questions as part of a qualitative study (Patton 2002). It is most appropriate when the aim of the study is to identify and select participants who have adequate knowledge about their experience regarding a specific phenomenon (Cresswell and Plano Clark 2011). There are many purposive sampling strategies used for qualitative research such as criterion, typical case, homogeneity, maximum variation and critical case (Palinkas et al. 2015). In this study, a homogeneity sampling strategy was adopted to recruit study participants. In general, this sampling strategy is appropriate when the aim of the study is to describe a particular small subgroup of a population in depth, with the intention of reducing the variation between the study participants (Patton 2002; Palinkas et al. 2015). Participants in the targeted sample were similar in terms of diagnosis, type of treatment, demographics and practising sports. The utilization of this strategy facilitated the exploration of different issues in relation with RTP.

Once all the participants had been identified, an invitation letter that contained general information about this study was given/ sent to potential participants. This letter provided adequate information regarding the eligibility to participate in the study. Additional detailed information could be found following a link, which was stated in the invitation letter, that took them to an online document that had comprehensive information about what was involve as participant in the study (PIS). In addition, an informed consent form was provided for each participant and they were asked to sign it if they agreed to participate, and then bring it on the day of the interview.

7.4.11 **Data collection-main study**

The procedure for the main data collection of this study was quite similar to that described in the pilot study (7.4.6). However, the main aim of conducting the pilot study was to find out if the proposed interview questions and procedures were appropriate for the study population targeted, and so that amendments could be suggested. If amendments were necessary, then a resubmission of the amended protocol was then required for ethics approval from the University of Southampton. As a result of amendments to some of the study documents (research design, PIS and interview guide), they were resubmitted for ethics approval.

Eligible participants were contacted to arrange a date and time for the interviews. Participants were instructed to suggest the most convenient date and time beforehand, so that the researcher could book a suitable room for the interview. The interviews were conducted at the School of Health Sciences at the University of Southampton (Building 67). Other rooms within other buildings of the University of Southampton were also considered in case no rooms were available at the desired time and date. The most important consideration was that the room had to provide a comfortable and quiet atmosphere during the interviews. However, some challenges were expected, such as participants being able to meet the researcher at the University of Southampton. It was decided that if a participant could not physically attend, they could be interviewed online using Skype or VSee or using another online video conferencing method. Telephone interviews were also suggested to those participants in cases when online methods were not available. In this study, two participants were interviewed over the phone.

Before starting the interview, an introductory statement, which included welcoming the participant and giving a brief overview of the study aims and objectives, was read aloud by the researcher. The statement also included information about the duration and flow of the interview. Participants were instructed to ask any questions before the start of the interview. They were also informed about their right to withdraw from the interview at any time before, during or after the interview. In addition, they were asked to complete a baseline information form about their age, sex and type of sport(s) played to illustrate their demographics. The researcher also made sure that the digital IC recorder was working properly and recording. Checking the recorder was repeated throughout the interview in case the recorder stopped working, in order to avoid wasting the participant’s time. The researcher also made sure that the consent form had been signed and provided by the participant. Then, the participant was asked for their permission to begin recording the interview.

During the interview, the researcher followed some guiding measures to ensure that the data collection procedures were systematic and well performed. McNamara (2009) suggested some recommendations to improve the flow and outcome of interviews:

1. The researcher should check if the recorder is recording from time to time.

2. The participants should be asked one question at a time. If an interesting point is mentioned, the researcher can take note and follow up on it once the participant has finished his/her answer. This will avoid interrupting the participant's train of thought.

3. The researcher should remain as neutral as possible by not showing any strong emotional reactions to any of the participants' responses. However, the researcher can use non-verbal cues as secondary prompts.

4. Regular interaction and encouragement of the participants in the form of occasional nods of the head, or utterances such as "yes", "uh huh" etc. should also be used by the researcher.

5. The researcher should be careful not to make any sudden movements or startling reactions, as the participant may falsely think his/her responses are surprising or striking, which in turn may influence the responses to the following questions.

6. Participants should be informed when moving from one theme/ topic to another. The researcher should also indicate when moving from one question to another, e.g. 'now you told me that, how about how other factors related to you as a person you think affected your RTP?'

7. The researcher must take control of the interview by making sure that the participants answer the interview questions sufficiently and in due time. Participants must be politely redirected if they deviate from the main flow of the interview.

In the interview, the researcher started by asking general, open questions about various factors that may have affected RTP after their lateral ankle sprain injury. Those general questions were then followed by more specific questions to prompt the participants to give more in-depth answers, in order to allow the researcher to explore the subject in more detail. Other questions were also asked during the interview to elicit more details and to encourage participants to provide extra data/ examples, these included:

1. Can you tell me more about that?
2. Would you give me an example/ more examples?
3. How did you feel about that?
4. In what way did that affect your return to playing sports?

At the end of the interview, the researcher thanked the participants once again and allowed them to ask any questions they may have about the data they provided. They were also informed that they would be represented by pseudonyms when the data were later transcribed. Pseudonyms were used to protect the anonymity and confidentiality of the study participants (Crow and Wiles 2008). In this study (Study four), the pseudonyms contained the participants' number, sex and age, e.g. P01 M 30.

7.4.12 **Data analyses**

At the end of the data collection of each interview, the digital audio recording was transferred from the IC recorder onto a hard drive, which was later stored in a locked cupboard in a postgraduate study room at the University of Southampton. They were then transcribed verbatim and verified by the researcher (SB) for the purpose of data analysis. Data transcription was started immediately after the first interview to improve the flow of the following interviews. Analysis was continued until the last interview was finished. Therefore, data analysis, including the identification of themes, was an ongoing process (iterative) and the researcher had to repeatedly revisit all of the interview transcripts to look for connections, similarities and differences between the identified themes.

7.4.12.1 **Purpose of analysis**

The purpose of analysis when conducting research greatly relates to its study aims and objectives. For this study, the main aim was 'to explore the experiences of sportspeople and influencing factors on RTP after a conservatively treated lateral ankle sprain'. Therefore, an exploratory approach was followed in order to accomplish those aims and objectives.

There are two approaches to qualitative data analysis: exploratory and confirmatory (Guest et al. 2012). The confirmatory approach entails comparing the current data against specific predetermined (priori) ideas or hypotheses, whereas an exploratory approach involves the researcher repeatedly and carefully reviewing the data, in order to inductively identify key ideas, trends, themes underpinning a topic. The researcher found an exploratory approach was more suitable for answering the aims and objectives of this study.

7.4.12.2 Method for data analysis

Individual scripts/ interviews in qualitative research present different sets of ideas, concepts, opinions, values and behaviours that do not make a lot of sense until they are all analysed, categorised, scrutinised and compared with each other (Silverman 2006). In order to produce meaningful categories/ themes from individual scripts, a specific and systematic method for analysis must be followed.

There are many types of qualitative analysis methods such as action research, conversation analysis, discourse analysis, grounded theory, narrative analysis, content analysis and thematic analysis. However, thematic analysis was found to be the most appropriate method among the qualitative data analysis methods for analysing the data of this study. The emerging themes from the study data were then considered influencing factors that affected the decision to RTP.

7.4.12.3 Thematic analysis

The data collected from this study (i.e. transcribed interviews) was analysed using a thematic approach. Thematic analysis is regarded as a suitable method for identifying, analysing, recording and reporting patterns or themes found in particular data (Boyatzis 1998; Braun and Clarke 2006). The main purpose of adopting thematic analysis was to organise and categorise all of the data into patterns/ themes that made sense of the individual data scripts. In addition, the researcher is considered a major contributor to the analysis outcomes, as his/ her intuition and reflections guide the development and identification of output themes (Braun et al. 2015). As the researcher identified the patterns and themes from the coded texts, a codebook can then be developed showing a descriptions and interconnections between different themes (Guest et al. 2012). The process of coding and thematising the data may in turn provide an insight into the hierarchy of the most important themes (Joffe 2012; Braun et al. 2015).

Thematic analysis used to be considered a tool for data analysis among major analytic methods such as grounded theory rather than an independent method on its own (Boyatzis 1998; Ryan and Bernard 2000). However, it has been increasingly considered a method in its own right in recent literature, due to its unique and distinctive features (Braun and Clarke 2006; Braun et al. 2015; Lyons and Coyle 2016; Neuendorf 2019), since it can be used to answer many types of research questions/aims, including those featured in this study, such as:

- **Experiences:** research questions focused on individuals' own experiences

- **Understanding and perceptions:** research questions focused on individuals' views on and conceptualisations of particular phenomena

- **Influencing factors:** research questions that explore the individual and social factors that underpin particular phenomena

- **Practices/ accounts of practices:** research questions that explore the things people do in the world and/or how people make sense of the things they do in the world

- **Representation:** research questions that explore the ideas that surround particular phenomena in particular media

- **Construction:** research questions focused on the role of language (or 'discourse') in constructing particular versions of 'reality'

7.4.12.4 **Process of thematic analysis**

During the analysis process, it is important that the researcher is familiar with rigorous and clear processes, in order to ensure reliable and accurate findings. Braun and Clarke (2006) recommended a repetitive six-phase process to conduct thematic analysis:

1. Familiarising oneself with the data: this can be done by repeatedly reading and re-reading the scripts and taking notes of ideas, interesting patterns, and common opinions.

2. Generating initial codes: the researcher documents the initial codes that identify important attributes relevant to the proposed research questions. Then those codes need to be applied (by segmenting and "tagging") to the corresponding phrases in the original dataset (i.e. text). Finally, the relevant data for each code need to be collated/ categorised.

3. Searching for themes: this can be done by first examining the codes and collated data. Then, broader patterns of meaning (potential themes) can be generated. This can be aided using diagrams and detailed notes to make sense of the identified theme.

4. Reviewing themes: the identified potential themes are then applied to the original dataset (text) and the resultant codes, to ensure that they match each other and provide a convincing story that answers the main research questions. During this stage, the themes can be modified, refined, split, combined or discarded.

5. Defining and naming themes: an ongoing and repetitive analysis of individual themes in relation to the whole story of the research. Consequently, the final themes need to be clearly defined and named.

6. Producing the report: weaving together all the analytic notes and the relevant extracts to present the themes into an argument to achieve research aims. All of the final themes need to be supported by extracts (quotes) from the original dataset to inform a clear flow of the research story.

These six steps were followed to analyse the results of this study. The main investigator (SB) identified the initial codes that later informed the subthemes and main themes. However, the outcomes were continuously and repeatedly discussed with a wider research team (CB, MW and LG) for verification, identification of additional themes/ subthemes. Those discussions also aimed to generate alternative interpretations to better describe the emerging themes. This process of continuous discussions was considered important in this study, as it led to the production of more rigorous final main themes.

The process of identifying codes and themes from a large set of qualitative data usually requires too much effort and is time consuming. In order to make this process easier and more systematic, researchers use one of the many types of Computer Assisted Qualitative Data Analysis Software (CAQDAS) such as ATLAS.ti, MAXqda, NVivo and N6. In this study, the data collected was analysed using NVivo 12 (Windows). NVivo is a computer program that has many important features required when analysing qualitative data. It is helpful to detect word frequencies and key words in a particular written text (transcribed interviews) (Leech and Onwuegbuzie 2011), as this in turn facilitates the identification, the organisation, and the analysis of potential output themes. It also helps the researcher understand the resultant study themes and any connections between them, which ultimately helps determine the final study themes. The main advantage of using NVivo over other CAQDAS is that it has the capability to analyse a wide range of qualitative data types such as discourse analysis, grounded theory, conversation analysis, ethnography, literature reviews, phenomenology and mixed methods.

Despite the fact that QDAS were founded in the early 1980s, very few researchers (16%) reported using them to analyse qualitative research (Mclafferty and Farley 2006). This could be due to the difficulty involved in learning how to use these programs, because although the program itself is used to simplify the process of data analysis, intensive training is required to master it. Indeed, the researcher attended a two-day intensive training course to learn how to appropriately use this program. Further readings of literature on the subject, as well as watching video clips about this facilitated the learning process.

7.5 **Ethical considerations**

In qualitative research, as is also the case in other research designs, potential ethical issues should be predetermined and carefully addressed, so that the research is socially and morally acceptable. Research conducted on human participants should be carried out according to the Declaration of Helsinki (World Medical Association Declaration of Helsinki 2013). The ultimate purpose of this declaration is to ensure that all participants are treated fairly and equally during any research in which they agree to participate. There are some specific ethical considerations that are most commonly appraised by sport and exercise researchers (Harriss and Atkinson 2015):

1. Respecting participants' rights and welfare: this must be of paramount concern when designing and conducting research on human beings.

2. Well-designed, clear and justifiable research protocol: the research protocol should be appropriately reviewed by people who have adequate expertise on the subject being investigated. Providing adequate information about what, when and how the research will be conducted is essential. All of the relevant information must be clearly provided to potential study participants prior to the start of that research.

3. Ethical review of the research: the research must be evaluated and approved by a research ethics committee before starting to conduct the research. Any due amendments to the research protocol before or during data collection must be reported and approved by the same ethics committee.

4. Completed informed consent: the study participants must freely provide a signed informed consent form before the start of the research.

5. Process of conducting the research: evaluating potential risks and how to address them during a research is very important. In addition, the research should be conducted in an appropriate setting by qualified and well-trained researchers. Participants' privacy and confidentiality must also be respected and preserved throughout the research process. Finally, the research must be in accordance with the laws and regulations of the country where the research is conducted.

6. Governance: any serious adverse events must be immediately reported to the ethics committee that approved the research for appropriate evaluation and to take appropriate decisions. After data collection is finished, all of the research documents such as the informed consent forms and the data collected (e.g. questionnaires, recorded interviews, pictures etc.) must be kept securely, so that no one except the research team can access them. The research team in this current study composed of four members (SB, CB, MW and LG).

In this current study, it was deemed unlikely that any part of the data collection process would cause any discomfort or distress to the potential participants. The research protocol and interview questions were developed and reviewed by a qualified and well-trained research team (SB, CB, MW and LG). None of the interview questions intended to uncover sensitive information from the study participants. However, in case they did become distressed at any point, participants were made aware that they had the full right to continue or withdraw from participation in the study whenever they wanted. Indeed, no distressing events occurred during the data collection phase of this study. The participants were also assured, in the event that they withdrew from the study, that any data collected would be appropriately destroyed. The participants were also informed that identifiable personal information such as names and contact details would not be used during the data analysis process or in any reports afterwards. The researcher only used pseudonyms when discussing the results of the interviews and in any later publications.

7.6 Ethical approval

Ethics approval was sought from the University of Southampton (ERGO No 48024). The researcher (SB), with guidance from the supervisory team (CB, MW and LG), was the person responsible for applying and following up with the ethics application. Any amendments and additions to the research process were reported to the ethics committee before conducting the research. As a result, a resubmission of all the study documents was carried out amendments to the interview guide and data collection process were made after the pilot study.

7.7 **Data protection**

All of the data collected during this study (signed informed consent forms, interview audio and transcribed recordings) were managed in accordance with the ethics guidelines, professional code of conduct and the data protection act (2018). The personal data related to the individuals was handled carefully by the direct care team and in accordance with the Data Protection Act 2018.

The data were stored in compliance with the Data Protection Act and in accordance with the University of Southampton Research Governance Office policy. During the data collection period, the researcher (SB) kept the collected data in a password-protected file on a securely encrypted hard drive owned by the researcher. The collected data (audio and transcribed interview data) were then transferred to a password-protected University PC, which was only available for a minimum of 10 years, according to the University of Southampton Ethics and Research Governance policy. This data was only shared within the research team (SB, CB, MW and LG).

7.8 **Validity and reliability in qualitative research**

In any research, including qualitative research methods, the concepts of validity and reliability should be considered and addressed. Although it can be challenging to ascertain a solid process to verify qualitative data, several strategies were proposed to validate the results (Silverman 2006, 2017).

Validity refers to whether the study accurately measures what it claims to measure (Silverman 2006). In qualitative research, this can be challenging, as the process of conducting individual interviews, similar to the ones conducted in this current study, can vary from one participant to another. However, some researchers claim that this can be attained by ensuring that the research study is well grounded conceptually and empirically (Pole and Lampard 2002). This means the validity of a particular qualitative research is determined by the distinctive elements and quality of the process of designing and conducting that research. In addition, the context and relevant examples, from the raw data, should be provided when interpreting the resulting themes. Involving a PPI group and conducting a pilot study could also be considered as ‘validity’ tools to ensure that the study design is well articulated to achieve the proposed aims and objectives.

Another important concept to consider regarding qualitative research is reliability. Reliability can be regarded as whether the same results can be produced using the same research design, process and measurements (Silverman 2006). Achieving reliability in qualitative research is another challenging task, because of the nature of data analysis, which usually constitutes the researcher's own perceptions and reflections (Pole and Lampard 2002). However, some measures can be taken to improve the reliability of results in this study. Silverman (2006) recommended that the process for data collection and analysis in a qualitative research study is clear and transparent, so that other researches can follow the same steps and reproduce similar results. In addition, pre-testing the research process by conducting PPI sessions and pilot studies to enhance the reliability is important. These measures were incorporated into the research study when it was designed. A pilot study was conducted after ethics approval was received from the University of Southampton. Finally, the emerging codes and themes were thoroughly discussed between the members of the research team (SB, CB, MW and LG). Accordingly, the themes were repeatedly reviewed, refined and verified to improve the interpretation of the study findings, and thus enhance the trustworthiness and reliability of this study.

7.9 **Results**

Eight participants were recruited and interviewed in this study. The included participants had a mean age of 30 ± 7 years (Table 7-2).

Table 7-2 Baseline information of all study participants

Participants	**Participant Code**	**Age**	**Sex**	**Primary sport**
Participant 1	001-M-31	31	M	Football
Participant 2	002-F-22	22	F	Rugby
Participant 3	003-M-45	45	M	Rugby
Participant 4	004-F-30	30	F	Running
Participant 5	005-F-25	25	F	Rugby
Participant 6	006-M-32	32	M	Running
Participant 7	007-F-25	25	F	Mountain climbing
Participant 8	008-M-32	32	M	Football

After analysing the data using NVivo computer assisted software, eight distinct themes emerged from the study data. The main themes and sub themes that were identified as a result of data analysis included are illustrated in Table 7-3.

Table 7-3 The emerging themes and subthemes

	Theme	Subtheme/s
1	Previous negative experience with healthcare service	• Improper healthcare practice
2	Limitation of resources	• Financial limitations • Unavailability of healthcare services close to the participant • No physiotherapist specialised in particular sports
3	Level of sport played	• Professional vs recreational sportspeople • First vs second team.
4	Self-management of injury towards RTP	• Use of taping/ ankle support • Use of RICE • Exercises • Medication (pain killers) • Compliance with treatment • RTP decision making policy
5	Perception of self and injury and RTP	• Not a serious injury • Self-perception as a sports person • Self-awareness of injury • Preinjury physical well-being
6	Previous history of managing ankle injury	• Had previous injury • Knowledge of sport injuries
7	Symptoms dictating RTP	• Pain severity • Joint instability • Recurrent injury of dominant foot
8	External motivation and expectations and support	• Availability of training centres • Family support • Encouragement from sportspeople • Influence of sports team/ coach

7.9.1 **Theme 1: Previous negative experience with healthcare service**

Two participants sought medical attention either from their GP (Participant 4) of from a physiotherapist (Participant 8). Both of them were not satisfied with the medical healthcare service that they received. Participant 4 had a past medical health condition that encouraged her to visit her GP, but she felt she was not taken seriously. She shared her story, which had left a negative impact as no longer trusted her GP:

004-F-30: "The healthcare near my house is not the healthcare I trust will take care of my pain seriously, believe me this is not the first time I have been to them. Previously I went to the GP, I mentioned some symptoms about sudden weight gain and other symptoms related to serious hormonal disturbances, but they did not take any action. I went back to my home country and had blood tests and they discovered some problems I had, and I was given medication, accordingly. I told the GP that I was getting irritating symptoms because of the hormonal disturbances, such as an increase in facial hair, but they did not take this seriously. I see it a big problem from my perspective."

When she sustained a lateral ankle sprain injury, she was not taken care of properly in her opinion:

004-F-30: "When I had the ankle sprain injury, pain was my main concern, but it seemed it was not theirs. They knew how much pain I had on the pain scale, but they did not take it seriously. I am sure that if the GP had taken my case seriously, then I would be much better."

The same participant generalised that experience beyond the GP level. She was reluctant to go to the emergency department, because she thought she might receive the same improper care:

004-F-30: "The thing that prevented me from going to the ED was that I was upset with them at the onset of injury. I will not go and waste my time again, and it was also the weekend, and I was thinking they would not accept my case as an emergency."

She also thought that if she had received proper care or if she had been referred to a physiotherapist then she might have felt more satisfied:

004-F-30: "I wish I had received proper treatment for my injury, so I hadn't got so upset. I did not receive proper advice even from the physiotherapist, and I was thinking why I am not getting better advice from the GP. Why was not I referred to a physio? And, why didn't the GP call me back again to ask about how my symptoms were and how I was doing."

She was also concerned about how she was assessed at the GP surgery, as they did not ask her about her history of injury and returning to play sports after the injury:

004-F-30 : "He (the GP) didn't mention anything about returning to sporting activities; he did not even ask me what caused my injury. I just said I had twisted my ankle. He did not ask me if I had twisted my ankle while playing sports or not."

Another participant (Participant 8) substantiated the previous participant claim's by highlighting the influence of having had a negative experience with a healthcare professional in the past. According to him, the experience with a physiotherapist was not as he had expected:

008-M-32: "I didn't go the see a physiotherapist the first time I injured my ankle . I did not go to see a physiotherapist for this second injury, For the previous injury, I applied ice, I took medicine and I went to a rehabilitation centre. I was seen by a physiotherapist. He gave me some exercises to do at home. But I felt he did not pay much attention to my injury, he was very busy. Because of that I did not go back."

7.9.2 Theme 2: Limitation of resources

Participants expressed their perceptions regarding the availability of various resources that they thought important to facilitate their recovery from their injury. They discussed this theme in three parts (subthemes): a) financial limitations, b) unavailability of healthcare services close by, and c) no physiotherapist specialised in particular sports.

<u>Subtheme 1: Financial limitations</u>

Participants were asked during the interviews about their perceptions of the medical healthcare services. Three participants (Participants 2, 5 and 7) reported that they had had some financial limitations which prevented them receiving proper treatment. Participant 2 highlighted the issue of inadequate funding for some particular sports (women's rugby):

002-F-22: "I think especially for us, because women's rugby is not as well funded as men's or other sports. I am sure it is not ideal, because it's in their best interests to get you back to play as soon as possible, but I think it starts to be improving."

Participant 5, mentioned that because she was a student, she could not afford to see a physiotherapist:

005-F-25: "I think because we can't afford it, so obviously we have to pay them, and as a club we don't get that much money from the university."

Another participant (Participant 7) also stated that because she was a student, she was not able to pay for regular physiotherapy treatment:

007-F-25: "Yes, but I did not know that at the time. And I think cost was a factor. I thought making an appointment with the NHS would be longer and I did not want to wait. Money was another factor, as I did not want to go to a physiotherapist that I did not know. I was a student at that time."

Subtheme 2: Unavailability of healthcare services close to the participant

Participants also reported that they actually had access to physiotherapy treatment, but the physiotherapy departments were quite difficult to reach, because they were not in the area where they lived. Participant 1 mentioned that he was offered a physiotherapy treatment, but he was concerned about getting there for regular treatment sessions:

001-M-31: "I had that option (physiotherapy), but it was far away so it would have been difficult to go there to have regular treatment."

Another participant (Participant 5) also indicated similar concerns about getting access to proper treatment at a distant physiotherapy department:

005-F-25 : "I had access (to physiotherapy) when I injured my knee and I went to MGH (hospital), and it is quite far if you don't have a car, so I had to get an Uber to get there and it costs me 20 pounds, and as a student I can't afford to pay that kind of money. I think this is another reason why I was less inclined to see a physio, because I knew they would send me to the same physio, which is quite far away. If we had access to the one on the campus I would go then."

Subtheme 3: no physiotherapist specialised in particular sports

One participant (Participant 2) also emphasised the importance of having a physiotherapist specialised in specific sports, like rugby in her case, so they know how to manage injuries that commonly occur when playing that specific sport:

002-F-22: "I think having a physio who is specialised in rugby, as opposed to a physio who has general knowledge about all sports, because the one who is *treating rugby players on a regular basis has a better understanding, like basically what is and isn't safe."*

The same participant continued to explain the procedure when a player gets injured. She highlighted two main issues that she thought important when managing sport injuries: full time physiotherapist in clubs and getting proper treatment beyond first aid treatment:

002-F-22: "For the university club, no, because we do not have a full time physio. As the first point, when you have an injury, you go and see someone at a Saint John's ambulance, which is… which is more like a first aid hospital, and if it's quite serious then you get an x-ray to see if is just a sprain or a broken bone. Then you get a pair of crutches in the first week."

Participant 3 was actually offered physiotherapy treatment, but decided not to have it, because it was very expensive and she could not afford it:

003-M-45: "The physio mentioned something about shockwave therapy, I looked into that and found it costs 260 pounds for 3 sessions, I decided to leave that at that moment, because it is so much to pay. I have got private medical insurance through work, so I don't know if that is covered, it is possible… that is something I will look into."

7.9.3 **Theme 3: Level of sport played**

Four participants described the level of sport played as a potential influencing factor for deciding when to RTP after lateral ankle sprain injury.

<u>Subtheme 1: Professional v recreational sportspeople</u>

Two participants (participant 2 and 8) considered playing at a professional level as being an important factor that determines whether players receive better care and fully recover. Participant 2 indicated that professional clubs are well funded, thus players get more attention and receive more effective treatment:

002-F-22 : "When you are a professional player, then they have a full time physio, so players can get better attention and receive treatment that is more efficient. So the higher you go in sports competitions, the higher the funding there is for treating injuries. I have played for a county, I have played for a local club, so I've played in a fair range of clubs, and I could see the difference in the *treatment of players at each level. For the Hampshire one, there was a physio there all the time, you also received messages about the exercises every day."*

Another participant (Participant 8) substantiated the perspective of the previous participant that playing at a professional level means injuries are taken more seriously. He indicated that he did not receive proper consultancy on RTP, because he was not playing at a professional level:

008-M-32: "I do not play for a professional team, so I did not really care about getting fully recovered and I went back and played. I mean my type of people are not professional, so they do not get any consultancy from others on when to RTP. I just make my own decision, if there is pain I stop, and if there is no pain, I go back and play. I think that's why I had some complications from the recent injury, because of that, I felt some clicks when I moved my ankle."

<u>Subtheme 2: First vs second team</u>

The other participants identifid some differences between players who play in the first team and other players who play for the second team within the same club. Participant 3 mentioned that missing a game for the second team was not as important as missing one for the first team. He considered himself as doing very well and wanted to just keep playing, rather than taking time to rest and miss games with the first team:

003-M-45: "This time when it happened, I was back playing the first thing, I have not had it in the past 3 or 4 years, and I have been playing quite well and it was frustration why is it happening now when I am doing well why did it happen on silly training exercise. I put a bandage to get back on the team no matter what. But if I have been playing regularly like in second team I might say ok I can miss that game and get it 100% fully recovered."

Similar thoughts were expressed by another participant (Participant 5), that is to say, that playing in the second team is less important than playing in the first team. He was concerned if he stopped playing, because of the injury, he might be removed from the first team:

005-F-25: "If I was on the twos team I think I would be less inclined to play, because they are not as developed as the first team, so I feel like I would not be as heartbroken about missing a twos match. But because I worked so hard to be on the ones I did not want to be knocked down to the twos if I stopped *playing. So I knew that would have happened if I stop playing there is the potential for me to be knocked down to the twos."*

7.9.4 **Theme 4: Self-management of injury towards RTP**

All eight participants in this study reported that they managed their lateral ankle sprain themselves. They either had previous experience of a lateral ankle sprain or were seen by a physician/ physiotherapist at the onset of the injury and they were advised to apply the treatment for themselves. The treatment they used included strapping/ ankle support, RICE, exercises and medication. They also discussed issues related to their compliance with exercise programmes and decision making after using those types of treatment.

<u>Subtheme 1: Use of taping/ ankle support</u>

Two participants thought about applying ankle supports (e.g. an inflatable ankle support/ air-cast) but soon stopped using them. One participant (Participant 3), was not comfortable with his/her ankle support, and therefore changed it to tape:

003-M-45: "I used to have one that was like an inflatable one, but I lost it in the house. I found it bulky. Then I just taped it up. A couple of other players in the club have got an ankle support like a lace up support. I used it but I found it irritating and then I just used the tape."

The other participant (Participant 7) also stated that ankle support was helpful for supporting the ankle joint, however, she stopped using them, as her friends had advised her that an ankle support might cause ankle joint weakness:

007-F-25: "I think ankle support was good for walking around and gave some support. But I didn't have them for a long time, because I heard that if you have them for a long time, then they make your ankle weaker."

Participant 2 applied tape to provide support to her ankle joint whenever she played rugby:

002-F-22: "If I was going to play rugby then I strapped it quite heavily to support it, I rolled it on the inside so it was quite swollen, so a lot of strapping gave quite a lot of support."

Another participant (Participant 6) also reported using taping to provide ankle joint support:

006-M-32: "Yes, I mean I have done my left ankle 6 times, I have done my right ankle 5 times so I have got a rough idea what I need to do. When I went back to play, I had it taped up so there was a bit of support."

Subtheme 2: Use of RICE

Most of the participants in this study applied ice and rested their ankle to control the pain and swelling after their lateral ankle sprain. One participant (Participant 3) spoke about the benefits of applying ice to reduce joint swelling:

003-M-45: "I had some time off after an injury, because I did not have to train or play. I think, also the fact I iced it straight away, within 15 minutes, probably helped to bring the initial swelling down quicker."

One participant (Participant 7), decided to combine RICE with hot and cold baths in order to get more joint stability:

007-F-25: "I did the RICE thing, I elevated it, I had cold hot contrast, and I walked around in hiking boots for a long time for more stability."

Another participant (Participant 6) went to hospital and was advised to apply ice and rest his ankle:

006-M-32: "Yes, I went to the hospital and they did an x-ray of my ankle. They told me that there were no broken bones, but there was some swelling, and they advised me to put some ice on it and rest it and not do any kind of sports for a few months."

All of those participants indicated that the application of RICE had been helpful to reduce the swelling and pain after their lateral ankle sprain injury, and, ultimately, it helped them to return to sporting activities quicker.

Subtheme 3: Exercises

One participant (Participant 2) was advised to do some active movements and strengthening exercises:

002-F-22: "It was more of rolling it quite a bit or leaning up against something or having the foot against a surface and then putting pressure on the heel to strengthen that. I think someone also suggested raising the foot and writing the alphabet with my ankle. Those exercises really helped to get better. I think I *used a rubber band at some point just to create some resistance to the movements."*

Subtheme 4: Medication (painkillers)

Painkillers were taken by some participants to reduce the pain and improve their daily life activities. According to one participant (Participant 2), Ibuprofen helped to reduce the inflammation and control the pain:

*002-F-22**: "**It wasn't always painful, I just knew that it was still healing, so I took ibuprofen just to try to reduce the inflammation. I was quite aware that it was quite inflamed."*

Another participant (Participant 4) had to take painkillers in order to be able to walk long distances with her mother:

004-F-30: "I took painkillers up to 2 months after the injury. Especially when my mother was with me and I wanted to tolerate longer distances, then I would take medication. I took medication every time I wanted to walk long distance, even 2 to 3 months after the injury."

Subtheme 5: Compliance with treatment

Three participants realised how important it is to follow proper treatment instructions and exercise programmes.

One participant (Participant 1) reported that because he was not very keen on being active and doing exercises, he was not be able to return to sporting activities very quickly:

001-M-3: "Because you know you have to apply the treatment consistently, some time you just feel too lazy to apply what should be applied, so yes I think I could have managed to get back to playing quicker if I had followed proper instructions."

Another participant (Participant 4) did some exercises, but not on a regular basis, and therefore she developed painful ankle movement and other complications:

004-F-30: "I tried to do some exercises, but I did not commit to doing them. I did planter flexion, dorsi flexion, inversion, eversion, but these were just before indoor running, and not always. If I went outdoors, I would not do them. When I returned to running, the inversion movement was still painful for a long time, *I used to be very careful when doing that movement, it was painful and unstable. I still feel some discomfort even now."*

A third participant (Participant 7) wanted to see a physiotherapist, but instead searched the Internet for some exercise programmes to follow. However, although she started doing some of those exercises, she did not do them regularly:

007-F-25 : "I was so encouraged to see a physiotherapist. I looked up exercises on the Internet, but after a while, I kind of, I hardly did those exercises. I did a little bit of, like, the online physiotherapist sort of stuff I found for ankle sprain, so it was like moving the foot up and down and side to side and with like a resistance band, but I just used elastic socks."

Subtheme 6: RTP decision-making policy

All of the participants in this study made their own decision about returning to play sports again. They stated that there is a lack of RTP policy to follow and assist them to make a safe RTP decision after an ankle injury at their clubs and on their sport teams. For instance, one participant (Participant 5) said that the only policy that exists in rugby is the one for concussion:

005-F-25: "The only RTP policy I know about is concussion, so if someone gets a concussion, then you aren't be allowed to play for 2 weeks. For ankles and knees, it is more like your own decision whether to go back and play or not"

Another participant (Participant 5) said even if there was a policy in rugby, the players might not follow it, because of the attitude of most rugby players on her team:

005-F-25: "I think they are many people who are stubborn in rugby, so I don't think a RTP policy would work, there are people with worse injuries than me. There is someone with rib problem who refuses not to play. I think there should be a policy, but in that case, then we almost wouldn't have a team, because there are so many injuries every week."

However, one rugby player (Participant 2) mentioned that there are some scales that provide approximate timings for recovery from different injuries, including lateral ankle sprains:

002-F-22: "There are scales, so for top injuries you cannot play for two weeks or a month, so for like any head injury, you cannot do any physical activity for two weeks. Then if it's a break, you can't play for probably for six weeks, minimum, and then with ankle injuries, you can play the next week, depending *on how serious your injury is. If it is too serious, then you may not be able to play for more than two weeks."*

7.9.5 **Theme 5: Perception of self and injury and RTP**

All of the participants expressed their views on this theme. Some participants indicated that ankle injury is not a serious injury compared to others, and therefore they were keen to return to playing sports more quickly. Other participants were more careful and provided sufficient time for their injury to fully recover, and thus delayed their return to playing sports.

<u>Subtheme 1: Not a serious injury</u>

One participant (Participant 5) reported that lateral ankle sprain is not as serious as other injuries such as knee injuries. She claimed that the presence of some particular symptoms indicate it is very important to seek medical attention:

*005-F-25***: "***I just rested it (her ankle) and I think there was one time I injured my knee, because my knee was very bad. At one point I couldn't bend it. I felt it painful like with my knee I have had problems with my knee as well, and I think because I could also hear a clicking noise and I had other symptoms, and so I said 'yes I probably should go and see someone'. But with my ankle, I did not have any symptoms associated with anything else but a sprain. I did not want to waste resources and see a medical expert, when I knew it was probably not that serious."*

<u>Subtheme 2: Self-perception as a sports person</u>

Four participants reported that they decided to return to playing sports, despite their injury not having fully recovered. They were so motivated to play again, because they like playing sports so much. One participant (Participant 2) reported putting pressure on herself to return to running and playing rugby because she considers herself an active person and she wanted to be active:

002-F-22 : "I just wanted to play anyway, and they said 'if you want to play, you can'. I think it was me that wanted to play, and the pressure of playing came from me. I am a quite sporty person, I do like to keep active, so for me I started running, maybe in an attempt after this injury, so that was the motivation for me, that was the motivation to get better faster."

The same participant (Participant 2) continued by explaining the measures she took to RTP:

002-F-22: "I wanted to play a game, I just played the game, and I strapped it and did some exercises."

Another participant (Participant 5) wanted to RTP, because she was leaving the team and she wanted to play in the last matches with that team. She was worried if she took it slowly, then she might not be selected to play in those matches:

005-F-25: "I think I just wanted to get back [to playing] as soon as possible, because, also, I am graduating this year and I knew I only had a few matches left. So I wanted to go back and play those last matches, because I would have been upset if I had not played those matches, as I am leaving, and then the varsity was coming up, which is a big thing. So I really wanted to play in that, because that was our last match. Because I was worried that I would't get picked for the team, so I put my injury behind me and I was like 'I'm going to get on that team and play regardless."

Participant 5 shared the same opinion of the previous participant (Participant 2), as she also said she wanted to RTP, because she is good at it and she loves playing rugby:

005-F-25: "I actually enjoy it and it is something that I am good at. I played for so long and now I am leaving, that was why I returned. I want to leave on a high really. I probably was not ready, but as soon the pain was bearable, I went back, so I just pushed through the pain really, because I love rugby so much"

Another participant (Participant 6) considered playing sports (football) as an important thing in his life, and thus was keen to RTP quicker:

006-M-32: "Sports have been always part of my life, so there was an urge to go back and play sport."

Participant 8 was also motivated to return to playing sports (football) because he likes it so much and wanted to play with his friends:

008-M-32: "The passion to play football is the most important factor that affected my RTP. I also like to play football with my friends. I love playing football, and so that was the most important thing that encouraged me to go back and play football."

<u>Subtheme 3: Self-awareness of injury</u>

Participants noted that they were aware of their injury, and therefore tried to take it slowly, in order to be completely recovered upon return to playing their sports. That is to say, realising and appreciating the time needed to recover from injuries such as lateral ankle sprain is an important factor that determines when to RTP.

One participant (Participant 5) was aware of her injury, and so she gradually returned to playing rugby again:

> *005-F-25: "I did not get back to training the first week when I did it, but I went back to training in the second week… just slowly working my way up to a full training session. I think before I played an actual match I went to training sessions, so I tried to see how much I could do during a training session and if I could not do an entire training session, then I would not play a match. I think until I was ready for training, I did not think I should go back [to playing a match]."*

She also added how she performed some training exercises to evaluate herself and make sure she was fit enough to return to playing rugby again:

> *005-F-25: "We basically just do running and then we do drills that are little mini rugby drills, so I passed them all. So I think for a while I was only able to do the running and then some of the hand drills. I could not play in an actual match because obviously it requires a lot of contact, which I was not comfortable doing, because a lot of people are grabbing and holding on to my leg, but I think that was for a while and I also strapped my ankle, which really helped, I found."*

Another participant (Participant 4) realised how serious her injury was , but she wanted to be as independent as possible in her daily life activities:

> *004-F-30**: "**Previously I was trying to do it myself, I thought it is a sprain not a fracture, so why are people helping me?! I did not want them to keep helping me, I wanted to recover quicker. I felt the problem wasn't that serious. I think I was in a denial, and I did not want to think that I could not do these simple things, and I could not imagine that the injury would affect me like that."*

Participant 7 felt that she had to stop doing sports because she had some symptoms and she could not walk on her foot:

007-F-25: "It swelled up, like, a lot more than the previous sprain. There was a lot more bruising and I could not walk on it without support for a little bit. But I think I knew it was a sprain that would just get better if I stayed off it a bit (from doing sports) and then took it slowly."

She also reflected on her injury and stated that she should have sought medical treatment for her injury:

007-F-25: "I definitely look back at it now [and think] that I should have gone and seen a doctor or a physiotherapist."

Participant 1 highlighted the influence of getting older on recovery from an injury and returning to playing sports after lateral ankle sprain injury:

001-M-31: "The more I become older the less willing I am to be back quicker, you know, to getting back to playing sports as fast as possible. When you grow older, you lose the motivation to do sports. The older you are, the more responsibilities and things you have to do, and that makes your RTP longer"

When the same participant (Participant 1) returned to play, he was careful about where he would start practicing his sport (football):

001-M-31: "I was very careful about where I was playing, so I tried to find a place that was more even, like indoor courts. So I started to play on them upon my return to playing again."

<u>Subtheme 4: Pre injury physical well-being</u>

One participant (Participant 3) highlighted the importance of a person's pre-injury physical status as a factor that dictates RTP after an ankle injury:

003-M-45: "I think it is because I had good muscles and balance, I do quite a bit of swimming, riding a bike so maybe that helped to get good balance, the fact I also played a lots of sports that helped over the years. "

7.9.6 **Theme 6: Previous history of managing an ankle injury**

Participants in this study highlighted that they could manage their current injury because they had had the same injury in the past. Therefore, they had, according to them, adequate knowledge of what was required to treat their injury.

Subtheme 1: Had a previous injury

A participant (Participant 1) learnt from previous their injury how long lateral ankle sprain injury takes to recover:

> *001-M-31: "I had a similar injury before, so I followed the same procedure and I managed to recover in almost two weeks. I took the same period to recover as I did for the first injury."*

Participant 3 substantiated what the previous participant said. He even knew the assessment procedures and the likely outcomes out of it:

> *003-M-45: "When I first hurt my ankle back in 1990, I went to the doctor and he looked at it and said ok… you are not dying, not bleeding, we will get it wrapped, so 4 hours later they asked me to come through and I told them I had twisted my ankle. They recommended an x-ray, after another hour waiting for the x-ray, the results were negative, so they told me no broken bones, you just need to rest it. So I wasn't going to see them again on a Thursday night, I knew what I had done, I could put weight on it so I knew nothing was broken, so I thought I do not want to waste 5 hours in A&E."*

Participant 5 was more concerned about pain severity, as she compared her current pain severity with that of a previous injury. She claimed that because the pain was not as bad, she felt she did not have to seek medical attention:

> *005-F-25: "I knew it was a sprain because I have had it in the past. I don't know… but I felt if the pain got any worse then I would go and see someone else, but I knew I was getting better, so I was like, there is not much point in me going to them for them to tell me what I probably already know they are going to tell me."*

Participant 6 felt more confident because he had had this injury before, and knew how long it normally takes to get back to playing sports again:

> *006-M-32: "It helped me because it was not the first injury I'd had; I had other injuries a long time ago, so I knew that I was going to recover and go back to playing again. That gave me confidence."*

Subtheme 2: Knowledge of sport injuries

One participant stated that because he had read some news about that type of injury in football leagues, he had an idea of how long it usually takes to recover from an ankle injury:

001-M-31: "from you know, reading the news, following football, following, you know, leagues in Europe I know that sometimes a person gets some kind of injuries and how long it takes to RTP."

7.9.7 **Theme 7: Symptoms dictating RTP**

Most of participants in this study considered symptoms such as pain, joint instability and recurrence of injury as recovery indicators. However, although they returned to play with those symptoms, they let their level of return be dictated by the symptoms.

Subtheme 1: Pain severity

Pain was found to be a main recovery and RTP indicator. Participant 2 appreciated the pain as a stopping factor for RTP. She reported that if she had pain before the match then she would not play the game:

002-F-22: "If I had more pain before the match then I wouldn't take part in the match from the beginning."

The same participant (Participant 2) explained why she took a long time to recover and the pain she felt while doing weight-bearing activities during her recovery:

002-F-22: "I wasn't able to bear weight through the heel so I was on a crutch for the first week, and then I started to walk on them and then I started to side run, but I couldn't run very far, so it took a long time… it took six weeks to be as well as before."

Participant 8 agreed with previous participants that pain is a sign of recovery from an ankle injury. He felt the pain when he returned to playing football and he had to apply some conservative treatments. He then realised that he was ready to play again because he felt no pain:

008-M-32: "Pain might be an indication of recovery, which means you are not fully recovered. I continued playing (upon RTP) but when I finished playing, I put ice on my ankle and I just felt that I had no pain, no other physical

> *problems, I had normal movement. I felt that was enough period of resting and I went back and played football."*

Participant 1 returned to playing football with pain, and because the pain was not severe, he managed to continue playing. However, the pain disappeared when he played a couple of matches later:

> *001-M-31: "The first time I was still feeling some pain. It was not that much, but then after practicing, I could play for longer after approximately one month without feeling any pain."*

Participant 2 discussed the difference between men and women in their perception of pain. She claimed that women tolerate pain more than men do, because women experience pain on a regular basis:

> *002-F-22: "I think for women, especially, we see pain differently from men, like because of period pain, you kind of don't see the pain of other injuries as a big deal."*

<u>Subtheme 2: Joint instability</u>

Two participants reported ankle joint instability. Both of them had spent a longer time recovering and they thought it was because they had joint instability. Participant 4 had severe ankle instability that persisted for a long time and prevented her from wearing her casual shoes and sandals:

> *004-F-30: "I felt unstable; I kept wearing ankle supports for a long time, for about three months. Because every time I moved it, I felt my ankle give away. I thought I had ruptured my ligament but is wasn't ruptured when I had an x-ray… it did not show any rupture. The feeling was bad, as I had not had a similar injury in the past. Even before that injury, I used to experience minor ankle twisting, but after those injuries it didn't became less stable. Now, after this last injury I haven't been able to wear sandals or high heel shoes for about a year, because I feel my ankle is not stable enough to wear sandals."*

The other participant (Participant 2) realised the effect of having joint instability on sport performance during activities such as sprinting:

002-F-22: "I wasn't as good as I was before the injury, because I couldn't run as fast as I normally do, because every time I put weight on my foot, it did not feel as stable as it usually does, it was ok but not 100%."

Subtheme 3: Recurrent injury of dominant foot

One participant (Participant 1) mentioned that because he had had a similar injury in the past in the same dominant foot, it had caused him to take longer to recover from this most recent ankle injury:

001-M-31: "Having the same injury in the same foot was, you know, one of the main causes affecting my performance to get back. I am left footed and I have the injury in the same foot, so that affected my performance."

7.9.8 Theme 8: External motivation and expectations and support

Participants in this study expressed their views on how people and sports places around them affected their decisions to return to playing their sporting activities. The availability of training places and support from surrounding people was deemed important regarding their recovery from ankle injuries.

Theme 1: Availability of training centres

Participant 1 reported that the availability of a training centre is very important in terms of recovering from ankle injuries. He also added that he had limited access to nearby playing courts too:

001-M-31: "The availability of fitness centres is not good in my area, there are not that many options you can go to. A place that can go and practice and improve my muscles and fitness is very important. Sometimes you cannot find places to play, as they might be busy or might be closed. This is important because if you cannot find a place to play, then you don't know if you are getting better or not."

Another participant (Participant 6) had access to a training centre and he found it very helpful helping him to recover, and thus return to playing sports more quickly:

006-M-32: "The place I was staying at was very close to the university and the gym. So being very close to gym was a very helpful factor to recover from my injury."

Subtheme 2: Family support

One participant (Participant 3) told the story about how his wife had managed to encourage him, in an indirect way, to return to playing his sport (rugby):

003-M-45: "My wife said get back and play because you are grumpy not playing, which was fair enough. So she was sort of supportive, she said 'I don't want to see you unfit'. I think she has been supportive, she knows that I enjoy playing rugby. I then felt like ok, get fit, get your ankle sorted and change your mood."

Subtheme 3: Encouragement from sportspeople

Some participants said that they usually enjoy playing sports with their friends, and that had helped them to find out how to treat their injuries and RTP after their injury.

Participant 1 stated that playing sports (football) with his friends was a source of encouragement. He also found doing sports with his friends or family members made him return to sports faster:

001-M-31: "Even if they (training facilities) are available, sometimes you cannot find someone to go with you and if you go alone you might get bored quickly and might stop training. But if you have a sports centre nearby and you know you have friends or family members who can join you then you can go together and that might help you to RTP faster."

Another participant (Participant 6) was encouraged by his friends to return to playing sports (football):

006-M-32: "Many of my friends also play sports regularly, so that encouraged me to get back and play. So stopping doing sports was hard for me, because playing sports was something I was doing regularly and something I love to do."

Participant 8 expressed a similar view, specifically, that his friends were a source of encouragement for him to return to playing sports (football) faster:

008-M-32: "It also made my RTP quicker. I just wanted to go back and play again with my friends. I consider playing sports a source of happiness for me."

Participant 2 took a great deal of advice from sportspeople who had had similar injuries before and had recovered:

002-F-22: "I took more advice from people. I did not really read about injuries on the Internet, because the Internet has so much wrong information, so for me it was more about talking to people with similar injuries who recovered and going to see someone who does fit your therapy."

Subtheme 4: Influence of sports team/ coach

Three participants discussed the influence of coaches, personal trainers and sports team members on their decision to RTP. That influence either helped those participants to recover from an injury or it actually forced them to RTP, despite not being fully recovered.

Participant 3 explained his relationship with the coach who gave him the opportunity to play for the first team. He, the participant, did not want to waste that opportunity and so he returned the favour to his coach:

003-M-45: "The coach was a master when I was at school and I had known him for 30 years. He basically gave me the chance to play for the first team because I had been training every week. And when the numbers fell short, it was like, whoever trains, gets in. So because he gave me that opportunity, I felt I should return the favour and try do as much I could to get fit."

The same participant (Participant 3) reported that he was given some treatment and RTP instruction by a physiotherapist, but he had to RTP and play a match with the team, because they were short of players:

003-M-45: "I saw a physio and she said that it was ok, but that another week's rest would do me good. But we were short on numbers for the Saturday, so I put myself on the bench hoping I would't be needed to play. We lost two people who did not show up, so that put me as the only person left on the bench. We then got an injury within 20 minutes, so I ended up playing 60 minutes, probably a week before I should have."

Another participant (Participant 2) was assisted by her personal trainer to follow an exercise training programme to strengthen her muscles:

> *002-F-22: "We had a personal trainer, I did some squats and was getting back into it, there wasn't any emphasis on muscles round the ankle joint, but after the injury I started doing more running and I found that really improved the pain. I think the personal trainer was more like just take it easy, do not use heavy weights, use less weights but higher reps."*

The same participant (Participant 2) explained the pressure to return to playing sports for a person who plays in a team:

> *002-F-22: "I think there was a bit of pressure to go and play again, as soon as I could, so that was probably why I didn't give it full time to heal. When you are on a team and there are people around you, you want to get back and play as soon as possible, so that makes you rush. However, if you are training by yourself you can give yourself enough time to recover."*

7.10 **Discussion**

To the best of the researcher's knowledge, this study (Study four) is the first study that has explored the perspectives of sportspeople and has confirmed the factors that influence RTP after a lateral ankle sprain. This unique qualitative study has facilitated further exploration of the experiences of sportspeople on RTP after conservatively treating a lateral ankle sprain. The participants in this study shared their experiences and they discussed various influencing factors for RTP after their injury. The results of this study provided unique insights into factors that influence the context in which making the decisions to RTP is made. In this study, eight emerging themes were identified as being potential influencing factors for RTP. Those themes were:

1. Previous negative experience with a healthcare service,
2. Limitation of resources
3. Level of sport played
4. Self-management of injury towards RTP
5. Perception of self and injury and RTP
6. Previous history of managing ankle injury
7. Symptoms dictating RTP
8. External motivation, including expectations and support from others

7.10.1 **Previous negative experience with a healthcare service**

The previously described negative experiences with a healthcare service was found to be an emergent theme in this study, as it was confirmed by participants in this study who had not been satisfied with the treatments provided. Patient satisfaction is an important measuring tool of the quality of a healthcare service. Although determining the quality of care is generally based on the healthcare process and health outcomes, patient satisfaction is used to complement the evaluation of a healthcare service (Browne et al. 2010). Indeed, patients can use patient satisfaction data to compare and choose appropriate healthcare plans and physicians (Browne et al. 2010). Patients who are not satisfied with a particular healthcare provider, such as their GP may not appear for treatment. As a result, they may not get the treatment required for their illness, and thus recovery might not occur quickly or at all. In this current study, one participant had a negative experience with the quality of the healthcare that she had received previously; therefore she did not approach that particular GP to treat her lateral ankle sprain. This is an important issue, as the condition of the patient may become worse and more complications may develop. Consequently, those who do not seek medical attention and develop post-injury complications may then become a burden on the healthcare system (Verhagen et al. 2005) .

In terms of lateral ankle sprain, recovery depends on the adequate treatment of the injured ligaments. Therefore, a treatment programme that includes resolving joint swelling and pain, followed by exercises to regain ankle joint mobility and surrounding muscle strength is important (Kerkhoffs et al. 2012). Researchers have recorded many symptoms that are associated with lateral ankle sprain during the early stage of recovery, such as joint instability (van Rijn et al. 2008b), pain (van Rijn et al. 2008b), swelling (Punt et al. 2015), restricted joint mobility (Punt et al. 2015) and a lack of dynamic postural control (Doherty et al. 2015). These symptoms may persist and become chronic complaints if they are not addressed during that early stage of lateral ankle sprain (Anandacoomarasamy and Barnsley 2005; Kemler et al. 2016). It was found that re-sprains and pain at rest are related to incomplete recovery observed during the twelve-month follow-up after a lateral ankle sprain injury (van Middelkoop et al. (2012). Therefore, participants in this study who had unfavourable experience with their GPs and/ or physiotherapists may become susceptible to developing those chronic symptoms in the future. They might have decided to resume their sporting activities before they were completely recovered, which may ultimately result in them becoming a burden on their healthcare providers, due to the increased number of visits, treatment prescriptions and physician working hours (Praemer et al. 1999; Shah et al. 2016). This may also have an impact on their wider social and sports circles if they relay those negative health care experiences. Perhaps, therefore, to determine why patients with sport injuries such as lateral ankle sprain have had negative experience with the provided health care services is an aspect that needs to be addressed in future research across a large scope.

7.10.2 Limitation of resources

The findings in this study confirmed three elements that composed the main theme: a limitation of resources. The three elements were financial limitations, unavailability of healthcare services close by and no physiotherapist specialised in particular sports.

Participants in this study reported having financial limitations that prevented them from receiving proper treatment for their lateral ankle sprain injury. One reason for this was that confirmed in the findings of this study was due to inadequate budgeting of some sports clubs. Receiving adequate funding is important to address players' different needs, including treatment after sport injuries. For instance, university teams have less income/ revenue, which makes them more prone to cut costs (Chad et al. 2013). In the UK, several universities have taken action to eliminate some sports teams, in order to reduce the growing expenditure in this area (Loughborough University 2018; Northumbria University 2018). Further action has also been taken to reduce the number of athletic staff, reduce the hours spent training and minimise the use of training facilities (Belson 2009). All of those actions have reflected negatively on the recovery of players with sport injuries. For example, players have less time to train, which in turn may impact their physical readiness when playing official matches. Furthermore, players might also not have the adequate training to become fit enough after they recover from their injuries. In addition, the availability of sports medicine professionals, such as athletic or fitness trainers, is important across various sport clubs to minimise the risk of injury. Those trainers are important to ensure the overall fitness and readiness of all the players before competitive games (Prentice 2014). Athletic trainers are also regarded as creating a "culture of precaution", because they have a great responsibility towards preventing sport injuries (Safai 2003). Therefore, sports associations may consider looking at prioritising funds to cover sports medicine services, in order to ensure safer sports participation. Other financial limitations were also indicated in this study, such as the fact that some participants could not cover the transportation costs needed to reach a physiotherapy clinic. Others indicated that their club did not have a large enough budget to employ a full-time physiotherapist.

Although GPs are well distributed across the UK (Confederation 2017; NHS England 2018), one participant reported that there was no GP nearby. Due to the fact she was in severe pain and could not walk or take public transport, she regarded that GP as being too far from her house.

Another participant stated that she did not want to wait and see a physiotherapist on the NHS, because of the long waiting time involved, as she wanted to return to playing sports quickly. Patient access to healthcare appears to be one of the main challenges for the healthcare industry. Examples of those limitations are limited appointment availability, transportation barriers, limited education about healthcare locations and a scarce allocation of healthcare sites. According to the responses from participants in this study, they had two options, either they had to pay a lot of money to get physiotherapy treatment from private physiotherapy clinics or pay for a taxi to go and come back from NHS physiotherapy clinic that were far away. Unfortunately, according to the participants in this study, even if they choose the second option, they had to wait for a long time between treatments, because the physiotherapists had a busy schedule.

Sportspeople who do not have access to proper treatment for their ankle injuries may have negative experiences during their recovery and on their return to sporting activities. This could be one of the reasons that most of participants in this study and the third study of this thesis made their own decisions regarding RTP and returned to sports with residual symptoms.

7.10.3 **Level of sport played**

Participants in this study also confirmed the difference between being a professional player and an amateur player. They also stressed the issues associated with playing for the first team and the second team at the same club. Some participants, who were playing for non-professional clubs, had issues with budgeting to cover treatments such as physiotherapy. This was also emphasised in the previous theme (7.10.2), specifically that those on low incomes such as students had financial issues when trying to cover their treatment costs. Sports teams such as those in universities and recreational sports clubs usually depend on their members' fees and external financial support to run their activities, unlike in professional sports (Bruce et al. 2007). Unfortunately, there is lack of research into the funding of amateur sports clubs such as university and local sports clubs compared to professional sports teams (Barget and Chavinier-Rela 2017). However, it could be speculated that since professional sports are more profitable, they receive more attention from investors and researchers. Amateur and university sports clubs need to be provided with at least a visiting physiotherapist who can provide advice on treatment and RTP after sports injuries.

The participants in this study also revealed that players who play for the first team are more likely to be encouraged to RTP faster, compared to those participants who play for the second team. They regarded playing at first team level as an opportunity, and so they did not want to miss any matches. They thought by missing some matches while playing the first team, would result in them being removed from the first team and demoted back to the second team. Another perspective that emerged from this study was that playing at a professional level means that injuries are perceived as more serious, and therefore appropriate treatment is more likely to be sought by players and more careful decision regarding RTP are more likely to be made. It could be possible that players at higher levels such as those playing sports professionally are more conscious of their performance, and thus do not want to risk their sports career by making inappropriate decisions regarding injury management and RTP after their injury. Indeed, a prospective comparative study showed that first division professional football players had a higher level of physical performance and a more stable psychological status compared to semi-professional and amateur players (Bekris et al. 2018). That in turn may have helped them to think more positively about making safer decisions for RTP. Another study investigating the difference between professional and amateur players found that professional athletes are less likely to experience negative feelings such as anxiety, worry, fear, anger, frustration, depression, and loneliness (Cohen et al. 2018). Furthermore, another study also found that professional players were characterised by the ability to cope with anxiety, their confidence, mental toughness/ resiliency, sports intelligence, the ability to focus and block distractions, competitiveness, a hard-work ethic, the ability to set and achieve goals, coachability, high levels of dispositional hope, optimism and adaptive perfection (Gould et al. 2010). It seems that players at higher levels have more medical and psychosocial support, and therefore have fewer concerns about how they manage their injuries and make safe decisions regarding RTP.

7.10.4 **Self-management of injury towards RTP**

Participants in this study confirmed some conservative treatment methods that they thought were effective in managing their lateral ankle sprain injury. The application of strapping/ taping, RICE, exercise and medications were all deemed effective, in their opinion, in reducing any pain and/ or swelling, restoring an active range of movements and facilitating faster RTP.

Indeed, evidence has showed that the use of conservative treatments including those that were mentioned by the study participants is effective for faster recovery from lateral ankle sprain. Furthermore, a systematic review featuring a meta-analysis found strong evidence supporting the use of ankle braces and moderate evidence supporting the use of neuromuscular exercise programmes in preventing re-sprains (Doherty et al. 2017). There was also moderate evidence to confirm the benefits of exercise and manual therapy techniques, as well as strong evidence to support the use of non-steroidal anti-inflammatory medications and early mobilisation to reduce pain and swelling and restore function after an injury. A more recent experts' consensus statement also concluded that immobilisation, followed by the use of tape or a brace, along with an exercise programme can be used for a short time to reduce pain and swelling (Vuurberg et al. 2018). In addition, they recommended the use of NSAIDs to reduce pain and swelling, however, caution should be taken, as they might suppress the natural healing process. Those experts were also in agreement with the findings of the previous review (Doherty et al. 2017), specifically that the use of ankle braces is effective in preventing re-sprains. Similarly, participants reported better treatment effects including faster recovery, which in turn facilitated their RTP.

However, most participants in this particular study had to make their own RTP decisions, with no advice from medical rehabilitation staff such as physiotherapists or podiatrists. This coincides with the results from the previous study (6.5.2.6), which reported that 84% of participants made their own decision about RTP and about 76% resumed their sporting activities with residual symptoms. It would be helpful if guidance existed in sports clubs, so that players with lateral ankle sprain could follow it and make better RTP decisions. Unfortunately, in this study, the participants reported that their sports clubs did not have RTP policies for lateral ankle sprain injuries, which likely caused participants to treat themselves and make their own decisions regarding RTP. Although encouraging individuals to treat their own injuries might reduce the burden on relevant healthcare services such as physiotherapy clinics, considering the absence of clear and evidence based RTP policy, it is better that they be supervised and guided towards a safe RTP and avoid premature RTP.

A supervised treatment for a lateral ankle sprain injury has been advocated in previous studies. Indeed, one systematic review concluded that the combination of supervised exercises with conventional treatment (immobilisation, non-supervised treatment including exercise instructions or use of external joint support) resulted in better and faster recovery, and therefore faster RTP (van Rijn et al. 2010b). In a more recent review, supervised exercises were found to be effective in reducing pain and joint instability, as well as improving ankle muscle strength and joint position sense (Feger et al. 2015). Others also found better results as a result of supervised exercises, specifically in term of producing less pain (van Rijn et al. 2007a), preventing re-sprains at 12 month follow-up (Holme et al. 1999) and minimising joint instability by the eight week follow-up (van Rijn et al. 2007a). Unfortunately, as a result of not following supervised treatment programmes, the participants in this study returned to their sporting activities with residual symptoms, which may indicate incomplete recovery from their lateral ankle sprain injury. As a result of incomplete recovery, those participants might have more serious complication in the future including re-sprains. Re-sprain was reported in 28% (van Middelkoop et al. 2012), 29%

(Holme et al. 1999) and 54% (Wester et al. 1996) of all study participants after twelve months following lateral ankle sprain in two studies on the subject. In addition, there was a correlation between re-sprain during the first three months and incomplete recovery following a lateral ankle sprain injury (van Middelkoop et al. 2012). Therefore, individuals with lateral ankle sprain should be encouraged to attend supervised treatment programmes, in order to receive better care and facilitate safe RTP decisions.

7.10.5 **Perception of self and injury and RTP**

The findings in this study confirmed four elements that composed the main theme: perception of self and injury and RTP. The four elements were: not a serious injury, self-perception as a sports person, self-awareness of injury and preinjury physical well-being.

Sportspeople with sport injuries experience a variety of negative psychological responses. Smith (1996), found that tension, low self-esteem, depression and anxiety are common experiences immediately after an injury and during rehabilitation (Smith 1996). In addition, the ability of an athlete with a sport injury to cope with stress after an injury was found to influence their recovery and the outcome of a rehabilitation programme (Crossman 1997). Those negative psychological responses were found to be particularly evident immediately after the injury and at the time of clearance to RTP, but decreased during the rehabilitation period (Morrey et al. 1999). In this study, only one participant expressed similar negative psychological responses such as stress, depression and anxiety, as she was not able to walk long distances immediately after sustaining her injury. That in turn, according to the participant, slowed her down from returning to sporting activities.

When it came to returning to play, some participants expressed mixed opinions about wanting to RTP quickly, although they were slightly uncertain due to still having symptoms. Other participants were more cautious about their recovery from the injury, and therefore took precautions upon their RTP. Two types of personality characteristics became evident in this study: the hasty players and the cautious players. The different personality characteristics of sportspeople might not only increase their risk of injury, but might also affect the rehabilitation process, which in turn can affect their recovery and RTP (Pain and Kerr 2004 ; Slimani et al. 2018). It was evident from this study (Study four) that participants perceived their injuries and recovery differently. While some participants were more careful about first being fully recovered to ensure safer RTP, others just wanted to play again, and did not give much thought about their residual symptoms. This study (Study four) and the previous study in this thesis (Study 3) showed that many participants RTP regardless of whether their injury has fully recovered or not (presence of residual symptoms).

The divided opinions of participants in this study (Study four) might be due to the fact that different sportspeople have different personality characteristics, which influenced their decisions throughout their recovery time. For instance, sportspeople who participate in high risk sports develop unique personality characteristics such as increased sensation seeking (Zuckerman 1990). Sensation seeking is characterised by the need for varied, novel, and complex sensations and experiences and the willingness to take physical, social, legal and financial risks for the sake of such experiences (Zuckerman 1990). Some participants in this study stated that despite not being fully recovered, they returned to play and put their foot at risk, because they just love their sports (rugby and football). Some of them (rugby players) even regarded their injury as a silly injury compared to, according to them, a knee injury. Individuals with this type of personality are likely to possess active coping skills, especially with pain after an injury (Meredith et al. 2015). They might be able to develop different coping strategies including ignoring the pain and diverting their attention, which in turn makes them able to resume their sporting activities and ignore their symptoms. A case report by a sports psychologist concluded that those individuals with this type of personality have a tendency of ignoring any medical advice and continue to participate in potentially destructive behaviour (Pain and Kerr 2004). This group of people, in particular, need to be made aware of the unfavourable consequences of an ankle injury. Their hasty decision to RTP, despite having residual symptoms, could be explained by not fully comprehending the consequences of their injury. It could also be reasoned that although they may have been aware of those long-term consequences, they simply did not want to wait and finish a lengthy rehabilitation programme, which may deprive their physical and emotional resources. Therefore, it might be helpful for a sports psychologist, together with a physiotherapist or a podiatrist, to create some awareness campaigns to highlight the problems that can occur as a result of not seeking proper advice on RTP after an injury.

7.10.6 **Previous history of managing ankle injury**

More than half of the participants in this study reported that they had had a similar injury in the past, which enabled them to manage their new injury. Those participants stated that they had learnt from previous injuries how to apply treatment and when to RTP again. Previous studies explored a variety of consequences (cognitive, emotional and social) after sports injuries (Andersen and Williams 1988; Smith et al. 1990; Mainwaring 1999; Granito and Carroll 2000). The majority of the responses were negative initially, although this reduced as they made progress during rehabilitation and recovered from their injury (Mainwaring 1999). The way that athletes react to an injury depends on many factors that shape their perception and later the recovery. Andersen and Williams (1988) proposed a stress response model showing the factors that may influence a sports injury to occur and the amount if recovery needed. The factors included in their model were personality, history of stressors and coping resources. Personality factors may include competitive trait anxiety, loss of control, hardiness and achievement motivation. A history of stressors may include previous injuries and life events, whereas coping resources may include social support and coping behaviours. These factors interact with each other to influence the cognitive evaluation and physiological response to a particular injury. Athletes with a predisposition to high stress levels, a low level of coping resources and low positive personality characteristics are more likely to evaluate a stressful event more negatively (Andersen and Williams 1988; Williams and Andersen 1998). Many other researchers have supported those results shown by Anderson and Williams' model, to explain the psychological response to an injury and the influence of previous experience on a particular sports injury situation (Petrie 1992, 1993; Ford et al. 2000; Sibold et al. 2011).

The participants in this study who had sustained lateral ankle sprain in the past and managed to treat themselves using their own experience might have developed their own self-efficacy skills. It was found that players with previous multiple injuries (second time or third time injuries) tend to develop particular coping strategies to deal with their new injuries (Johnson 1996). Individuals who experience a sports injury for the first time present with psychological difficulties such as stress during the rehabilitation period, lower self-confidence and a lower score on an overall mood scale than those individuals who have had the injury in the past. On the contrary, individuals with a history of injury in the past were more likely to accept their new injury and had higher levels of social orientation and activity. In addition, they experienced less anxiety when experiencing recurrent injuries and they considered their injuries as less stressful and threatening. Some participants in this study even managed to comprehend the recovery and what is considered as a positive outcome towards RTP. They stated that the knowledge that they had gained from previous injuries was an important factor for gaining self-confidence, and thus motivated them to RTP. Johnson (1996) claimed that experience gained from a history of severe injury facilitates particular psychological qualities such as an improved intrinsic capacity to recover properly, an increased ability to deal with a stressful injury experience and to share one's own experience with friends and family.

7.10.7 **Symptoms dictating RTP**

All of the participants in this study reported symptoms that they considered as guiding indicators for recovery from their injury. This seems to contradict the findings from the previous study (Study three), in which 76% of participants resumed training with residual symptoms. However, although the interviewed participants (Study four) used those symptoms to determine their recovery from lateral ankle sprain, they also resumed training with residual symptoms. The most prevalent symptom confirmed by participants was pain, as it was considered the main factor to guide them whether to resume sporting activities or not. Some participants appreciated the presence of pain as a sign of not being fully recovered from an injury, thus they decided to stop participating in training. Pain was also considered to evaluate performance upon RTP, and to measure whether participants had returned with full physical capability. Indeed, pain has been identified as recovery indicator that is associated with patient's satisfaction and adherence to a rehabilitation programme (Tooth et al. 2003; Bergés et al. 2006). Pain reduction has also been shown to be considered a primary goal to facilitate the recovery process after surgery (Nygaard et al. 2000; White et al. 2007). Other authors found pain as a prognostic factor for return-to-work following surgery for carpal tunnel syndrome (Peters et al. 2006) and low back disc herniation surgery (Seyedmehdi et al. 2015).
Untreated pain can therefore increase the duration of recovery and affect a person's ability to carry out everyday activities (Wu et al. 2003). In addition, multisite pain in patients with joint hypermobility syndrome was found to be a significant predictor of a lower SF12: Physical Component score compared with healthy individuals (Clark et al. 2015). Therefore, pain is an eminent factor that needs to be adequately addressed and considered within different rehabilitations programmes. Indeed, pain relief methods have often been integrated within different rehabilitation programmes, in order to achieve better treatment outcomes (Brewer 2009).

Previous literature has looked at the relationship between pain and recovery from ankle injuries including lateral ankle sprain. Measures of pain during the later stages of the rehabilitation period, rather than immediately after the onset of injury, was found to be a good prognostic factor for recovery after a lateral ankle sprain injury (Thompson et al. 2017) . A secondary data analysis found that pain on palpation and pain on active dorsiflexion movement at four weeks were strong predictors of function (Karlsson score) at four months (O'Connor et al. 2013). Furthermore, another observational study found that self-reported pain at rest at 3 months is related to incomplete recovery at 12 months (van Middelkoop et al. 2012). A more recent study of 584 participants from a UK multicentre randomised clinical trial was conducted to investigate potential predictive factors for poor recovery from a lateral ankle sprain injury, and found that pain when resting, pain bearing weight, ability to bear weight to all be predictors (Schlussel et al. 2018). From the results of those previous studies, it is evident that pain can be used as an outcome measure to determine the rate and the course of recovery from lateral ankle sprain. However, there is a lack of evidence to support the relationship between pain and RTP, as a recovery time point, after an ankle sprain (Al Bimani et al. 2018b).

Some participants in this study resumed their sporting activities despite having some degree of pain. Interestingly, one participant reported that she had played for 40 minutes with pain of 5-6/10 on VAS pain scale when she returned to training. This was also indicated in a previous section in this study (7.10.5) when different participants' perceptions of their injuries and recovery were discussed to explore what is known as sensation seeking (Zuckerman 1990). Different people have different sensory sensitivity to pain, which in turn determines their pain threshold. According to Dunn (1997), people who present with high neurological thresholds score higher on scales of sensation seeking (active response) and low registration (passive response). In contrast, people with low neurological thresholds score higher on scales of sensation avoiding (active response) and sensory sensitivity (passive response). A cross-sectional study investigated the relationship between sensory processing styles and the use of pain coping strategies to understand individual differences in coping with pain (Meredith et al. 2015). They found that people with low registration, which implies a high sensory threshold and passive behavioural response, were more likely to ignore any pain they felt. They also found that sensory sensitivity, which implies a low sensory threshold and passive behavioural response, was significantly and positively correlated with catastrophising (i.e. view or present a situation as considerably worse than it actually is). In addition, sensation seeking, which implies a high sensory threshold and active behavioural response, was associated with ignoring pain. Finally, sensation avoiding, which implies a low sensory threshold and active behavioural response, was also found to be positively associated with catastrophising. Some of those results have implications for this current study (Study four), as some of the participants continued to play even with a high degree of pain. Therefore, it is important to understand and detect these differences during the early stages of rehabilitation, in order to maximise the outcomes of rehabilitation programmes, as well as inform safer decisions for RTP.

7.10.8 **External motivation and expectations and support from others**

Participants reported a number of perspectives related to this main theme. According to the participants, the availability of a training centre nearby was stated as being an important factor facilitating better recovery from their injury. Indirect family support, as stated by one of the participants was also expressed as being helpful to speed up the process of RTP. Most importantly, the encouragement and influence of teammates, coaches or personal trainers were mostly commonly reported as being a significantly influential factor regarding quicker RTP.

In any type of sports, sportspeople are potentially influenced by different people around them. The influence of those around them in sports is called the sports culture. In an early sociological study, this was described as a 'culture of risk', as it can normalise an injury, and thus lead to players playing with pain (Nixon 1992). Nixon (1992) recognised a sport and social network, called 'sportsnet' that a particular player interacts with. This network may include coaches, teammates, club owners and medical staff, among others. The sportsnet is claimed to have an impact on athletes' health, as it influences their decision to take risks regarding when to play when experiencing pain and an injury, for the sake of winning. Those athletes who have sport injuries are likely to seek advice and support from that sportsnet. This was evident in this current study (Study four), as many of the study participants sought help and advice from teammates, coaches, personal trainers, to manage their injury, and later to RTP. This was also captured in the results of the previous study in this thesis (Study 3), as many participants resumed their training with symptoms such as pain, swelling and restricted ankle movements.

Another aspect identified in this study was that participants felt what is referred to as a sense of group bonds and team commitments (Young and Charlesworth 2004). Those participants who decided to RTP, even with symptoms such as pain, cited a similar reason, saying that they felt part of the group and enjoyed playing with their teammates. As a result, they felt that they did not want to let their teammates, coaches and training partners down. It seems that the close relationship between the participants and the people around them was strong enough for them to ignore the potential consequences of their own injuries. Similar results were found by (Podlog and Eklund 2006), who revealed that injured people felt separated from their teammates and training partners while they had the injury. Therefore, going back to training was important to them to stay connected with the teammates or the coach. The participants in this study (Study four) regarded this strong relationship as a source of support during the injury, however, this might have caused them to unwisely resume training prematurely, despite having a painful foot. Those participants need to be aware of the potential consequences of their injury and to find a balance between risking early RTP and meeting their own personal/ psychological needs.

7.11 Strength and potential limitations

7.11.1 Strengths

This study uniquely used a qualitative approach to further investigate the factors influencing RTP after conservatively treating a lateral ankle sprain. It was designed based on the ICF framework, to ensure different factors that might influence recovery (RTP) from lateral ankle sprain were addressed. The ICF framework is widely used to understand the potential factors influencing different diseases/ conditions such as rheumatoid arthritis (Stucki et al. 2004), osteoarthritis (Dreinhöfer et al. 2004), hand function (Kus et al. 2012), spinal cord injury (Cieza et al. 2010), low back pain (Cieza et al. 2004) and many other conditions.

The use of semi-structured interviews was key to extracting in-depth and rich information from sports people who had previously sustained a lateral ankle sprain. The use of open-ended and general questions was found to be an effective method for this study, as it encouraged the participants to state their own perspectives, without being guided by the researcher. It also encouraged them to be more open and honest in expressing their views and concerns, as there was a friendly atmosphere.

The involvement of a PPI group and pilot study provided the researcher with methods to improve the research material, including the whole study design, interview questions, participant information sheets and advertisement poster. Based on the feedback from both groups, amendments were carried out in terms of rephrasing interview questions and many other language amendments were made to make all of the study documents simple and easily understood by the participants targeted.

7.11.2 Potential limitations

As is the case in most qualitative research, there may be a lack of generalisability of the results. The researcher attempted to recruit participants from a variety of demographic backgrounds. However, this was controlled by the response rate and the participants who actually consented to participate in this study. Although this study confirmed a wide range of factors influencing RTP, including physical, personal and psychosocial, caution should be taken when generalising these results. Therefore, future research is warranted to investigate the relationship between these factors and RTP in the form of prospective quantitative studies.

Another potential limitation was the number of participants that were recruited in this study. Based on previous studies and the objectives of this study, it was initially planned to recruit 6-10 participants. However, challenges always exist when determining an adequate sample size in non-probabilistic samples (purposive sampling), in order not to reach data saturation in qualitative research (Galvin 2015). That was addressed during data collection by monitoring the emerging themes to determine the saturation point of the data. In this study, data analysis was carried out after each interview had been conducted. As a result, it was found that the data obtained from the final participant (Participant 8) did not add any new knowledge to inform new themes/ subthemes.

Another potential limitation was the fact that one investigator conducted the data analysis, in terms of identifying initial codes that eventually made up the emerging themes. However, this process was continuously assisted by the study team (CB, MW and LG). Emerging themes were discussed by that team for verification, and the identification of any additional points of interest in the study data. The main investigator (SB) and the study team had regular meetings to discuss the outcome of the initial themes that were identified and extracted from the NVivo software. This procedure was considered an effective method for ensuing the study findings were rigorous and informed by different perspectives. As a result, eight main themes, along with corresponding sub-themes, were then determined and reported as the findings of this study.

7.11.3 **Clinical implications**

Clinical uncertainty about the process for decision-making regarding RTP after lateral ankle sprain is evident from the findings of this study. It seems that sportspeople do not have clear guidance about when to resume their sporting activities following lateral ankle sprain. Most of the participants in this study did not have the opportunity to be seen by a physiotherapist or a podiatrist to be given clear instructions on RTP. Those participants confirmed important issues in terms of why they did not seek proper medical attention to facilitate their RTP, these included, but are not limited to, inadequate funding, difficulty reaching distant physiotherapy clinics and the unavailability of a specialised sports clinician. In addition, it was revealed that many returned to playing sports despite having symptoms such as pain, swelling and instability. Those behaviours, i.e. RTP with symptoms, need to be addressed by conducting educational programmes, in order to improve the awareness of sportspeople on how to manage their sport injuries, especially lateral ankle sprain.

Some participants in this study were given timeline recommendations for RTP by a physiotherapist. However, the participants were not re-examined by the same physiotherapist when they returned to training and playing sports. As this was an emergent finding from the data of this current study, it is not clear why the therapists treating them did not follow up with those patients and provide them with a safe clearance for RTP. The use of standardised clinical tests, undertaken ideally by the same physiotherapist, may provide a clearer method of determining if a patient is ready to RTP. This would in turn convey a clearer message to the patient and would thus prevent premature RTP and later minimise the development of residual symptoms.

7.11.4 **Future research**

The study found eight influencing factors that can be considered to understand the process decision-making regarding RTP among sportspeople with lateral ankle sprain. Those influencing factors need to be investigated to determine their relationship with RTP in future studies, such as in prospective cohort studies. Doing so will help guiding sportspeople to take safer decisions for RTP.

Currently, it is not clear how clinicians such as physiotherapists/podiatrists made recommendations for RTP. Some participants in this study were seen by a physiotherapist that did not provide clear guidance about the appropriate time to return to playing sports. It would be informative to explore those issues regarding clearance for RTP from the perspectives of the therapists treating sportspeople with ankle injuries. Therefore, a future qualitative study investigating those issues is recommended, in order to provide a broader picture and better understanding of the factors influencing RTP after lateral ankle sprain injuries from the expert clinician’s perspective.

Finally, an important finding is that most of the participants in this study (Study four) and in the previous study (Study three) resumed their training despite having residual symptoms. Some of the participants clearly stated that even if a RTP policy existed, they would not follow it, as they would just keep playing despite having injuries/ residual symptoms. Therefore, future interventional work is required to investigate optimal methods of influencing those behaviours.

7.12 **Conclusion**

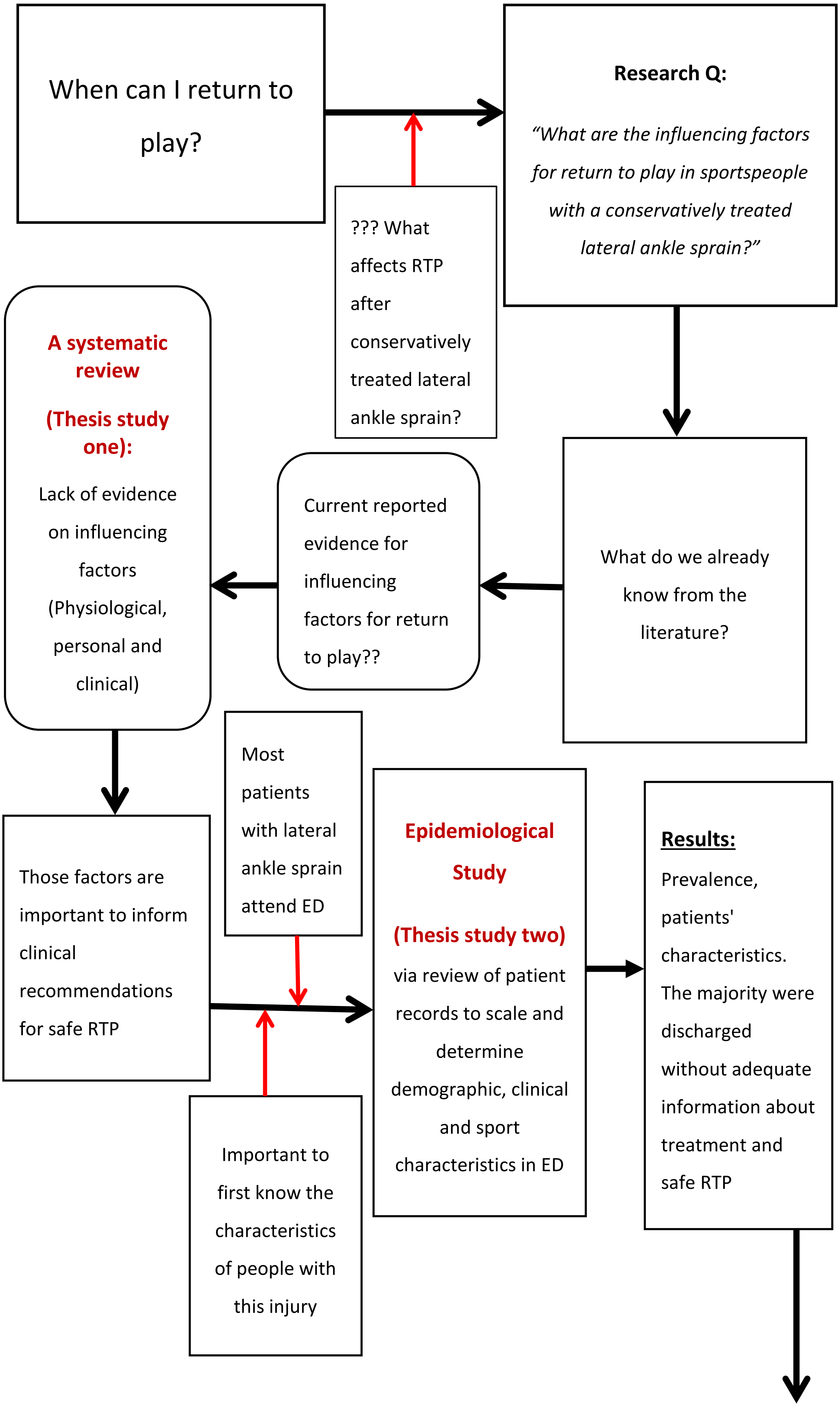
In conclusion, eight themes were identified as the main factors influencing RTP after lateral ankle sprain injury. 1) Previous negative experience with healthcare services. 2) Limitation of resources. 3) Level of sport played. 4) Self-management of injury towards RTP. 5) Perception of self and injury and RTP. 6) Previous history of managing an ankle injury 7) Symptoms dictating RTP. 8) External motivation and expectations and support. The identification of those factors provided an insight and a clearer picture as to how and why participants made their own RTP decisions and what factors influenced those decisions. Those factors will help to inform the preparation of future clinical recommendations for RTP for similar populations. Meanwhile, those patients who are seen by a clinician can be advised not to resume training with symptoms such as pain, joint swelling and restricted ankle movements. The resolution of those symptoms is important to ensure optimal recovery from an injury, and it may, in turn, decrease the incidence of developing residual symptoms.

A key emergent finding from this study is that despite participants recognising that symptoms (such as pain reduction) were an important indicator for recovery, they resumed training irrespective of this, with residual symptoms. These findings provide a deeper insight into what motivates sportspeople to RTP, over and above the presence of residual symptoms. This knowledge is essential for coaches and clinicians who may be guiding a players RTP. In the presence of those behavioural practices, clinicians and coaches are advised to take this into consideration when advising sportspeople about an appropriate time for RTP.allowing those sports people to resume training with residual symptoms might prolong their recovery from injuries thus affecting their soprt performance. They futher might be a burdon on health care services for seeking frequent visits and clinical investigations.

Chapter 8: General discussion and conclusions

The preceding chapters have presented a series of four investigations that, through a mixed methods approach, have explored the factors that affect RTP following a lateral ankle sprain (Figure 8-1). The first study was conducted to investigate if there are any factors that influence RTP. The second study investigated the demographic, sport related and clinical characteristics of patients with a lateral ankle sprain. It also investigated the common causes of injury and sport types, as well as the treatment outcomes after treatment at the emergency department. The third study investigated the relationship between various demographic, sport related and clinical factors and RTP. Finally, the fourth study explored in further depth reasons why sportspeople might RTP with residual symptoms and the various factors that influenced this choice.

This chapter aims to draw together the findings of these four investigations and to discuss the presented body of work as an integrated programme of research. In addition, the advancement in knowledge and contribution towards clinical practice made by this research program is considered. Furthermore, recommendations are made regarding safe RTP following a lateral ankle sprain. Finally, the limitations of the reported studies are also acknowledged and recommendations for future research are presented.


When can I return to play?
Research Q:
"What are the influencing factors for return to play in sportspeople with a conservatively treated lateral ankle sprain?"
??? What affects RTP after conservatively treated lateral ankle sprain?
A systematic review
(Thesis study one):
Lack of evidence on influencing factors (Physiological, personal and clinical)
Current reported evidence for influencing factors for return to play??
What do we already know from the literature?
Most patients with lateral ankle sprain attend ED
Those factors are important to inform clinical recommendations for safe RTP
Epidemiological Study
(Thesis study two)
via review of patient records to scale and determine demographic, clinical and sport characteristics in ED
Results:
Prevalence, patients' characteristics. The majority were discharged without adequate information about treatment and safe RTP
Important to first know the characteristics of people with this injury

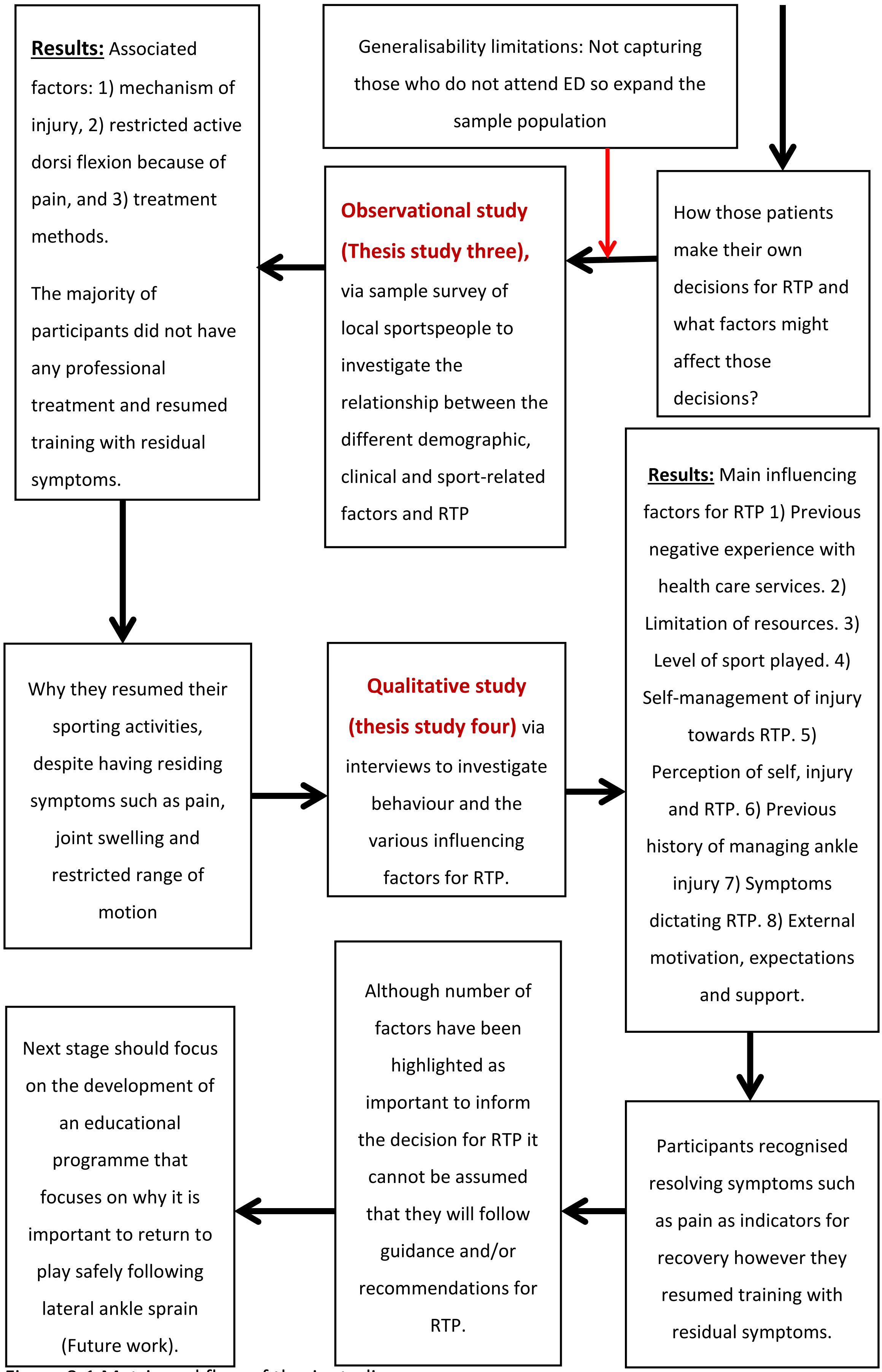


Figure 8-1 Matrix and flow of thesis studies

8.1 Factors influencing RTP following lateral ankle sprain

This thesis was the first, using a mixed methods approach, to investigate the evidence related to factors influencing RTP after the conservative treatment of a lateral ankle sprain. First, a systematic literature review (Study one) was carried out to determine the evidence related to factors influencing RTP following a conservatively treated lateral acute ankle sprain (Al Bimani et al. 2018b). The results highlighted that there is a lack of evidence regarding the influencing factors for RTP in the literature. They also highlighted, for the first time, the disparity in the definitions of and criteria for RTP after an ankle sprain in the previous studies. Similar results were then reported in a more recent systematic review indicating that none of previous studies used a criteria based RTS decision-making process for patients with lateral ankle sprain injury (Tassignon et al. 2019). Therefore, it was then planned to investigate those influencing factors and determine their effect on RTP in sportspeople who had a lateral ankle sprain.

A cross-sectional epidemiological study (Study two) was conducted to determine the prevalence and characteristics of new patients with acute ankle sprain admitted to the emergency department (Al Bimani et al. 2018a). This study was the first in the UK that investigated three fundamental aspects concerning patients attending an ED in the UK with an ankle sprain, specifically the prevalence and the demographic and clinical characteristics. Becoming aware of these aspects has highlighted the current clinical practice, thus resulting in recommendations for improvement. In addition, knowing the prevalence of this injury, along with the patient characteristics, the study highlighted the need for reviewing the utilisation of relevant clinical resources such as ankle and foot x-rays. In addition, the study highlighted some issues regarding the current discharge procedures at emergency departments, including the discharge instruction sheet and patient follow-up system. A main finding from this study was that more than half of patients (58%) were sent home from the ED with no follow up treatments or instructions about return to work/ sports/ activities. In addition, it was found that about 26% of patients had sustained their lateral ankle sprain while playing sports. Therefore, an investigation of how sportspeople make their own decisions for RTP and what factors might affect those decisions was undertaken (study three).

The retrospective observational study (Study three) was conducted to investigate the relationship between the different demographic, clinical and sport-related factors and RTP using the sample survey method. Those different factors had not been considered in previous observational studies that investigated the factors affecting RTP after a lateral ankle sprain (Wilson and Gansneder 2000; Cross et al. 2002; Medina McKeon et al. 2014). It also aimed to investigate the residual symptoms associated with RTP and how and who made the decision to RTP. In addition, it employed a more suitable type of regression (Negative Binomial regression) instead of simple linear regression. This type of regression was used because the criterion variable was a non-normally distributed count data. It was not clear if this had been the case in the previous observational studies (Wilson and Gansneder, 2000; Cross et al., 2002). The results from this study have also highlighted an important clinical aspect, that is to say that most participants did not approach clinicians such as physiotherapists or podiatrists to follow a treatment plan and receive their recommendations regarding RTP. This is important for both clinicians and researchers, as most of those sportspeople were found to develop residual symptoms (Kemler et al. 2016), which, in turn, may see them become a burden on healthcare systems in the future, due to increased follow-up appointments and treatment costs (Verhagen et al., 2005; Meerding et al., 2006; Lamb et al., 2009). In terms of influencing factors for RTP, results showed that participants with planter flexion mechanism and no restricted dorsi flexion due to pain, as well as participants who treated themselves had a faster RTP than other participants in the final multivariable model. It was not clear at that time (end of Study three) why participants had a tendency to resume their sporting activities quickly, even though they had symptoms such as pain. It was also not also clear why most of the participants did not seek professional treatment and RTP clearance. Therefore, a qualitative study to explore these issues in depth was conducted (study four).

A final study in this thesis (Study four) was conducted to explore the factors influencing RTP after a lateral ankle sprain from the perspectives of sportspeople themselves. As a result, eight factors (themes) emerged that were identified as influential in the process of deciding when to RTP after an ankle sprain:

1. Previous negative experience with healthcare services
2. Limitation of resources
3. Level of sport played
4. Self-management of injury towards RTP
5. Perception of self, injury and RTP
6. Previous history of managing ankle injury
7. Symptoms dictating RTP
8. External motivation, expectations and support from others

This study (Study four) highlighted important issues including behavioural factors that explained why participants in the previous study (Study three) did not seek professional treatment and why they made their own RTP decisions. Researchers are also reminded to be aware of this when recruiting unsupervised sportspeople in their studies, as those sportspeople might not follow instructions regarding appropriate treatment methods and RTP, which may in turn affect the validity of their findings.

8.2 Achievement of study aims

The primary aim of this thesis was to investigate the physiological, personal and environmental factors, as well as the clinical ones, that influence RTP after conservatively treated lateral ankle sprain. The secondary aim of the thesis research was to provide evidence that determines which factors should be included in the future development of clinical recommendations for safe RTP following a lateral ankle sprain. Those aims were investigated using four consecutive studies that holistically explored the factors that influence RTP (see Chapters four, five, six and seven). The results from the quantitative studies showed that majority had symptoms upon their RTP including pain, joint swelling, restricted AROM and joint instability. They also showed that mechanism of injury, restricted AROM of dorsi flexion due to pain and treatment programme are associated with RTP. Participants with inversion mechanism of ankle sprain injury and those with restricted active dorsi flexion because of pain had longer RTP than others with plantar flexion injury or no joint movement restriction. Whereas, participants who treated themselves returned to play quicker compared to others who received professional treatment. Those three factors are important when advising sportspeople about RTP as they might make inappropriate RTP decisions. The relationship between those factors and normal physiological process of tissue healing, however, appears to be ignored. The first stage of tissue healing process is characterised by vasodilation, bleeding and inflammation which in turn gives rise to local swelling and pain or tenderness (section 2.4). Since the majority of participants in this study resumed their sporting activities with residing symptoms including pain and joint swelling, they might not have yet completed the first stage of tissue healing. That in turn might have suppressed the normal healing process suggesting that the ligament is not yet recovered from injury. Those clinical symptoms (pain and joint swelling) are also typical clinical symptoms as a result of a grade two and three of ankle sprain (section 2.5). They are usually used by clinicians to assess recovery from injuries including ankle sprain (Wester et al. 1996; Ardevol et al. 2002; Petrella et al. 2007; Petrella et al. 2009; Bendahou et al. 2014). Despite that, the majority of participants in this investigation resumed their training with symptoms. What was surprising is that all participants that had been seen by clinicians also returned to play with residing symptoms. Clinicians are therefore also advised to consider those factors and take into account the normal process ligament tissue healing to decide on optimal and safe RTP after injury. From this study (Study 3), it was not clear why clinicians allowed participants to RTP with residing symptoms (section 6.5.2.6). It was questioned by the researcher whether clinicians ignored the timeline for ligament healing or they actually provided recommendation on optimal timelines but participants chose to resume their sporting activities anyways. The pathophysiology of ligament injury has been understood since long time(Fang et al. 1937; Jack 1950 ; Frank et al. 1992) which also makes it questionable as to why current clinical practice does not appear to follow that timeline for healing in relation to RTP accordingly. Those trends in this investigation when injured UK sportspeople resumed their activities were also observed anecdotally in the researcher's country (Oman). The researcher hypothesised that those trends could be due to several factors which were not clear after analysing the results of the third study in this thesis. It was speculated by the researcher that those behaviours could be due to not receiving professional treatment or because that sportspeople did not comply with RTP recommendations that were provided by the treating clinician. Studies showed that about 57% of individuals did not receive any professional treatment following their lateral ankle sprain injury (McKay et al. 2001). The second study in this thesis also found that a similar percentage of 58% of their participants were sent home with no RTP recommendations. This is also true of other sports injuries, apart from ankle sprain, for example, it was calculated that about 40% of athletes failed to comply with the RTP recommendations after sport concussions (Cancelliere et al. 2013). To the best knowledge of the researcher, following the findings from the first three thesis investigations, there is a lack of knowledge of the compliance of individuals with ankle sprain with professional treatment and the impact it has on recovery from the injury.

Therefore, to understand those behaviours a follow up study (Study 4) was conducted to explore those decisions in depth and to also determine other factors, personal, environmental and physiological, in order to achieve the aims of this thesis completely.

The qualitative study (Study 4) determined eight themes of factors that influence RTP: 1) Previous negative experience with healthcare services. 2) Limitation of resources. 3) Level of sport played. 4) Self-management of injury towards RTP. 5) Perception of self, injury and RTP. 6) Previous history of managing ankle injury 7) Symptoms dictating RTP. 8) External motivation, expectations and support. The identification of all those factors is important to inform both future research and clinical practice. After doing this study, understanding of the influencing factors has become clearer. The reasons why those sportspeople resume their sporting activities with residing symptoms were thoroughly highlighted by study participants. It seems that there is a challenge in delivering appropriate knowledge of RTP for both the society and, to some extent, clinicians as indicated by the participants. Although some participants realised the importance of resolving clinical symptoms after the injury they decided to resume their sporting activities before they were fully recovered. Many of them stated that they resumed training to check whether their injury was recovered or not. They also stated other reasons for resuming training with residing symptoms including influence of surrounding people or because they could not resist stopping training of their favourite sport. Therefore, a novel recommendation from this thesis is to develop an educational program to educate sportspeople on the benefits of having professional treatment for their ankle sprain injury and to follow the recommended RTP advises.

Finally, the four studies in this thesis have investigated and answered the main thesis aims. The influencing factors (clinical, physiological, personal and environmental) were identified and discussed in relation with clinical practice. Those factors are considered important in terms of advancing current clinical practice as well as informing future research. Researchers are recommended to include those factors in their future observational studies to confirm their effect in different sport cohorts. Future longitudinal studies are also recommended to investigate whether sportspeople with lateral ankle sprain comply with professional treatment and whether different treatment pathways have an impact on compliance and/or recovery from injury. In addition, clinicians are now advised about those potential influencing factors that may affect RTP after lateral ankle sprain. Those factors should be considered while constructing treatment plans as well as while advising sportspeople about RTP (section 7.11.3). Considering those factors in clinical practice might help sportspeople understand the benefits of following optimal and safe RTP. That in turn might decrease the manifestation of later complications thus decrease the burden on healthcare services (section 7.11.3).

8.3 **Recommendations**

A novel recommendation of this thesis is the suggestion of developing an educational programme. A programme of this kind may help to change the behaviour of sportspeople who may not be aware of the clinical aspects associated with lateral ankle sprain, including the benefits of following an appropriate treatment programme and exercises, followed by making a safe decision regarding RTP after their lateral ankle sprain injury (Clanton et al., 2012; Richie and Izadi, 2015; Tassignon et al., 2019). This programme could be constructed to inform sportspeople with a lateral ankle sprain about the various issues concerning this injury. It could be composed of information about effective conservative treatments, RTP and precautionary measures after RTP (Doherty et al., 2017; Vuurberg et al., 2018). It could also integrate simple education, self-management and coping strategies, as well as interventional exercises that are tailored to rehabilitate those who have had this injury. This programme could be found online or as an application that enables people to access the relevant information about an ankle sprain injury, which in turn may help reduce the number of face-to-face clinical appointments. People could also use it to gain access other necessary information, to seek advice and connect with the relevant healthcare professionals as required. This is in line the long-term plan of the NHS to digitise some healthcare services. Indeed, the NHS's long-term plan is to empower people, support health and care professionals, support clinical care, improve population health and improve clinical efficiency and safety using technology (HFMA 2019).

The proposed ankle sprain programme put forward in this thesis would also include information from the existing literature about treatments and prevention measures (Doherty et al., 2017; Vuurberg et al., 2018) that are already detailed in the literature. With regard to the RTP component, focus group discussions composed of experts in the field of managing ankle sprains could be conducted to discuss various issues that have been identified in this thesis (Study one, (Al Bimani et al. 2018b)), including a unified definition of and criteria for RTP after a lateral ankle sprain injury (Definition and criteria for RTP). To select potential candidates for this educational programme, the discriminatory prognostic model that was developed by the SPRAINED team could be followed (Schlussel et al. 2018). As part of that prognostic model, age, BMI, pain when resting, pain bearing weight, ability to bear weight, days from injury until assessment and injury recurrence would be used to discriminate between those individuals who will have a better or poorer recovery after a lateral ankle sprain.

This programme could be similar to the ESCAPE-pain rehabilitation programme that was developed for people with chronic OA pain in the knees and hips (ESCAPE 2019). The ESCAPE-pain programme was found to produce better function by people who used it, as measured by the Western Ontario and McMaster Universities Osteoarthritis Index physical functioning (WOMAC-func), compared to participants who continued to usual primary care (Hurley et al., 2007a). It was also found to be more cost-effective than the usual primary healthcare methods (Hurley et al., 2007b; Jessep et al., 2009). Indeed, Hurley et al. (2010) found participants who followed the ESCAPE-pain education programme had a greater improvement in pain, physical and psychological function, greater knowledge and understanding of their condition and treatment options. In addition, participants showed a greater ability to use exercise to control their symptoms and perform better.

A similar educational programme, like the one proposed in this thesis, could also help improve the outcomes of the treatment programme, which in turn would help them to make safer decisions regarding RTP. This, in turn, would help minimise residual symptoms after recovery. After finishing the interviews of the fourth study, some participants asked the researcher a few questions about treatment options and RTP after their injury, indicating they understood the benefits of following evidence-based treatment and clearance for RTP from a specialised clinician such as a physiotherapist or a podiatrist.

8.4 Future research

A few key areas for future research are recommended, to increase the understanding of the decision to RTP after lateral ankle sprain. Firstly, a study that determines a unified definition of and clear criteria for RTP after a lateral ankle sprain is required. This could be achieved by conducting focus group discussions (Delphi study) of expert clinicians from physiotherapy, podiatry or sport medicine with the purpose of producing a concise yet validated definition of and criteria for RTP. This is necessary, as a unified definition and criteria for RTP via producing a consensus statement would be useful when sportspeople are advised about their return to sporting activities, especially in terms of intensity, timing and type of training. This in turn would help to eliminate any confusion and ensure inappropriate RTP decisions are avoided in the future.

The other issue highlighted in this thesis (Study two) is that a large percentage of patients were sent home with no follow-up. Those patients who were sent home with no follow-up treatments might be at risk of premature return to work/ sport. Although they were provided with discharge instructions, nothing was mentioned about recovery thresholds, i.e. approximate ligament healing timeframes. Currently, it is not clear what is happening with those patients or how they manage their ankle sprain at home. Thus, a follow-up study is recommended to investigate the course of recovery from this type of injury in that particular population. It may also highlight the need to modify the current discharge instruction sheet by identifying the information missing. Indeed, it was clear from the results of the third study that patients may not have had appropriate information about when to return to sports, as most of them returned to sports with symptoms including pain, swelling and restricted movements. Therefore, highlighting these issues may have an impact on reducing the occurrence of residual symptoms and future re-sprains. This, in turn, may then contribute to reducing related healthcare expenditure.

The results from both the quantitative (Study three) and qualitative (Study four) studies in this thesis determined some influencing factors that were found to be associated with RTP after a lateral ankle sprain. Those influencing factors need to be confirmed for their relationship with RTP in future prospective studies. Doing so will help constructing evidence-based criteria for RTP, which in turn will guide sportspeople to make safer decisions for RTP.

8.5 Summary of advancement of knowledge

This programme of research has utilised a series of investigations utilising different study designs to understand the factors that affect RTP following a lateral ankle sprain. The advance in knowledge made by the research studies forming this thesis has been discussed in the corresponding investigation chapters. However, key advances in knowledge made through this programme of work include:

- There is a lack of evidence to support clear clinical guidance for RTP after an ankle sprain, as there was no clear definition and criteria for RTP after this injury.
- There is a lack of clear prognostic/ predictive factors for RTP, as demographic and psychological factors were not considered in previous observational studies.
- Over half of the patients (58%) were sent home with no follow-up treatment. Instead, they were provided with a discharge instruction sheet that did not contain information about return to sports, work or activity.
- The majority of participants (84%) made their own decision for RTP and most of them (76%) returned to sports, despite having residual symptoms such as pain, swelling and restricted ankle joint motion.
- Seven predictor variables were found to be associated with RTP in the univariable regression analysis: sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion due to pain**,** history of chronic instability and treatment programme. However, three predictor variables contributed to a stable model and produced significant statistical results in the final multivariable model:

    1. The number of days of RTP are expected to increase at a rate of 2.38 for participants with an inversion injury compared to participants with a plantar flexion injury, given that all of the other variables are held constant in the model.

    2. The number of days of RTP are expected to increase at a rate of 2.38 for participants with restricted active dorsi flexion because of pain compared to participants with no restricted dorsi flexion, given that all of the other variables are held constant in the model.

    3. The number of days of RTP are expected to decrease at a rate of .76 for participants who treated themselves compared to participants who had medical healthcare, given all other variables are held constant in the model.

- Eight themes were identified as the main factors influencing RTP after an ankle sprain injury. 1) Previous negative experience with healthcare services. 2) Limitation of resources. 3) Level of sport played. 4) Self-management of injury towards RTP. 5) Perception of self, injury and RTP. 6) Previous history of managing ankle injury 7) Symptoms dictating RTP. 8) External motivation, expectations and support.
- Participants recognised resolving symptoms such as pain as indicators for recovery, however, they resumed training with some degree of pain.

8.6 Potential limitations of the thesis

A key limitation of this thesis is the data that was collected at one point in time (cross-sectional) and precludes inferring causality. For example, some participants resumed their training with residual symptoms, however, it was not possible to know precisely if their symptoms had developed because of the most recent ankle sprain or otherwise. The progress of those symptoms was not followed up in time to determine their contribution to the decision to RTP after their injury. In addition, RTP, as an outcome measure, was defined as resuming sport training with no symptoms, however, the majority of participants resumed training with residual symptoms. However, that was an important finding that highlighted the need to conduct a follow-up study to explain this phenomenon. Beside the fact that the cause and effect relationship could not be precisely determined, the results from the quantitative studies in this thesis could have been prone to bias, due to the low response and a miscalculation due to recall bias. A precautionary measure was taken to minimise the risk of recall bias by limiting the occurrence of injury to the previous six months. Furthermore, the data in this thesis was mainly collected from the south of England (Wessex), which, therefore, did not allow for the results to be compared to those from across the UK, as that was beyond the scope and practicality of this thesis. As a result of these aforementioned limitations, caution should be practiced when results are interpreted and generalised to a larger population. Despite that, the thesis is considered to be the first that has investigated the different aspects of RTP. The sample size that was recruited for the quantitative study (Study three) was larger than that samples used in previous observational studies. In addition, it was considered that taking a mixed-methods approach by adding a qualitative study in this thesis was important to reduce the limitations of the previous quantitative studies in this thesis and also to provide explanations for observations in the previous studies in this thesis that were inexplicable.

This thesis used a mixed-methods approach by conducting a qualitative study (Study four) to compliment the results from the previous quantitative studies (Study two and study three). There are many challenges associated with using a mixed-methods approach in research. Firstly, mixed-methods studies are found to take much more time and resources in terms of planning and implementing (Creswell, 2003; Creswell and Plano Clark, 2007; Creswell and Plano Clark, 2011; Creswell, 2013). This was the researcher's experience during this thesis, as the development and implementation of both the quantitative and qualitative studies occurred in separate time frames. Secondly, limited resources such as time and finance were another challenging factor, especially during the recruitment of participants and during the data collection phase. However, although the data collection and analysis of every consecutive study in this thesis took a great deal of time, it was useful to inform the aims and methods for the following study. The use of a mixed-method design also added more value to this thesis and is considered a strength when interpreting the findings of all of the studies. To the best of the researcher's knowledge, this mixed-methods thesis is the first to investigate the factors influencing RTP after a lateral ankle sprain. Moreover, combining both quantitative and qualitative studies to answer the main research questions were found to produce robust and meaningful results.

8.7 Reflections

This PhD journey has been inspired by the previous clinical and academic roles of the researcher (SB), which also collectively shaped the research aims. The researcher's previous clinical practice focused on treating sportspeople who suffer from different types of injuries. From his clinical observations, the most commonly reported injury was an ankle sprain, particularly affecting the lateral ankle ligament. Many athletes respond successfully to the treatment; however, some develop chronic symptoms. In addition, the researcher conducted a narrative literature review after his Master's degree, and found that athletes who suffer an ankle sprain injury are more likely to develop chronic symptoms. Subsequently, the researcher supervised three BSc students at the faculty of physiotherapy in Oman. All of that inspired and encouraged the researcher to pursue his studies to a PhD level to enhance his clinical practice in the management of ankle sprains.

The ideas of this thesis were developed, evolved and shaped into a researchable scientific question from the first day of the PhD study. Continuous and valuable discussions with supervisors (CB, MW and LG) lead to it becoming feasible to investigate those ideas in the form of a PhD study. The core idea of this thesis was initiated to inform this question: When can I return to play? The question was continuously asked by different athletes that the researcher treated throughout his clinical experience. Athletes consider this question the most important of all questions, as it determines their ultimate recovery from an injury, thus allowing them to resume their sporting activities once again. Therefore, this was reformatted into a research question:

“What are the influencing factors for RTP in sportspeople with a conservatively treated lateral ankle sprain?”

This research question was further divided into four main research aims (studies). The first was to conduct a literature review (systematic review, Study one) to find out if there are any potential factors influencing RTP and to explore the definition of and criteria for RTP after conservatively treating an ankle sprain. After that, a second study was conducted to scale the prevalence and characterise patients attending an emergency department with an ankle sprain according to their demographic, clinical and sport-related features (epidemiological study, Study two). Next, a third study was conducted to determine the self-reported factors that might predict RTP after an ankle sprain injury. Finally, a qualitative study was conducted to explore the self-reported influencing factors in more depth.

Throughout the process of conducting those four studies, the researcher gained a number of research skills that included:

- Experience of how systematic reviews, epidemiological studies and observational studies are designed.
- Experience of mixed methods research.
- A greater understanding of methods of sampling and collecting data from a variety of clinical and non-clinical settings.
- A greater understanding of the statistical analysis of ankle injury population data, especially multivariable regression analysis techniques. This was in part thanks to great support from supervisors, a statistician, a PhD colleague (Amira Al Amri, statistics student) and self-study, whis also made the analysis interesting and easy to learn. Those skills can be later applied to the analyses of different populations in the future.
- Experience of research methods for qualitative research including developing interview questions, conducting face to face interviews, data analysis using NVivo computer software and finally reporting the emerging themes.

The researcher also acquired other skills from conducting the second, third and fourth studies such as collaborating and improving his communication skills with other professionals. For example, contact was made with Professor Crouch and his team, who work at the ED of

Southampton General Hospital, in order to access the study data for the second study. Without him, it would not have been possible to access the data, as the researcher was not a member of the direct healthcare team (a condition from ethics committee). In the third and fourth studies, it was very important to communicate with different local private physiotherapists, club managers, university clubs, athletes, and athlete trainers, in order to recruit participants to complete the survey questionnaire of the third study and conduct the interviews in person in the fourth study.

Lastly, doing this PhD was an exciting journey that resulted in the findings being disseminated beyond the limits of the University. Besides presenting the results at key conferences in the field, the researcher had the opportunity to publish two papers in scientific journals. The first study (systematic review) was published in an international peer review journal (The Physician and Sportsmedicine). The second study was also published in an international peer reviewed journal (International Emergency Nursing Journal). In addition, the researcher is now preparing the third and fourth studies for publication.

8.8 **Summary**

The primary aim of this thesis was to determine the factors influencing RTP after a conservatively treated lateral ankle sprain. The findings from the four studies in this thesis provided a unique view of several aspects concerning RTP after an ankle sprain injury. It was found, through the systematic review, that there was lack of evidence regarding the factors influencing RTP. The definition of and criteria for RTP were not consistently stated in the literature, which made it difficult to draw a solid conclusion. This lack of clarity was supported by the findings from the investigation into patients presenting with ankle injuries at an emergency department. Most of the patients admitted to the ED with ankle sprain were sent home without adequate information about self-care and a clear decision on when to return to sport and/or work. A-follow-up self-report study was therefore conducted among individuals who had had an acute ankle sprain to describe this population and further explore what factors influenced their decision to return to playing sports. In terms of predicting the factors for RTP, three factors were found to be associated with RTP after an ankle sprain: mechanism of injury, restricted AROM of dorsi flexion due to pain and treatment methods. Notably, it was found that most participants in that study returned to playing their sport despite having residual symptoms such as pain, joint swelling and restricted AROM. Of further note, most did not seek any professional medical treatment or advice from expert clinicians such as physiotherapists and podiatrists.

The final investigation therefore sought to further understand these decisions through in-depth one-to-one interviews. Although the participants in the qualitative study tried to justify their actions in returning to play their sport with residual symptoms, it was evident that they had different priorities that potentially were related to their behaviour within the sport that led them to resume training with symptoms. Future researchers may consider investigating the patterns of behaviour surrounding the decision to return to playing their sports in more depth, in order to provide measurable strategies to correct them.

Finally, based on the results from this thesis, a number of factors related to ankle injury have been highlighted as important to inform the decision on when an athlete or sportsperson is clear to RTP, yet it cannot be assumed that they will follow this guidance and/or recommendations regarding RTP. Meanwhile, an 'awareness' programme is recommended as an intervention to highlight the benefits of following treatment advice and making safe decisions for RTP after a lateral ankle sprain, as well as regarding rehabilitation strategies. This programme would inform those sportspeople who do not seek medical treatment or help when deciding when to RTP, which in turn could decrease the incidents of those developing residual symptoms at the time of resuming their sporting activities.

Publications

Results from this thesis have been published in peer reviewed journals, presented at international conferences, or are currently being prepared for publication. Details of these publications are as follows:

Research articles

Al Bimani, SA, Gates, L., Warner, M. and Bowen, C. (2016). Prognostic factors for return to play following conservatively treated acute ankle sprain: a systematic review. Journal of Ankle and Foot (Suppl).

Al Bimani SA, Gates L, Warner M, Crouch R and Bowen C (2018a) Characteristics of patients with ankle sprain presenting to an emergency department in the south of England (UK): A seven-month review. *Int. Emerg. Nurs.* 41: 38-44 (Appendix 26)

Al Bimani SA, Gates LS, Warner M and Bowen C (2018b) Factors influencing return to play following conservatively treated ankle sprain: a systematic review. *Physician and Sportsmedecine* 47(1): 31-46 (Appendix 27)

Conference presentations

Al Bimani, SA., Gates, L., Warner, M. and Bowen, C. (2016). Prognostic factors for return to play following conservatively treated acute ankle sprain: a systematic review. Scientific poster in College of Podiatry Annual Conference 2016 (Appendix 28)

Al Bimani, SA., Gates, L., Warner, M. Ewings, Sean, Crouch, R and Bowen, C. Characteristics of patients with ankle sprain presenting to an emergency department in the south of England (UK): A seven-month review. Scientific poster in Southampton Medical and Health Research Conference 2017. (Appendix 29)

Articles in preparation/ submission/ resubmission

Al Bimani, S., Gates, L., Warner, M. and Bowen, C. (2019). Predictive factors for time to return to play in athletes with conservatively treated acute ankle sprain. In preparation.

Al Bimani, S., Gates, L., Warner, M. and Bowen, C. (2019). The experiences of sportspeople on return to play after conservatively treated lateral ankle sprain. In preparation.

Appendices

Appendix 1 Literature review versus systematic review

Feature	Narrative Review	Systematic Review
Question	Often broad in scope	Often a focused clinical question
Sources and search	Not usually specified, potentially biased	Comprehensive sources and explicit search strategy
Selection	Not usually specified, potentially biased	Criterion-based selection, uniformly applied
Appraisal	Variable	Rigorous critical appraisal
Synthesis	Often a qualitative summary	Qualitative or quantitative summary
Inferences	Sometimes evidence-based	Usually evidence-based

They have several unique features compared with other types of literature reviews, including but not limited to the following:

1. They have a well-defined and structured review protocol that clearly describes the methods used to address a particular research question.
2. They involve a systematic and comprehensive search strategy in order to identify as many relevant articles as possible.
3. The search strategy is documented so it can be used in future searches.
4. Inclusion and exclusion criteria are identified for the selection of relevant articles.
5. They use quality appraisal tools to assess the methodological quality of the included articles and detect any bias.
6. It is fundamental that they be carried out prior to conducting a quantitative meta-analysis.

In terms of the approach, a systematic review is conducted according to a structured approach in order to make it rigorous and reproducible. A three-stage process was proposed by Tranfield et al. (2003), which clearly outlines how it should be planned, conducted and reported and disseminated as shown in the following table.

The Stages of Conducting a Systematic Review

Stage I-Planning the review	Phase 0 - Identification for the need for a review
	Phase 1 - Preparation of a proposal for a review
	Phase 2 - Development of a review protocol
Stage II -Conducting a review	Phase 3 - Identification of research
	Phase 4 - Selection of studies
	Phase 5 - Study quality assessment
	Phase 6 - Data extraction and monitoring progress
	Phase 7 - Data synthesis
Stage III- Reporting and dissemination	Phase 8 - The report and recommendations
	Phase 9 - Getting evidence into practice

A key element in systematic reviews is that the search strategy is accurately documented, so that it can be used in future studies. Kable et al. (2012) proposed a 12-step process for conducting and documenting the search strategy for a systematic review:

1. State the clear purpose of the search, including a focused research question that needs to be researched.

2. State the search engines or online databases that are going to be searched for evidence. In addition, other resources like grey literature, non-academic databases and Internet search engines also need to be stated.

3. Include search limits that specify the boundaries and extent of the search. Examples include date, language, journals, study subjects, type of studies, sex and geography.

4. Comprise a full description of the inclusion and exclusion criteria of the articles that are included in the review. The criteria may include specific characteristics of the population of interest, treatment methods and outcome measures.

5. Include a list of all the search terms used to identify the articles that might be included in the review. These key search terms are in addition to Boolean search operators such as

AND, OR and NOT. Boolean search modifiers also need to be stated e.g. asterisk (*), parentheses and quotation marks (“ ”). Different spelling of terms, plurals and synonym also need to be stated.

6. Provide a list of search processes and terms for each of the databases searched, as well as state the number of included and excluded articles.
7. Investigate the relevance of the identified articles against the inclusion and exclusion criteria.
8. Summarise the articles identified as relevant in a table so that it is easy for the researcher to have an overview of their different characteristics. Table headings may include study design, purpose, population, outcome measures and key findings.
9. State the number of articles at each stage of the search and provide reasons for excluding any articles.
10. Perform a quality appraisal of the articles in order to exclude poorly conducted articles or those with severely biased results.
11. Perform a critical review to understand the quality of the included articles and provide recommendations for future research activities.
12. Check the reference lists to identify the same authors of multiple articles.

Appendix 2 Online data sources

Data source	Description
AMED	It provides data related to alternative medicine for physicians, therapists, medical researchers and clinicians. It contains basic bibliographic records from more than 500 journals, as many of those journals are not indexed in other biomedical journals.
CINAHL Plus	A large collection of full texts from more than 760 nursing and allied health journals. Of those, 451 are exclusively indexed in *CINAHL®*. It also provides indexing for more than 5,000 journals for nursing and allied health. It contains more than 4 million records from 1937 to the present.
EMBASE	A highly versatile, multipurpose and up-to-date biomedical database that has journal coverage from 1947 to the present, including over 32 million records and over 8,500 journals from over 95 countries.
MEDLINE (EBSCO)	Provides trusted medical information on medicine, nursing, dentistry, veterinary medicine, the health care system and pre-clinical sciences. It uses MeSH (Medical Subject Headings) indexing to search citations from more than 5,600 biomedical journals. Of those, 1,400 journals are indexed on MEDLINE with a full text database.
PsycINFO	The largest resource for peer-reviewed literature that contains abstracts of scholarly journal articles, book chapters, books, and dissertations to mainly provide information about psychological aspects of related fields such as medicine, psychiatry, nursing, sociology, education, pharmacology, among others. It contains more than 3 million citations and summaries dating back to 1600.
Scopus	The largest abstract and citation database that covers peer-reviewed literature. It is a large resource for scientific, technical, medical and social sciences journals with about 21,000 titles indexed from 1996 onward.
SPORTDiscus	It is a premier source of articles covering a wide area of sport and sport medicine. It provides extensive, relevant content that is very important to researchers, students and clinicians. Topics include sports physiology, sports psychology, physical education, recreation, fitness, health and other relevant sports studies.

Data source	Description
Pedro	It is a physiotherapy evidence database of over 38,000 randomised trials, systematic reviews and clinical practice guidelines in physiotherapy. The methodological quality of all the articles on this database have been independently examined to evaluate the strength and limitations of individual articles.
Cochrane library	It is a collection of six databases that contain different types of high-quality, independent evidence to inform healthcare decision-making: 1. Cochrane Database of Systematic Reviews (10,034 records) 2. Cochrane Central Register of Controlled Trials (1,100,937 records) 3. Cochrane Methodology Register (*15,764 records)* 4. Database of Abstract of Reviews of Effects (*36,795* Records) 5. Health Technology Assessment Database (*16,559 records)* 6. NHS Economic Evaluation Database (*15,015 records)*
Open Grey	Multidisciplinary open access repository contains grey literature of theses, conference papers and technical reports from major European institutions. It provides citation of about 700,000 records that are written in English.
Google Scholar	An online search engine that broadly searches for scholarly literature across many disciplines and sources such as articles, books, theses and abstracts. The data is extracted from academic publishers, professional societies, online repositories, universities and other websites.

Appendix 3 Key terms for search

1. Key terms were derived from the research question: " Factors influencing time to RTP following conservatively treated lateral ankle sprain" In order to identify those key terms, a PICO framework was developed to identify different search terms that could be included in the main search. The PICO acronym stands for P - patient, problem or population; I - intervention; C - comparison, control or comparator; O – outcome. Where applicable, the researchers broke up the PICO question into four main facets: Population, Intervention, Control and Outcome. Then, a list of synonyms was developed and submitted to individual databases. The research question in this review was:

"Among sportspeople with conservatively treated lateral ankle sprain, what are the factors influencing RTP?"

Therefore, this was the breakdown of the research question:

- P = Population: Sportspeople with conservatively treated lateral ankle sprain.
- I = Intervention: Prognostic/ predictive/ influencing/ associated factors (Patients' demographic characteristics, injury related factors, sport related factors and conservative treatment).
- C = Comparison (can be none or placebo): Placebo/ comparison (RCTs) or none (observational studies).
- O = Outcome: Time to RTP (number of days from injury until athlete resumes sporting activities)

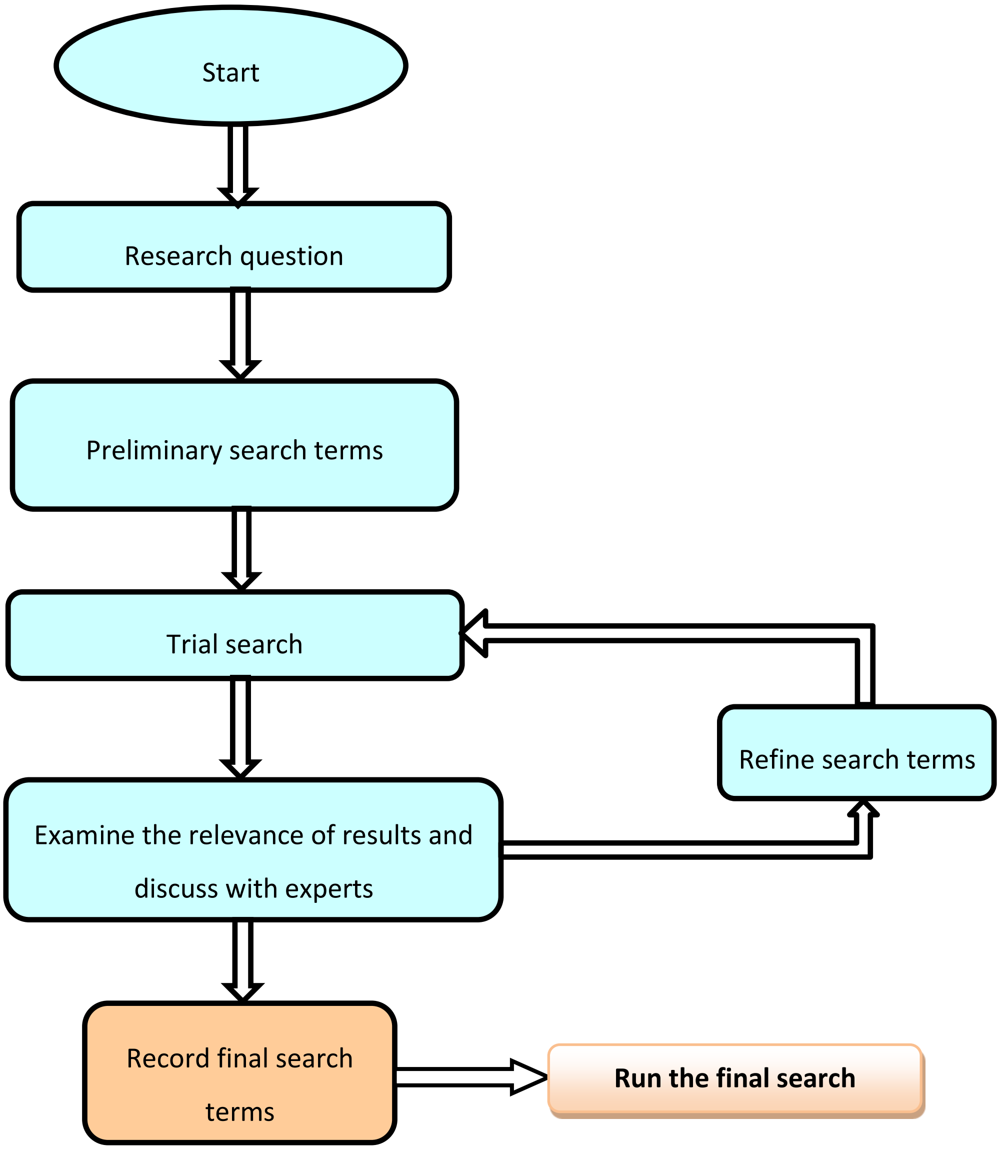
2. Preliminary searches of evidence from relevant systematic reviews and clinical trials were conducted. Key articles known to researchers were retrieved and reviewed and key terms were noted and used when searching for studies for this systematic review. Furthermore, reviewing the titles, abstracts and/or full text from those key articles provided an idea of the key terms used in the literature on the topic similar to the one investigated in this review.

3. Google Scholar, a scientific platform containing various studies including those of relevance to this review, was searched. As a result, non-scientific articles retrieved from

the Internet were reviewed and some extra key terms were added to the preliminary list of search terms.

4. A discussion with an experienced health sciences librarian (SD) from the university library took place. The key terms and search strategy were discussed with her in order to make them sensitive and specific, since sensitive search strategy identifies relevant articles and specific search strategy excludes irrelevant articles (Aromataris and Riitano 2014).

Following each of those methods, the list of search terms was examined and updated to include new terms or exclude irrelevant terms as shown in the following figure.



Development of the search strategy

A consensus meeting was held by the same four reviewers (SB, LG, MW and CB) to address any inconsistencies and agree on the final list of search terms. They also discussed and agreed the inclusion criteria for the selection of papers in this review.

Appropriate synonyms were then used for each of the main search terms and subsequently entered into individual online databases (Appendix 1). Different index terms or subject headings were considered when searching individual databases, as every database has its own standard list of search terms, and those terms might differ from one database to another (Aromataris and Riitano 2014). The Boolean operators “AND” and “OR” were used to link the main search terms “ankle”, “sprain” and “return to play”. Using “AND” between two terms requires both of them to appear in the article, whereas using “OR” requires either one of them to be present in the article. In addition, search field descriptors such as “TI, meaning title” or “ab, meaning abstract” were added when necessary for some databases. Truncation was also used to broaden the search by including different beginnings and endings of a specific word e.g. play* = play or plays or playing or played.

Appendix 4 Main terms and search strategy (Study one)

1. AMED - The Allied and Complementary Medicine Database

#	Search Terms	
S1	TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR TI inversion	4,007
S2	AB Ankle OR AB (lateral N2 ligament) OR AB (ankle N1 joint*) or AB (inversion)	6,107
S3	S1 OR S2	7,588
S4	TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear* TI (ankle N1 (injur* or sprain*))	13,058
S5	AB Sprain* OR AB Strain* OR AB Rupture* OR AB injur* OR AB tear OR AB (ankle N1 (injur* or sprain*))	18,325
S6	S4 OR S5	23,745
S7	S3 AND S6	1,939
S8	TI (return* N3 (sport* OR activ* OR train* OR play* OR compet* OR participat*)) OR TI (disab* N3 duration*)	190
S9	AB (return* N3 (sport* OR activ* OR train* OR play* OR compet* OR participat*)) OR AB (disab* N3 duration*)	981
S10	TX (return* N3 (sport* OR play OR activit* OR train* OR compet* OR participat*))	944
S11	S8 OR S9 OR S10	1,061
S12	S7 AND S11	93
Total articles: 93		

2. CINAHL Plus with Full Text

#	Search Terms	
S1	(MH "Ankle") OR (MH "Lateral Ligament, Ankle") OR (MH "Ankle Joint") OR TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR AB Ankle OR AB (lateral N2 ligament) OR AB (ankle N1 joint*)	21,885
S2	(MH "Rupture") OR (MH "Sprains and Strains") OR TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear*OR AB Sprain* OR AB Strain* OR AB Rupture* OR AB injur* OR AB tear*	202,361
S3	S1 AND S2	5,667
S4	(MH "Ankle Sprain") OR (MH "Ankle injuries") OR (TI "Ankle Sprain") OR (AB "Ankle Sprain") OR (TI "Ankle Injur*") OR (AB "Ankle Injur*")	4301
S5	S3 OR S4	7,433
S6	TI (return* N3 (sport* OR activ* OR train* OR play* OR compet* OR participat*)	923
S7	AB (return* N3 (sport* OR play* OR activ* OR train* OR compet* OR participat*)	4,732
S8	((MH "Recovery") OR (MH "Recovery, Exercise) OR (MH "sports Re-Entry"))	24,106
S9	TI ((disab* N3 duration*)	29
S10	AB (disab* N3 duration*)	347
S11	TX (return* N3 (sport* OR play* OR activit* OR train* OR compet* OR participat*))	11,410
S12	S6 OR S7 OR S8 OR S9 OR S10 OR S11	35,417
S13	S5 AND S12	563
	Narrow by: English AND Academic Journals	458
Total articles: 458		

3. EMBASE

#	Search Terms	
S1	ankle/ or ankle lateral ligament/ or ankle.ti,ab. OR (ankle adj joint$).ti,ab. OR (ankle adj lateral adj ligament).ti,ab.	71815
S2	Sprain/ OR ligament rupture/ OR rupture/ OR (Sprain$ OR	1758955

	Strain$ OR Rupture$ OR injur$ OR tear$).ti,ab. OR (inversion adj sprain$).ti,ab.	
S3	S1 AND S2	14749
S4	Ankle Injury/ OR Ankle Sprain/ OR (Ankle adj sprain$).ti,ab. OR (Ankle adjInjur$).ti,ab.	9843
S5	S3 OR S4	18889
S6	(return$ adj3 (sport$ ORactivit$ OR train$ OR play$ ORcompet$ OR participat$)).ti,ab. OR exercise recovery/ OR return to sport/ OR (disab* N3 duration*).ti,ab.	16556
S7	S4 AND S5	560
Total articles: 560		

4. MEDLINE (EBSCO)

#	Search Terms	
S1	(MH "Ankle") OR (MH "Lateral Ligament, Ankle") OR (MH "Ankle Joint") OR TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR AB Ankle OR AB (lateral N2 ligament) OR AB (ankle N1 joint*)	56,074
S2	(MH "Rupture") OR (MH "Sprains and Strains") OR TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear*OR AB Sprain* OR AB Strain* OR AB Rupture* OR AB injur* OR AB tear*	1,457, 448
S3	S1 AND S2	12,514
S4	(MH "Ankle injuries") or (TI “Ankle Sprain*”) or AB (Ankle N3 (Sprain* or Injur* or Injur* or tear or rupture* or inversion)) or ((TI “Ankle N3 (Sprain* or Injur* or tear or rupture* or inversion)) or (inversion N1 sprain*) OR AB (inversion N1 sprain*)	11,190
S5	S3 OR S4	17,335

S6	(TI return) N ((TI sport* or TI activ* or TI train* or TI play* or TI compet*) OR (AB sport* or AB activit* or AB train* or AB play* or AB compet*)) OR TI ((disab* N3 duration*) OR AB (disab* N3 duration*)	1,613
S7	(MH "Recovery of function")	43,385
	TX ("return* to sport*") OR (return* N3 activit*)	10,963
S8	S6 OR S7	44,932
S11	S5 AND S10	701
	Narrow by: English AND Academic Journals	664
Total articles: 664		

5. PsycINFO

#	Search Terms	
S1	DE "Ankle" OR TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR AB Ankle OR AB (lateral N2 ligament) OR AB (ankle N1 joint*)	2,313
S2	TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear*OR AB Sprain* OR AB Strain* OR AB Rupture* OR AB injur* OR AB tear*	107,907
S3	S1 AND S2	333
S4	(DE "Recovery (Disorders)")	11,389
S5	(TI return*) N3 ((TI sport* OR TI activ* OR TI train* OR TI play* OR TI compet* OR participate*) OR TI ((disab* N3 duration*)	161
S6	(AB sport* OR AB activ* OR AB train* OR AB play* OR AB compet* OR participate*)) OR AB (disab* N3 duration*)	1,158,482
S7	TX (return* N3 (sport* OR play* OR activit* OR train* OR compet*	1,725

	OR participat*))	
S8	S4 OR S4 OR S5 OR S6 OR S7	1,167,025
S9	S3 AND S8	210
	Narrow by: English AND Academic Journals	146
Total articles: 146		

6. Scopus

#	Search Terms	
S1	TITLE-ABS-KEY (ankle*) or (lateral W/2 ligament) OR (ankle W/1 joint*)	99,016
S2	TITLE-ABS-KEY (sprain*) OR (strain*) OR (rupture*) OR (injur*) OR (tear*)	6,751,390
S3	S1 AND S2	45,503
S4	TITLE-ABS-KEY (ankle W/1 (injur* or sprain*))	13,663
S5	S3 OR S4	14,503
S6	TITLE-ABS-KEY (("return to sport*") OR ((return) W/3 (sport* OR activ* OR train* OR play* OR compet*)))	15,730
S7	S5 AND S6	837
S8	Narrow by: English AND Academic Journals	573
Total articles: 574		

7. Sports discus via EBSCOHost

#	Search Terms	
S1	SU Ankle ORTI Ankle 0R ((TI lateral) N3 (TI ligament)) OR TI (inversion) OR AB Ankle OR ((AB lateral) N3 (AB ligament)) OR AB (inversion) OR SU Ankle Lateral Ligament	17,920
S2	(TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear*) OR (AB Sprain* OR AB Strain* OR AB Rupture* OR AB injur* OR AB tear) OR SU sprains OR SU Strain	104,193
S3	S1 AND S2	6,983
S4	TI (ankle N3 (injur* or sprain*)) OR AB (ankle N3 (injur* or sprain*))	3,726
S5	S3 OR S4	7,051
S6	(TI return*) N3 ((TI sport* OR TI activ* OR TI train* OR TI play* OR TI compet*) OR (AB sport* OR AB activit* OR AB train* OR AB play* OR AB compet*)) OR TI recovery OR AB recovery OR TI “return to sport” OR AB “return to sport” OR TI (disab* N3 duration*) OR AB (disab* N3 duration*)	24,748
S7	TX (return* N3 (sport* OR play OR activit* OR train* OR compet* OR participat*))	5,225
S6	S6 OR S7	28,266
S7	S5 AND S6	519
S8	Narrow by: English AND Academic Journals	387
Total articles: 387		

8. Physiotherapy Evidence Database (http://www.pedro.org.au/)

#	Search Terms
S1	ankle* sprain* "return to play*"simple search in titles and abstracts

Total articles: 2

9. The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL)

#	Search Terms
S1	'Sprain* AND ankle* AND ("return to play*" OR "return to activit*") in Title, Abstract, Keywords in Trials
Total articles: 6	

10. Grey literature was also searched using openGREY

#	Search Terms
S1	"ankle sprain*"
Total articles: 11	

Field codes	Description
*	At the end of a term indicates that this term has been truncated (i.e.
ti,ab	Indicates a search for a term in title/abstract
/	MeSH heading
adj, N ,	Words have to appear next to each other.
DE	Descriptors
TX	Search in text
SU	Subject (specific terms)
exp	Explode the subject heading, to retrieve more specific terms

Appendix 5 NHS ethics approval from West of Scotland Research Ethics Service (Study two)

WoSRES
West of Scotland Research Ethics Service

NHS
Greater Glasgow and Clyde

West of Scotland REC 3
West of Scotland Research Ethics Service
West Glasgow Ambulatory Care Hospital
(former Royal Hospital for Sick Children Yorkhill)
Dalnair Street
Glasgow G3 8SW
www.nhsggc.org.uk

Mr Saed Al Bimani
MPhil/PhD Candidate
University of Southampton
University of Southampton
Faculty of Health Sciences
Highfield
Southampton
SO17 1BJ

Date 15th April 2016
Your Ref
Our Ref
Direct line 0141 232 1805
E-mail WOSREC3@ggc.scot.nhs.uk

Dear Mr Al Bimani

Study title:	**A retrospective observational study to identify the incidence and common causes of acute ankle sprain within the emergency department setting.**
REC reference:	**16/WS/0081**
IRAS project ID:	**202053**

The Proportionate Review Sub-committee of the West of Scotland REC 3 reviewed the above application on 14 April 2016.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this favourable opinion letter. The expectation is that this information will be published for all studies that receive an ethical opinion but should you wish to provide a substitute contact point, wish to make a request to defer, or require further information, please contact the REC Manager Mrs Liz Jamieson, wosrec3@ggc.scot.nhs.uk. Under very limited circumstances (e.g. for student research which has received an unfavourable opinion), it may be possible to grant an exemption to the publication of the study.

Ethical opinion

On behalf of the Committee, the sub-committee gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Appendix 6 HRA ethics approval (Study two)

NHS
Health Research Authority

Mr Saed Al Bimani
MPhil/PhD Candidate
University of Southamopton
University of Southampton, Faculty of Health Sciences
Highfield
Southampton
SO17 1BJ

Email: hra.approval@nhs.net

08 August 2016

Dear Mr Al Bimani

Letter of HRA Approval for a study processed through pre-HRA Approval systems

Study title:	**A retrospective observational study to identify the incidence and common causes of acute ankle sprain within the emergency department setting.**
IRAS project ID:	**202053**
Sponsor	**University of Southampton**

Thank you for your request for HRA Approval to be issued for the above referenced study.

I am pleased to confirm that the study has been given **HRA Approval.** This has been issued on the basis that the study is compliant with the UK wide standards for research in the NHS.

The extension of HRA Approval to this study on this basis allows the sponsor and participating NHS organisations in England to set-up the study in accordance with HRA Approval processes, with decisions on study set-up being taken on the basis of capacity and capability alone.

If you have submitted an amendment to the HRA between 23 March 2016 and the date of this letter, this letter incorporates the HRA Approval for that amendment, which may be implemented in accordance with the amendment categorisation email (e.g. not prior to REC Favourable Opinion, MHRA Clinical Trial Authorisation etc., as applicable). If the submitted amendment included the addition of a new NHS organisation in England, the addition of the new NHS organisation is also approved and should be set up in accordance with HRA Approval processes (e.g. the organisation should be invited to assess and arrange its capacity and capability to deliver the study and confirm once it is ready to do so).

IRAS project ID	202053

Participation of NHS Organisations in England

Please note that full information to enable set up of participating NHS organisations in England is not provided in this letter, on the basis that activities to set up these NHS organisations is likely to be underway already.

The sponsor should provide a copy of this letter, together with the local document package and a list of the documents provided, to participating NHS organisations in England that are being set up in accordance with HRA Approval Processes. It is for the sponsor to ensure that any documents provided to participating organisations are the current, approved documents.

For non-commercial studies the local document package should include an appropriate Statement of Activities and HRA Schedule of Events. The sponsor should also provide the template agreement to be used in the study, where the sponsor is using an agreement in addition to the Statement of Activities. Participating NHS organisations in England should be aware that the Statement of Activities and HRA Schedule of Events for this study have not been assessed and validated by the HRA. Any changes that are appropriate to the content of the Statement of Activities and HRA Schedule of Events should be agreed in a pragmatic fashion as part of the process of assessing, arranging and confirming capacity and capability to deliver the study. If subsequent NHS organisations in England are added, an amendment should be submitted to the HRA..

For commercial studies the local document package should include a validated industry costing template and the template agreement to be used with participating NHS organisations in England.

It is critical that you involve both the research management function (e.g. R&D office and, if the study is on the NIHR portfolio, the LCRN) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details and further information about working with the research management function for each organisation can be accessed from www.hra.nhs.uk/hra-approval.

After HRA Approval

In addition to the document, *"After Ethical Review – guidance for sponsors and investigators"*, issued with your REC Favourable Opinion, please note the following:

- HRA Approval applies for the duration of your REC favourable opinion, unless otherwise notified in writing by the HRA.
- Substantial amendments should be submitted directly to the Research Ethics Committee, as detailed in the *After Ethical Review* document. Non-substantial amendments should be submitted for review by the HRA using the form provided on the HRA website, and emailed to hra.amendments@nhs.net.
- The HRA will categorise amendments (substantial and non-substantial) and issue confirmation of continued HRA Approval. Further details can be found on the HRA website.

IRAS project ID	202053

Scope

HRA Approval provides an approval for research involving patients or staff in NHS organisations in England.

If your study involves NHS organisations in other countries in the UK, please contact the relevant national coordinating functions for support and advice. Further information can be found at http://www.hra.nhs.uk/resources/applying-for-reviews/nhs-hsc-rd-review/.

If there are participating non-NHS organisations, local agreement should be obtained in accordance with the procedures of the local participating non-NHS organisation.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please email the HRA at hra.approval@nhs.net. Additionally, one of our staff would be happy to call and discuss your experience of HRA Approval.

HRA Training

We are pleased to welcome researchers and research management staff at our training days – see details at http://www.hra.nhs.uk/hra-training/.

If you have any queries about the issue of this letter please, in the first instance, see the further information provided in the question and answer document on the HRA website.

Your IRAS project ID is 202053. Please quote this on all correspondence.

Yours sincerely

Isobel Lyle
Senior Assessor
Email: hra.approval@nhs.net

Copy to: *Ms Diana Galpi, University of Southampton*
Miss Jennifer Peach, University Hospital Southampton NHS Foundation Trust

Appendix 7 Letter of access to emergency department of University Hospital Southampton (Study two)

University Hospital Southampton **NHS**
NHS Foundation Trust

Clinical Governance
R&D Department
SCBR Level E, Laboratory & Pathology Block
Mailpoint 138
Southampton General Hospital
Southampton
SO16 6YD

Tel: 023 8079 8689
Taru.Jussila-Knappett@uhs.nhs.uk

Mr Saed AlBimani
10 Oakdene Court
Welbeck Avenue
SO17 1UT
Southampton

19 August 2016

Dear Mr Al Bimani

Letter of access for research
(RHM* T&O0174 *A retrospective review of patients' records involving data review of anonymised data with no likely impact on diagnosis or treatment)

This letter confirms your right of access to conduct research through **University Hospital Southampton NHS Foundation Trust (UHS)** for the purpose and on the terms and conditions set out below. This right of access commences on **19 August 2016** and ends on **1 October 2016** unless terminated earlier in accordance with the clauses below.

You have a right of access to conduct such research as confirmed in writing in the letter of permission for research from this NHS organisation. Please note that you cannot start the research until the Principal Investigator for the research project has received a letter from us giving permission to conduct the project.

The information supplied about your role in research at **UHS** has been reviewed and you do not require an honorary research contract with this NHS organisation. We are satisfied that such pre-engagement checks as we consider necessary have been carried out.

You are considered to be a legal visitor to **UHS** premises. You are not entitled to any form of payment or access to other benefits provided by this NHS organisation to employees and this letter does not give rise to any other relationship between you and this NHS organisation, in particular that of an employee.

While undertaking research through **UHS**, you will remain accountable to your employer **(University of Southampton)** but you are required to follow the reasonable instructions of **Prof Robert Crouch** in this NHS organisation or those given on her/his behalf in relation to the terms of this right of access.

Where any third party claim is made, whether or not legal proceedings are issued, arising out of or in connection with your right of access, you are required to co-operate fully with any investigation by this NHS organisation in connection with any such claim and to give all such assistance as may reasonably be required regarding the conduct of any legal proceedings.

You must act in accordance with **UHS** policies and procedures, which are available to you upon request, and the Research Governance Framework.

LoA non-NHS – V1, Dec 2008
www.uhs.nhs.uk

Page 1 of 2

7

You are required to co-operate with **UHS** in discharging its duties under the Health and Safety at Work etc Act 1974 and other health and safety legislation and to take reasonable care for the health and safety of yourself and others while on UHS premises. You must observe the same standards of care and propriety in dealing with patients, staff, visitors, equipment and premises as is expected of any other contract holder and you must act appropriately, responsibly and professionally at all times.

You are required to ensure that all information regarding patients or staff remains secure and *strictly confidential* at all times. You must ensure that you understand and comply with the requirements of the NHS Confidentiality Code of Practice (http://www.dh.gov.uk/assetRoot/04/06/92/54/04069254.pdf) and the Data Protection Act 1998. Furthermore you should be aware that under the Act, unauthorised disclosure of information is an offence and such disclosures may lead to prosecution.

You should ensure that, where you are issued with an identity or security card, a bleep number, email or library account, keys or protective clothing, these are returned upon termination of this arrangement. Please also ensure that while on the premises you wear your ID badge at all times, or are able to prove your identity if challenged. Please note that this NHS organisation accepts no responsibility for damage to or loss of personal property.

We may terminate your right to attend at any time either by giving seven days' written notice to you or immediately without any notice if you are in breach of any of the terms or conditions described in this letter or if you commit any act that we reasonably consider to amount to serious misconduct or to be disruptive and/or prejudicial to the interests and/or business of this NHS organisation or if you are convicted of any criminal offence. Your substantive employer is responsible for your conduct during this research project and may in the circumstances described above instigate disciplinary action against you.

UHS will not indemnify you against any liability incurred as a result of any breach of confidentiality or breach of the Data Protection Act 1998. Any breach of the Data Protection Act 1998 may result in legal action against you and/or your substantive employer.

If your current role or involvement in research changes, or any of the information provided in your Research Passport changes, you must inform your employer through their normal procedures. You must also inform your nominated manager in this NHS organisation.

I also enclose a copy of this letter for you to forward on to your employer's HR Department.

Yours sincerely,

Taru Jussila-Knappett
Research Governance Officer

Appendix 8 Other accidental causes of injury (Study two)

N=6		
Age	Sex	Cause
22	m	Eversion injury, foot rolled over the ball
17	m	Hit by an object
44	f	Inversion injury, in accident
79	f	Inversion injury, tripped on bath tub
48	m	Inversion injury, while riding motorbike
23	m	Landed on ankle, jamming it, no eversion or inversion

Appendix 9 Facilitation letter from local collaborator at emergency department to conduct (Study two)

University Hospital Southampton NHS
NHS Foundation Trust
Emergency Department
Tremona Road
Southampton
SO16 6YD

Prof Robert Crouch OBE
Contact: 023 8120 4121 (or Extension 8343)
robert.crouch@uhs.nhs.uk

Saed Al Bimani
PhD Student
Faculty of Health Sciences
Building 45
University of Southampton
Highfield Campus
Southampton
SO17 1BJ
United Kingdom

December 24, 2015

Dear Mr Al Bimani

Re: **"An investigation to identify predictors for time to return to play following acute lateral ankle sprains in sport people"**

I write to confirm I have been involved in the design of the above study and will facilitate the collection of data within the Emergency Department. Recruitment and data collection will be subject to ethical approval through the University and the Health Research Authority though the IRAS process.

I look forward to continuing to work with you on this study.

Yours sincerely

Professor Robert Crouch OBE, RN, PhD, FRCN, FRCEM (Hon)
Consultant Nurse & Honorary Professor Emergency Care
Emergency Department and Faculty of Health Sciences
University of Southampton

Appendix 10 Capacity and capability letter to conduct the (Study two)

University Hospital Southampton NHS Foundation Trust NHS

Please reply to: Research and Development
SGH - Level E, Laboratory & Pathology
Block, SCBR - MP 138
Southampton General Hospital

Telephone: 023 8120 4901
Fax: 023 8120 8678
E-mail: taru.jussila-knappett@uhs.nhs.uk

Dr Robert Crouch
Emergency Dept
Southampton General Hospital
Tremona Road
Southampton
SO16 6YD

19 August 2016

Dear Dr Crouch

ID: RHM T&O0171 A retrospective observational study to identify the incidence and common causes of acute ankle sprain within the emergency department setting.

EudraCT:

Thank you for submitting all the required documentation to enable the Trust to confirm capacity and capability.

I write to confirm that as of 19 August 2016 University Hospital Southampton NHS Foundation Trust has the capacity and capability to deliver the above referenced study.

Please find attached the list of documents to be used at site.

We agree to start this study when the sponsor University of Southampton, gives the green light to begin.

Please note that according to the 70 day benchmark you should aim to recruit your first patient by 18 October 2016.

Please note: That any changes need to be timeously notified to the R&D office. This includes providing copies of:
. All substantial amendments and favourable opinions;
. All Serious Adverse Events (SAEs);
. NRES Annual Progress Reports;
. Annual MHRA Safety Reports;
. NRES End of Study Declaration;
. Notifications of significant breaches of GCP or protocol.

For further information regarding how to notify us of any amendments to the study please refer to the Amendments Guidance for Researchers found at http:/www.crncc.nihr.ac.uk/about_us/processes/csp.

Many thanks

Yours sincerely

Taru Jussila-Knappett
Research Governance Officer

Appendix 11 Letter of support from statistician (Study two)

16th March 2016

Dear Mr Al Bimani,

Re: **A retrospective review of patients' records**

I can confirm that I have reviewed the study protocol and will provide statistical support for the study named above.

Yours sincerely,

Sean Ewings

Appendix 12 Current discharge instruction sheet of ED Southampton General Hospital

University Hospital Southampton NHS
NHS Foundation Trust

Patient information factsheet

Sprained ankle

What is an ankle sprain?
An ankle sprain is an injury that causes stretch or tear of one or more ligaments in the ankle joint. Most sprains occur on the outside of the ankle, but they can occur on the inside as well.

On average, these injuries can take up to six weeks to heal. Some can take longer and your practitioner will advise you individually about how long it will take for your injury to heal.

How it is diagnosed?
To diagnose a sprained ankle, your practitioner will ask you how the injury occurred and what symptoms you have been getting. He or she will examine your ankle carefully. X-rays may or may not be taken of your ankle.

How is it treated?
Treatment may include:

- Applying ice packs to your ankle for 20 minutes every three to four hours for the first two days after injury
- Elevating your ankle by placing a pillow underneath your foot
- Carrying out rehabilitation exercises
- Your practitioner may feel it is appropriate to refer to a physiotherapist.

Depending on the severity of your sprain, you will need to start putting your weight on your ankle as soon as you are able.

What are the exercises?
You should carry out the following exercises as directed by your practitioner:

Ankle range of motion
You can do this exercise sitting or lying down. Pretend you are writing each of the letters of the alphabet with your big toe

Towel exercises
Sit on a hard surface with your injured leg stretched out in front of you. Loop a towel around the ball of your foot and pull the towel towards your body, keeping your knee straight. Then gently press the ball of your foot down and point your toes, stretching the towel. Return to the starting position. Repeat ten times, three times a day.

Heel raises
Standing, balance yourself on both feet behind a chair. Rise up on your toes, hold for five seconds and then lower yourself down. Repeat ten times, three times a day.

Single leg balance
Stand without any support and attempt to balance on your injured leg. Begin with your eyes open and then balance with your eyes closed. Hold the single leg position for 30 seconds. Repeat three times a day.

www.uhs.nhs.uk

Appendix 13 PPI review of the advertising poster (Study three)

Nottingham Uni

PPI COMMENTS SHEET

research & innovation

Study Title/Reference: Predictive factors for recovery from acute ankle pain Type of document reviewed (i.e. patient information sheet): Advertisement/Poster		Date: 1st March 2016 Facilitator: Jane Flewitt
Respondent number	Comments	Date comments received
1	"Did you sprain your ankle?" isn't very normal English, more American . I would find "Have you sprained your ankle?" more accessible. Change "*What factors do you think affect your return to sport after ankle injury?"* to "What function do you think might affect your return to sport after ankle injury" 's' added to " *Have any question?*" to read: 'Have any questions?'	17th February 2016
2	I thought the words were fine. Not sure what the idea of the name and phone number are at the bottom. If needed they should be the right way up and there should only be one. If there are different number for different target groups whether by sex, type of sport, treatment etc then this should be sorted by giving callers choices when they ring in. This should be a maximum of three choices. (note from Jane	17th February 2016

Respondent number	Comments	Date comments received
	Flewitt – I don't think it was clear that these would be removable strips for people to take away with them – in retrospect I perhaps should have made this clear when I sent the forms out for review) I would have had a picture of a sports person or the leg of a sports person with a swollen ankle rather than the 'medical picture'. I'm not sure anyone seeing the picture would immediately engage with it and think to themselves 'Oh that looks like it is aimed at me!'	
3	THINK THE POSTER IS GOOD AND STRIKING, SHOULD GAIN ATTENTION.	18th February 2016
4	Given I know this is an advert for a research project, the terms and words are understandable, but some sentences could be made clearer. However, the word 'research' is never used, and I'm not sure relying on people to understand that the term 'participant' implies a research project is sufficient to recruit people. Box with participation information could be clarified: As a suggestion… If you are aged 14 and over and play sport, and would like to take part, please contact Saed Al Bimani, physiotherapist, at (email address) or call (phone number). If you are under 18, please ask your parent/guardian to contact us on your behalf. - Including the designation 'physiotherapist' would give the reader confidence about the research and researcher.	18th February 2016

Respondent number	Comments	Date comments received
	The title is very clear as far as it goes, but perhaps needs to include ‘and do you play sport?’ - the researcher is attracting a wide age range, but there is not mention of parents responding on behalf of their child - the use of the speech bubble is effective, but the wording perhaps needs reconsidering. It is asking a question that doesn’t appear on the patient questionnaire until the follow up. It seems likely the patient might well answer the poster question with ‘my sprained ankle.’ The poster is quite appealing. The title makes clear the researcher is looking for people who have sprained their ankle, though not that they should also play sport. Black on yellow is easy to read. Is the cartoon of the woman appropriate for such a wide age, particularly those who do sport? It clutters the image. The use of a speech bubble with a question is engaging, but I’m not sure it’s the right question for either the intent of the project or to gather participants.	
5	I think the poster could do with a date, and perhaps larger writing.	18th February 2016
7	I found [the advertisement] confusing and 'fussy'. The diagram is not obviously an ankle for me and the sideways, repetitive contact details at the bottom I find irritating. If I was passing this on the wall, I'm not sure I	23rd February 2016

Respondent number	Comments	Date comments received
	would be attracted.	

Appendix 14 PPI review of the study questionnaire (Study three)

Nottingham University Hospitals NHS
NHS Trust

PPI COMMENTS SHEET

Study Title/Reference: Predictive factors for recovery from acute ankle pain Type of document reviewed (i.e. patient information sheet): Questionnaire and follow up	Date: 1st March 2016 Facilitator: Jane Flewitt

Respondent number	Ref/Page number	Comments	Date comments received
2		I thought the words were fine Participants should be told at the beginning that there is a follow up phone call rather than right at the end. Also it is clearly not anonymous if their phone number is given out.	17th February 2016
6		I understood all words/sentences shown on the document and found the wording to be appropriate. The paragraphs were straightforward and easy	21st February 2016

Respondent number	Ref/Page number	Comments	Date comments received
		to understand for a lay person. I felt this questionnaire was simple and a lay person would have no problem answering the questions.	
7		Questionnaire seems fine, although, personally, I always have problems measuring amount of pain on a scale.	23rd February 2016
	Question 1/ page 1	The sports chosen a bit random. If, for instance I was a cross country runner, high jumper, netball player, a cricketer and on and on, I would wonder why my sport was felt to be less important.	
1	Question 2/ page 1	include question mark after sport '… your main sport? Provide...'	17th February 2016
	Questions 2 and 5 / page 1	Should be set out in a consistent way. The second part of Question 5 should be a separate question.	

Respondent number	Ref/Page number	Comments	Date comments received
	Question 3/ page 1	Change ‘you’ to ‘your’ to read: ‘…do you play your main sport?’	
	Question 9 / page 2	I’m no medical expert so please forgive me if this is a stupid comment but aren’t the terrain (flat surface, cross country field, poor quality pitch, artificial pitch etc) and the conditions (dry, muddy, wet, icy, etc) important considerations?	
	Question 11 / page 2	The photographs in Question 11 are suitable as they show the 2 most common types of ankle injury.	
	Question 12 / page 2	Would it be better to ask which ankle as which side might be interpreted as which side of the ankle.	
	Question 14/ page 2	Include ‘have to read: ‘If you have had this injury on the same....’.	
	Question 15 / page 2	Asks about the opposite ankle but questions16 and 17 ask about the	

Respondent number	Ref/Page number	Comments	Date comments received
		opposite foot – it should be consistent.	
	Question 17/page 3	Include question mark: ' ...... foot?'	
3	Question 18/ page 3	Include comma after days: How many hours, or days, was it…' By now a several questions have been asked about a variety of injuries. Maybe it needs a something like 'coming back to you most recent injury…..' Change 'Clinician' to Doctor/Nurse	18th February 2016
	Questions 21 and 22 / page 4	Change wording to: 'Are any of the following movements…' instead of 'Are either of the following movements…' I'm not sure I would be able to say whether it was the pain or the swelling. I understood the requirements for the diagrams in Questions 21 and 22 and would have understood which boxes	

Respondent number	Ref/Page number	Comments	Date comments received
		to tick.	
	Question 23 /page 4	Change wording to read: '… ever feel loose or as if it was going to give way' for a period longer than 6 months?' instead of '…ever feel loose or as if it was going to give way' and persisted longer than 6 months?'	
	Question 28 / page 4	centimetres (not centimeters)	
	Follow up:	Question numbers are wrong - 4 says Question 5, etc. i.e. Question 4 has been omitted affecting subsequent numbering.	
	Question 2 / page 5	I would use BEST time instead of appropriate.	
	page 6	All questions need either a box or lines for the answers to the questions to be filled in.	
	4. Question 5 / page 6	Use 'Doctor/Nurse' instead of 'clinician'.	
	5. Question 6 /page 6	Change to read: 'Are there any other factors that affected your return	

Respondent number	Ref/Page number	Comments	Date comments received
		to play?.... Instead of 'affected' should read AFFECTING	
	Question 2 / page 6	End of line one; should read BEFORE not for, plus same page question 4 Clinician is used again and the numbers go wrong after that. Do you need question numbers twice anyway??	

Appendix 15 PPI review of participant information sheet (Study three)

research & innovation

Nottingham University Hospitals NHS Trust

PPI COMMENTS SHEET

Study Title/Reference: Predictive factors for recovery from acute ankle pain Type of document reviewed (i.e. patient information sheet): Participant Information Sheets	Date: 1st March 2016 Facilitator: Jane Flewitt

Respondent number	Ref/Page number	Comments	Date comments received
1 4	Page 5	Amend first sentence to read: ‘Please read this information carefully before deciding if you are willing for your child to take part in this research.’ The researcher's opening statement on the information sheet reads: "You are invited to take part in a research assessing factors for recovery that might affect recovery from ankle sprain.” This suggests the researcher is not really sure what he is aiming to achieve, it makes no sense to me. He needs to be able to	17th February 2016 18th February 2016

Respondent number	Ref/Page number	Comments	Date comments received
		make this statement clear to give reviewers a reference point. Without this I feel it's an almost impossible and huge task to comment on the content of the documents. The title of his project "Predictive factors for recovery from acute ankle sprain." didn't help either because it makes no mention of sport. His questionnaire, however, relates to sport and there he writes perhaps a little more clearly about his research intent: "Your participation is very important to the success of this project that will help us better understand ankle injury and returning to playing sport."	
7	Page 5: Invitation	Remove 'a' and 'for recovery'; first sentence should read: 'Your child is being invited to take part in research assessing factors that might affect recovery from ankle sprain.'	23rd February 2016
	Page 5: Why your child has been chosen?	Second sentence, remove 'In addition,' Suggest sentence amended to read: 'The	

Respondent number	Ref/Page number	Comments	Date comments received
		research will take place…'	
	Page 5: What will happen?	First sentence: insert 'a' to read '…a questionnaire asking **a** few questions about him/herself,…' Fifth sentence: Include comma after 'follow up' to read: 'In addition, at follow up, your child…'	
	Page 2, 6 and 9: Are there any risks involved?	Final sentence, would suggest removing 'Time when you…' and amending to read: 'Information about the return to sport and associated factors will also be asked only once…'	
	Page 2, 6 and 9: Will participation be confidential?	Initial sentence: Suggest changing from 'The collection and procession of information in this research…' to read: 'Data collected and analysis is in compliance…' Third sentence: Amend to read: 'Data will be stored in a university computer **in a** password-protected folder.'	
8	Page 6: Participant's rights	Fifth sentence: Change 'withdrew' to 'withdraw' to read: '…can also **withdraw** from participation at any point.'	27th February

Respondent number	Ref/Page number	Comments	Date comments received
		Replace ‘withdrew’ to ‘withdraw’	2016
	Page 7	Change spelling of organising / organised to English spelling (rather than using the z forms).	
3		I think diagrams and pictures are all acceptable	18th February 2016
6	Page 8: Invitation	Second sentence: Include ‘a’ to read: ‘This research is part of **a** PhD project…’ I felt the first line of the paragraph, titled “Invitation” could be worded simpler for the lay person. I have suggested how this line could be improved below. The first line in the paragraph “invitation” - You are invited to take part in a research assessing factors for recovery that might affect recovery from ankle sprain – I feel this could be worded simpler for the lay person. For example, you are invited to take part in a research study that I am conducting to assess what issues may affect a	21st February 2016

Respondent number	Ref/Page number	Comments	Date comments received
		person's recovery from an ankle sprain.	
	Page 8: What will happen if I take part	Second sentence, replace 'Beside' with 'In addition,'. Include 'a' before 'few' to read: '**In addition,** you will be asked to complete a questionnaire asking **a** few questions…'	
5	Pages 8 –10	The subheadings are all base on "I" apart from "Will you be paid?" which perhaps could be changed to 'Will I be paid?'	18th February 2016
	General	Well, I think the documentation is pretty good. I like the use of pictures on the 14-17 PIS. The language is good - friendly, non-technical and easy to understand, without being patronising. Well done! Apart from the first line of the invitation paragraph, I was able to read and understand the remaining document. The document was informative and covered questions and answers that would have been asked by the participant if they were not included, for instance, are there any risks involved? Will my information be kept confidential? Thought all the papers were concise, easy	

		to understand and to the point. Excellent Study in my opinion.	

Appendix 16 Advertising poster (Study three)

Appendix 17 Participant Information Sheet (Study three)

Study Title: An investigation to identify influencing factors for time to return to play following lateral ankle sprain.

Researcher: Saed Al Bimani ERGO reference: 25336

Please read this information carefully before deciding if you are willing to take part in this research**.**

Invitation

You are being invited to take part in a research study that is being conducted to assess what issues may affect a person's recovery from ankle sprain. This research is part of PhD project as the researcher (Saed Al Bimani) is a doctorate student at The University of Southampton and a qualified physiotherapist. This research is supervised by research experienced staff members from the Faculty of Health Sciences of Southampton University. It aims to understand what affects recovery from ankle sprains. The results of this research will identify the factors that might affect return to playing sport and therefore hope to improve management of ankle sprains.

Why have you been chosen?

You have been chosen because you live in Hampshire area, aged 18 years and above, play sport at least once a week and had lateral ankle sprain that did not have surgical treatment. Lateral ankle sprain is an injury that causes stretch or tear of ligaments of the outside part of the ankle. Occurs when the foot rolls underneath the ankle or leg. Usually there is pain and/or swelling on the outside of the ankle following this injury. We are interested in knowing what factors influence your return to playing sport after lateral ankle sprain. Knowing that may identify those individuals who need longer or shorter recovery time.

What will happen to me if I take part?

It is important to read this information leaflet carefully over the next day, please allow yourself up to 24 hours to consider your participation. If you decide to participate, you will be required to complete the online questionnaire. In the questionnaire, there are questions about yourself, your average weekly training and/ or sport information and history of your ankle injury. You will be also asked about the time when you returned to sport activity and what may have influenced that. This questionnaire should take about 10-15 minutes to complete. You can copy the link provided at the end of this leaflet and answer the online questionnaire.

Are there any benefits in my taking part?

Taking part in this study will not directly benefit you, as there are no payments or incentives being offered. However, the information we get from this study will increase our knowledge and inform future research about lateral ankle sprain and will help manage this injury better.

Are there any risks involved?

There will be no risk or discomfort to you as a result from participating in this research. You will be only required to complete a questionnaire. Participation will cost you nothing.

Will your participation be confidential?

Data collection and analysis is in compliance with the Data Protection Act (1998) and University of Southampton Ethics Policy. The information provided by you in this questionnaire will be used for research purposes. It will not be used in a manner which would allow identification of your individual responses.

All study data will be kept in a password-protected University computer for 10 years according to University of Southampton Ethics and Research Governance policy.

At no time will any individual responses be disclosed to any sources other than the primary investigator (Saed Al Bimani) unless it is for 'Governance' purposes, where direct access to source data and documentation by recognized persons only may be required. If at any time aspects of poor practice or safeguarding issues are raised then these will be reported to the relevant personnel (supervisor) due to a duty of care.

Participant's rights

You will have adequate time to understand the nature of the participation and decide accordingly. You have the right to stop your participation at any time during the study period without your legal rights or routine care being compromised. You also have the right to withdraw any information that has previously been supplied. You will be asked permission at the beginning of the questionnaire. You also have the right to ask any questions when you have any doubts regarding the research or participation. You also have the right to know the results of the study by contacting me on the e-mail provided at the end of this form.

What happens if something goes wrong?

In unlikely cases of concern, you should contact the researcher (Saed Al Bimani) on 07477113561 or send an email to sab1g14@soton.ac.uk. If you would like to make a complaint about this study or talk to someone outside of the research team you should contact the Research Governance Office (Address: University of Southampton, Building 37, Highfield, Southampton, SO17 1BJ; Tel: +44 (0)23 8059 5058; Email: rgoinfo@soton.ac.uk. If you remain unhappy and wish to complain formally, the Research Governance Office can provide you with details about the University of Southampton Complaints Procedure.

Who is organising and funding the research?

The study is being organised by research staff from the faculty of Health Sciences, University of Southampton. This study will contribute to a PhD thesis (Saed Al Bimani) and it is funded by the Omani Cultural Attaché and Ministry of Higher Education in Oman.

Who has reviewed the study?

The study design has been peer reviewed by the faculty of Health Sciences, University of Southampton. The study has also been reviewed and approved by Ethics and Research Governance Online (ERGO) at the University of Southampton.

What will happen when the study ends?

When the study ends, all study data will be securely stored in a password-protected computer at the premises of the University of Southampton for a period of 10 years according to University of Southampton Ethics and Research Governance policy. After 10 years, the University Estate and facilities at the University of Southampton will destroy all study data carefully. They provide a service for the removal of sensitive personal data which requires destruction to ensure that the contents remain private. The results will be used to inform research with people who have had lateral ankle sprain. These results will be presented at scientific conferences and may be published in scientific journals. Please mind that we are not going to publish identifiable data. Please let us know if you would like a copy of the published results of the study.

Where can I get more information?

Should you have any questions or doubts related to participation, please feel free to contact the researcher (Saed Al Bimani), sab1g14@soton.ac.uk phone 02380 59 2982 or 07477113561 between 10:00 am and 7:00 pm.

Consent to participate

Please note that by completing this questionnaire you are indicating your consent to participate in this research. In addition, you will be required to check a box at the beginning of the questionnaire.

How can you access the online questionnaire?

You can access the questionnaire online at: https://docs.google.com/forms/d/1ow8ADZwdyW-FqPenNtKD5tDsyBsiP2I--aMVpOqeLYA/edit Or you can scan the code:

Appendix 18 Online questionnaire (Study three)

Time to return to playing sport following lateral ankle sprain

Thank you for taking time to participate in this study.

The researcher is a qualified physiotherapist and PhD student at The University of Southampton. Your participation is very important to the success of this project that will help us better understand lateral ankle sprain injury and returning to playing sport. Lateral ankle sprain is an injury that causes stretch or tear of ligaments of the outside part of the ankle. Occurs when the foot rolls underneath the ankle or leg. Usually there is pain and/or swelling on the outside of the ankle.

Inclusion criteria:
1. Aged 18 and over
2. Play sport at least once a week
3. Had lateral ankle sprain within last 6 months. It is an injury that causes stretch or tear of ligaments of the outside part of the ankle. Occurs when the foot rolls underneath the ankle or leg.
4. Did not have surgical treatment for this sprain.
5. Have not had ankle/foot fracture within last 6 months.

This questionnaire will take approximately 10-15 minutes to complete. We respect your privacy as your responses will be anonymous and confidential. You are not required to provide any personal information such as name or contact details. Your responses will be securely stored at the premises of the University of Southampton for a period of 10 years and after this period all data will be carefully destroyed by the University of Southampton.

Please note that by completing this questionnaire you are indicating your consent to participate in this research.

This study was approved by Ethics and Research Governance Online (University of Southampton) on 9th of May 2017 (REC No 25336).

Should you have any questions or doubts related to participation, please feel free to contact the researcher (Saed Al Bimani), sab1g14@soton.ac.uk phone 02380 59 2982 or 07477113561 between 10:00 am and 7:00 pm

More information about particiption in this study: https://goo.gl/Ss079U

*Required

1. **Please tick the box if you agree to participate in this study** *

Tick all that apply.

☐ I agree to participate in this study

2. **Which sport do you play the most?**
Mark only one oval.

- Soccer
- Basketball
- Rugby
- Hockey
- Volleyball
- Handball
- Squash
- Netball
- Cheerleading
- Other: ________________

3. **On average, how many days a week do you play your main sport? provide a number from 1-7**
Mark only one oval.

- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

4. **On average, how many hours per week do you play your main sport?**

____

5. **At what level do you play your main sport?**
Mark only one oval.

- ( ) Professional club
- ( ) Local club
- ( ) Sport association
- ( ) University
- ( ) Leisure and recreation
- ( ) Other: ____________________

6. **What other sports do you play?**

____

7. **On average, how many days per week do you play sports in total?**
Mark only one oval.

- ( ) 1 day
- ( ) 2 days
- ( ) 3 days
- ( ) 4 days
- ( ) 5 days
- ( ) 6 days
- ( ) 7 days

8. **On average, how many hours per week do you play sports in total?**

____

9. **Who identified that you had lateral ankle sprain? lateral ankle sprain is an injury that causes stretch or tear of ligaments of the outside part of the ankle. Occurs when the foot rolls underneath the ankle or leg. Usually there is pain and/or swelling on the outside of the ankle.**
Mark only one oval.

- ( ) Physiotherapist
- ( ) GP
- ( ) Sport medical team
- ( ) Yourself
- ( ) Other: ____________________

10. **Date of injury: Day/Month/Year**

____

11. **Time of injury**

____

Example: 8.30 a.m.

12. **What were you doing when the injury happened?**

Mark only one oval.

- ◯ Walking
- ◯ Running
- ◯ Jumping
- ◯ Tackling/ Being tackled
- ◯ Other: _______________

13. **If your injury occurred while playing sport, then state which sport**

____

14. **What happened to your ankle during the injury? indicate which picture represents your injury? (check the box that applies)**

Mark only one oval.

- ◯ A
- ◯ B
- ◯ Other: _______________

Rolled over the side A

Pushed backwards/ extended B

15. **Which side did you injure?**
Mark only one oval.

◯ Right
◯ Left

16. **Which is your dominant foot?**
Mark only one oval.

◯ Right footed
◯ Left footed
◯ Both right and left

17. **Is this your first lateral ankle sprain in this ankle?**
Mark only one oval.

◯ Yes
◯ No

18. **If you had this injury on the same ankle before, how many times?**

____

19. **If you had this injury on the same ankle before, when was the most recent one? Day/Month/Year**

____

20. **Have you ever had lateral ankle sprain in the opposite ankle?**
Mark only one oval.

◯ Yes
◯ No

21. **If you had this injury on the opposite foot before, how many times?**

____

22. **If you had this injury on the opposite foot before, when was the most recent one? Day/Month/Year**

____

23. **Have you ever had any other injuries in the same foot? please specify**

24. **In the year before your current injury, had the same ankle ever felt loose or as if it was going to 'give way'?**
Mark only one oval.
- Yes
- No

25. **How many hours, days was it from your most recent lateral ankle sprain happening until you received medical attention?**

26. **How many hours, days was it from your most recent lateral ankle sprain happening until you became able to walk with no pain?**

27. **As a result of the most recent lateral ankle sprain, has your ankle become swollen?**
Mark only one oval.
- Yes
- No

28. **How painful was the injury when it happened? please select a number on the scale below, where 0 means no pain and 10 is the worst pain ever to indicate how painful your ankle was "WHEN YOUR FOOT WAS NOT PLACED ON THE FLOOR".**
Mark only one oval.

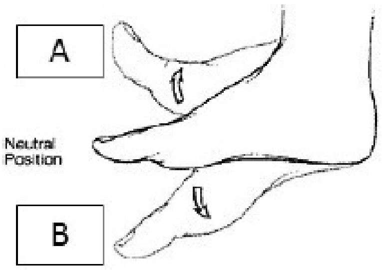
	0	1	2	3	4	5	6	7	8	9	10
No pain	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭

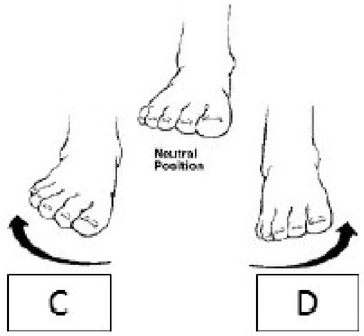
29. **How painful was the injury when it happened? please select a number on the scale below, where 0 means no pain and 10 is the worst pain ever to indicate how painful your ankle was "WHEN YOU PLACED YOUR FOOT ON THE FLOOR AND TRIED TO STAND OR WALK".**
Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10
No pain	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭

30. **Were either of the following movements limited because of "PAIN" compared to your non-injured side? (check the box that applies, you can check more than one box)**
Tick all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D

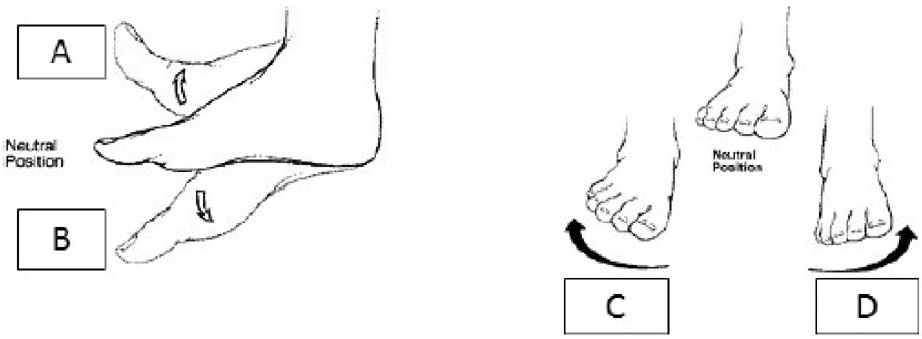




31. **Were either of the following movements limited because of "SWELLING" compared to your non-injured side? (check the box that applies, you can check more than one box)**

Tick all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D



32. **Immediately after this injury, how was your weight bearing status?**

Mark only one oval.

- ( ) Weight bear only
- ( ) Cannot weight bear
- ( ) Walk with assistive device
- ( ) Walk without assistive device
- ( ) Ambulate stairs
- ( ) Hop on involved extremity
- ( ) Jog/No functional limitations

33. **Immediately after this injury, did your health limit you in these activities?**
Mark only one oval per row.

	Yes, Limited a lot	Yes, limited a little	No, not limited at all
Vigorous activities such as running, lifting heavy objects, participating in strenuous sports limited?	⬭	⬭	⬭
Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	⬭	⬭	⬭
Lifting or carrying groceries	⬭	⬭	⬭
Climbing several flights of stairs	⬭	⬭	⬭
Climbing one flight of stairs	⬭	⬭	⬭
Bending, kneeling, or stooping	⬭	⬭	⬭
Walking more than a mile	⬭	⬭	⬭
Walking several blocks	⬭	⬭	⬭
Walking one block	⬭	⬭	⬭
Bathing or dressing yourself	⬭	⬭	⬭

34. **Who provided treatment for this injury?**
Mark only one oval.

- ⬭ Physiotherapist
- ⬭ GP
- ⬭ Sport medical team
- ⬭ Yourself
- ⬭ Other: ____________________

35. **What treatment did you apply for this injury? (check the box that applies, you can check more than one box)**
Tick all that apply.

- [ ] Rest, ice, compression and elevation (RICE)
- [ ] Plaster cast
- [ ] Elastic or tube bandage
- [ ] Tape or ankle strap
- [ ] Active movement of ankle joint, i.e. moving foot up, down and to the sides
- [ ] Balance exercises using balance board
- [ ] Strengthening exercises
- [ ] Joint mobilization by a clinician
- [ ] Electrical stimulation devices such as TENS machines
- [ ] Therapeutic Ultrasound
- [ ] Cycling
- [ ] Sport-specific training
- [ ] Other: ____________________

36. **Did you take any pain relief medications after this injury? if yes, please specify what type of medications**

____
____
____
____
____

37. **How long did you take pain relief medications after this injury?**

____
____
____
____
____

38. **What is your sex?**
Mark only one oval.

- Male
- Female

39. **What is your current age?**

____

40. **Weight: Kilograms OR Stone & lbs, please specify**

____

41. **Height: Centimeters OR Feet & inches, please specify**

____

42. **Please state the first two digits of your post code**

____

43. **Did you return to playing sport after this injury? return to playing sport is defined as resuming sport-specific training with no pain and without opponent contact**
Mark only one oval.

- Yes
- No

44. **When did you return to playing sport following this injury?Day/Month/Year**

____

45. **What type of sport/s did you return to?**

____

46. **Did you return to the same level of sport activity that you were at prior to the this injury?**
Mark only one oval.

- ( ) Yes
- ( ) No

47. **Who made the decision to return to playing sport?**
Mark only one oval.

- ( ) Physiotherapist
- ( ) GP
- ( ) Sport medical team
- ( ) Yourself
- ( ) Other: ____________________

48. **Right after the injury, were you given recommendations by a clinician about minimum expected time to return to sporting activity? if yes, please specify the duration**

____

49. **If you have not yet returned to playing sport then when do you think you will?**

____
____
____
____
____

50. **Why have you not returned to playing sport yet?**

____
____
____
____
____

51. **Did you have any symptoms in the injured ankle when you returned to playing sports?**
Tick all that apply.

- [ ] No symptoms
- [ ] Pain
- [ ] Swelling
- [ ] Restricted ankle movement
- [ ] Joint feels loose or as if it is going to "give way"
- [ ] Other: ____________________

YOU ARE ALMOST THERE...if you have more time, we also need to know about other factors that may influence return to playing sports

52. **What problems, if any, in the way your feet move (e.g. ankle movement) or the structures of your feet (e.g. nerves, muscles, ligaments or skin) you think influenced your return to playing sports?**

____
____
____
____
____

53. **How did problems in your body function or structure/ part influence your return to playing sports**

____
____
____
____
____

54. What personal factors (e.g. gender, age, social or psychological) you think influenced your return to playing sports?

55. How did personal factors influence your return to playing sports?

56. What external environmental factors (e.g. supports and relationships, attitudes, services, policies) you think influenced return to playing sports?

57. How did external environmental factors influence return to playing sports?

Thank you once again for answering these questions and assisting us in our research.

58. **If you would like to have the opportunity to participate in a follow-up study (one time individual interview) on how other factors affect return to playing sports after ankle sprain then please enter your e mail address here**

____

Powered by
Google Forms

Appendix 19 Multi variable models, Negative Binomial (Study three)

	Variables	Goodness of Fit		Omnibus Test		
		Akaike's Information Criterion (AIC)	df	Likelihood Ratio Chi-Square	df	Sig.
Model 1	age, sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain, history of chronic instability and treatment program	942.16	89	16.79	8	.032
Model 2	sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain, history of chronic instability and treatment program	940.21	90	16.73	7	.019
Model 3	BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain, history of chronic instability and treatment program	939.19	91	15.754	6	.015
Model 4	cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain, history of chronic instability and treatment program	988.46	96	14.95	5	.011
Model 5	mechanism of injury, restricted AROM of dorsi flexion because of pain, history of chronic instability and treatment program	990.78	97	10.641	4	.031
Model 6	sex, BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment program	946.43	92	16.58	6	.011

	Variables	Goodness of Fit		Omnibus Test		
		Akaike's Information Criterion (AIC)	df	Likelihood Ratio Chi-Square	df	Sig.
Model 7	BMI, cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment program	946.04	93	14.97	5	.011
Model 8	cause of injury, mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment program	966.08	98	13.50	4	.009
Model 9	BMI, mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment program	946.02	94	12.99	4	.011
Model 10	mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment program	998.52	99	9.06	3	.029
Model 11	cause of injury, mechanism of injury and restricted AROM of dorsi flexion because of pain	1004.157	100	11.75	3	.008*
Model 12	BMI, cause of injury, mechanism of injury, chronic instability, restricted AROM of dorsi flexion because of pain and treatment program	939.19	91	15.754	6	.015*
Model 13	Sex, mechanism of injury, restricted AROM of dorsi flexion because of pain and treatment program	998.10	98	11.09	4	.026*
Model 14	Age, mechanism of injury, restricted AROM of dorsi flexion because of pain	999.50	98	10.07	4	.039

	Variables	Goodness of Fit		Omnibus Test		
		Akaike's Information Criterion (AIC)	df	Likelihood Ratio Chi-Square	df	Sig.
	and treatment program					

Appendix 20 Responses to open-ended questions (Study three)

Questions	Responses
What problems, if any, in the way your feet move (e.g. ankle movement) or the structures of your feet (e.g. nerves, muscles, ligaments or skin) you think influenced your return to playing sports? How did problems in your body function or structure/ part influence your return to playing sports	• Yes • Pain .cannot kick the ball etc. • Weak muscles; Weak ligaments • One foot aches more than the other after a match • N/A • Nil • low arch • none • The body will not be fit to resume playing due to its weakness • Just took a long time • Just had to be more careful • I don't think I understand this question,, but, I think my increased body weight triggered this problem • correct foot positioning first • had to play as we were short • No pain on running • I wore ankle strapping for a while playing football, and prefer to wear ankle supporting walking boots while hiking. I also am careful when trail running.
What personal factors (e.g. gender, age, social or psychological) you think influenced your return to playing sports? How did personal factors influence your return to playing sports?	• psychological • No sports hospitals??? • Gender; Age; Social and psychological • Need to exercise at my age • Age • Playing soccer is a stress reliever for me plus its physiological overall benefits on my body • mental health, anxiety and bipolar • didn't want to let team down • Not sure I understand this question.... I like playing sports & running... • Nil • Gender: Females are less likely to return faster due to body structure comparing to men. Age and social: The more age the less likely to have faster RTP. Psychological: The more similar injuries the more psychological effect which can prevent RTP. • A bit, it's a social and fun activity • I really wanted to play the sport again • Stated on the previous question • made me return later

	• team player • Determination?
What external environmental factors (e.g. supports and relationships, attitudes, services, policies) you think influenced return to playing sports?	• Bad soccer fields. • Supports and relationships, Services • None • My parents supported me and so did my coaches to take it easy • Relationships • team cohesion and relationships • Used tape to prevent another inversion sprain • Very little, apart from initial advice that ankle was not broken, and that i needed to exercise/balance it to recover properly.
How did external environmental factors influence return to playing sports?	• Supports and relationships: Might not get the full support from the surrounding environment to RTP where frustration will play a major influence. Services: The less services available close to my accommodation, the less likely to have encouraging RTP. • None • A lot • made me hesitant to return • wet day so ground was forgiving, hard ground may have been more painful • Not much?

Appendix 21 First draft of interview questions (Study four)

<table>
<tr><th>Main questions</th><th>follow up or probing questions</th><th>Other possible contextual questions (in general)</th></tr>
<tr><td>1. What problems in your body function or structure/ part you think influenced your RTP?</td><td rowspan="2">1. How about feeling of pain?
2. How about moving your feet?
3. How about other structures around your feet, e.g. skin
4. How about feeling e.g. touch, pressure
5. How about swelling if you had, short muscles, stiff ankles</td><td rowspan="6">• Could you further elaborate on what you have just said?

• Can you tell me more about this?

• Would you give me an example/ more examples?

• Would you consider this factor as a barrier or facilitator to RTP

• How did you feel about this?</td></tr>
<tr><td>2. How did problems in your body function or structure/ part influence your RTP?</td></tr>
<tr><td>3. What personal factors (your personal characteristics) you think influenced your RTP?</td><td rowspan="2">1. How do you think being a man or women affected RTP?
2. How about being at your age affected your RTP
3. How about the way you personally managed your injury?
4. How about your personal social background?
5. How about your education level?
6. How about your job?
How about your past and current experience?
7. How did your usual attitude/ behaviour towards having an injury?</td></tr>
<tr><td>4. How did personal factors influence your RTP?</td></tr>
<tr><td>5. What external environmental factors (related to people/ society around you) you think influenced your RTP?</td><td rowspan="2">1. How about having ankle support or splint if had one after your ankle injury? Shoe types?
2. How about the sport court flooring you usually play on? Weather? Time e.g. morning, afternoon, evening?
3. How about people around you? Family, friends, coaches, therapists, trainers
4. How about health care services e.g. awareness, availability, access, costs?
5. How about sport policies if you play with a group or a team?</td></tr>
<tr><td>6. How did external environmental factors influence your RTP?</td></tr>
</table>

Appendix 22 Interview questions/ guide (Study four)

Interview Topic Guide

Introduction

1. Introduce myself and thank them for agreeing to talk to us.
2. Tell them the interview will last approximately 60-90 minutes
3. Tell the purpose of the interview/ study: To explore the perspectives of sportspeople on return to play after conservatively treated lateral ankle sprain.
4. Confirm their demographic data recorded on the baseline information sheet
5. Ask them if they have any questions before starting the interview
6. Ask their permission to start the interview and audio record it

Topic/ Questions

1. Can you tell me about your experience of return to playing sports after your injury?
    a. Recovery/ Criteria
    b. Symptoms
    c. Performance
2. Can you tell me about how things in your feet affected your return to playing sports?
    a. Movements
    b. Structures
3. Can you tell me about things related to you as a person that you think influenced your return to playing sports?
4. Can you tell me about things around you that you think influenced your return to playing sports?
5. Is there anything else you think is important to tell about your experience with return to playing sports?

End of interview

Thank them again for coming to talk to me about their experience.

Appendix 23 Invitation letter (Study four)

Invitation

Welcome to our study

You are being invited to take part in a study that will be conducted to assess return to play after ankle sprain injuries. Your valuable participation will help us better understand what factors affect return to sport after ankle sprain. The researcher is a qualified physiotherapist and a PhD student at The University of Southampton.

In this study, the researcher will ask questions about various factors that might be regarded as barriers of facilitators for return to playing sports after ankle sprain injury. The interview will approximately take one to one and a half hours. More information about participation in this study can be found in the attached participant information sheet (PIS).

I do not anticipate that taking this study will contain any risk or inconvenience to you. Your participation is strictly voluntary and you may withdraw your participation at any time without penalty. I will always respect your privacy, as your participation will be confidential.

Should you have any questions or doubts related to participation, please feel free to contact the researcher (Saed Al Bimani), sab1g14@soton.ac.uk phone 02380 59 2982 or 07477113561 Monday to Friday between 10:00 am and 7:00 pm. Furthermore, once the study is completed, I would be happy to share the results with you if you desire.

This study was approved by Ethics and Research Governance Online (University of Southampton) (REC No 48024).

If you agree to participate, you will be kindly required to sign the attached informed consent form and hand it over to the researcher at the day of the interview.

Appendix 24 Participant information sheet (Study four)

Participant Information Sheet

Study Title: Experiences of sportspeople with conservatively treated ankle sprain on return to play: a qualitative study

Researcher: Saed Al Bimani

ERGO reference (ethics): 48024

Please read this information carefully before deciding if you are willing to take part in this research.

Invitation

You are being invited to take part in a research study that is being conducted to assess what issues may affect a person's recovery from ankle sprain. This research is part of PhD project as the researcher (Saed Al Bimani) is a doctorate student at The University of Southampton and a qualified physiotherapist. This research is supervised by research experienced staff members from the School of Health Sciences of the University of Southampton. It aims to understand what factors affect return to playing sports after ankle sprain injury, which in turn will help to improve the management of ankle sprains.

Why have I been asked to participate?

You have been asked to participate because you are aged 18 years and above, play sport at least once a week and had lateral ankle sprain. Lateral ankle sprain is an injury that causes stretch or tear of ligaments of the outside part of the ankle. It occurs when the foot rolls underneath the ankle or leg. Usually there is pain and/or swelling on the outside of the ankle following this injury. The researcher will recruit six to ten participants who have already returned to playing sports after this injury.

What will happen to me if I take part?

If you decide to participate in this study, you will be asked to complete a 6-item demographic questionnaire. Then you will participate in an audio-recorded interview lasting approximately 60 minutes. The interview will be scheduled at a mutually agreeable time and location. In the interview, there will be questions about your experience with return to playing sports after your injury. You will be also asked about the date when you had the injury and the date when you returned to playing sports again. If you agree to participate in this study, you will be required to contact the researcher by e-mail of phone call. These are listed at the bottom of this page.

Are there any benefits in my taking part?

If you agree to participate, you will be paid to cover your travel expenses on the day of the interview, please bring the receipt/ ticket with you. In addition, the researcher will offer snacks and drinks on the day of the interview.

Are there any risks involved?

There will be no risk or discomfort to you as a result from participating in this research. You will be only required to answer questions about your experience with return to playing sports after your injury. None of the interview questions is meant to seek sensitive information. However, in case any distress events occur, the interview will be stopped and you will be guided to seek appropriate and professional help if needed.

What data will be collected?

In the interview, the researcher will start asking broad open questions about different factors that may have affected return to playing sports after ankle sprain. Those broad questions were then followed by follow up or prompting questions to explore participants' answers in more depth. Please be informed that identifiable personal information such as names or contact details will not be used in data analysis or reports afterwards. The researcher will only use pseudonyms (Coded identity) when discussing the results and in any later publications. Any documents that contain personal information (e.g. informed consent form) will be stored in a lockable cabinet within the premises of the University of Southampton.

Will my participation be confidential?

Your participation and the information we collect about you during the course of the research will be kept strictly confidential. The collected data will be only used for research purposes. All procedures of this study will be conducted in compliance with the Data Protection Act (2018) and University of Southampton Ethics Policy. The information provided by you in the interview will be kept in a password-protected University computer for a minimum of 10 years according to University of Southampton Ethics and Research Governance policy. Other documents such as informed consent forms will be stored in a lockable cabinet within the premises of the University of Southampton.

At no time will any personal data be disclosed to any sources other than the primary researcher (Saed Al Bimani) unless it is for 'Governance' purposes, where direct access to source data and documentation by recognized persons only may be required. If at any time aspects of poor practice or safeguarding issues are raised then these will be reported to the relevant personnel (supervisor, CB) due to a duty of care.

Do I have to take part?

No, it is entirely up to you to decide whether to take part. If you decide you want to take part, you will need to sign a consent form to show you have agreed to take part. You will also need to contact the researcher to agree on a date and time to attend for the interview.

What happens if I change my mind?

You will have adequate time to understand the nature of the participation and decide accordingly. You have the right to stop your participation at any time during the study period without your legal rights or routine care being affected. You also have the right to withdraw any information that has previously been supplied. You also have the right to ask any questions when you have any doubts regarding the research or participation.

What will happen to the results of the research?

Your personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent. The results of this study will be reported in a student thesis as a requirement for a PhD award. They might also be published in peer-reviewed journals. Please be noted that your identifiable personal information will not be stated in any of those reports.

Where can I get more information?

Should you have any questions or doubts related to participation in this study, please feel free to contact the researcher (Saed Al Bimani), sab1g14@soton.ac.uk phone 02380 59 2982 between 10:00 am and 7:00 pm.

What happens if there is a problem?

If you have a concern about any aspect of this study, you should speak to the researcher (Saed Al Bimani, 02380 59 2982 sab1g14@soton.ac.uk) who will do his best to answer your questions.

If you remain unhappy or have a complaint about any aspect of this study, please contact the University of Southampton Research Integrity and Governance Manager (023 8059 5058, rgoinfo@soton.ac.uk)

Data Protection Privacy Notice

The University of Southampton conducts research to the highest standards of research integrity. As a publicly-funded organisation, the University has to ensure that it is in the public interest when we use personally-identifiable information about people who have agreed to take part in research. This means that when you agree to take part in a research study, we will use information about you in the ways needed, and for the purposes specified, to conduct and complete the research project. Under data protection law, 'Personal data' means any information that relates to and is capable of identifying a living individual. The University's data protection policy governing the use of personal data by the University can be found on its website (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page).

This Participant Information Sheet tells you what data will be collected for this project and whether this includes any personal data. Please ask the research team if you have any questions or are unclear what data is being collected about you.

Our privacy notice for research participants provides more information on how the University of Southampton collects and uses your personal data when you take part in one of our research projects and can be found at http://www.southampton.ac.uk/assets/sharepoint/intranet/ls/Public/Research%20and%20Integrity%20Privacy%20Notice/Privacy%20Notice%20for%20Research%20Participants.pdf

Any personal data we collect in this study will be used only for the purposes of carrying out our research and will be handled according to the University's policies in line with data protection law. If any personal data is used from which you can be identified directly, it will not be disclosed to anyone else without your consent unless the University of Southampton is required by law to disclose it.

Data protection law requires us to have a valid legal reason ('lawful basis') to process and use your Personal data. The lawful basis for processing personal information in this research study is for the performance of a task carried out in the public interest. Personal data collected for research will not be used for any other purpose.

For the purposes of data protection law, the University of Southampton is the ‘Data Controller’ for this study, which means that we are responsible for looking after your information and using it properly. The University of Southampton will keep identifiable information about you for a minimum of 10 years after the study has finished after which time any link between you and your information will be removed.

To safeguard your rights, we will use the minimum personal data necessary to achieve our research study objectives. Your data protection rights – such as to access, change, or transfer such information - may be limited, however, in order for the research output to be reliable and accurate. The University will not do anything with your personal data that you would not reasonably expect.

If you have any questions about how your personal data is used, or wish to exercise any of your rights, please consult the University’s data protection webpage (https://www.southampton.ac.uk/legalservices/what-we-do/data-protection-and-foi.page) where you can make a request using our online form. If you need further assistance, please contact the University’s Data Protection Officer (data.protection@soton.ac.uk).

Thank you for taking the time to read the information sheet and considering taking part in this research.

Appendix 25 consent form (Study four)

CONSENT FORM

Study title: Experiences of sportspeople with conservatively treated ankle sprain on return to play: a qualitative study

Researcher name: Saed Al Bimani

ERGO number: 48024

Participant Identification Number (Pseudonym):

Please initial the boxes if you agree with the statements:

I have read and understood the information sheet (03/03/2019/ Version number 1) and have had the opportunity to ask questions about the study.	
I agree to take part in this research project and agree for my data to be used for the purpose of this study.	
I understand my participation is voluntary and I may withdraw at any time for any reason without my participation rights being affected.	
I understand that I may be quoted directly in reports of the research but that I will not be directly identified (e.g. that my name will not be used).	
I understand that taking part in the study involve audio recording which will be transcribed and then destroyed for the purposes set out in the participation information sheet.	
I understand that my personal information collected about me such as my name or where I live will not be shared beyond the study team.	

Name of participant (print name)……………………………………………………………………………

Signature of participant………………………………………………………………………………….

Date…………………………………………………………………………………….   ………………….

Name of researcher (print name)……………………………………………………………………………

Signature of researcher ………………………………………………………………………………….

Date……………………………………………………………………………………………………….

Appendix 26 Published study one

THE PHYSICIAN AND SPORTSMEDICINE
2019, VOL. 47, NO. 1, 31–46
https://doi.org/10.1080/00913847.2018.1533392

Taylor & Francis
Taylor & Francis Group

Check for updates

CLINICAL FEATURE
REVIEW

Factors influencing return to play following conservatively treated ankle sprain: a systematic review

Saed A. Al Bimani[a,b,c], Lucy S. Gates[a,b], Martin Warner[a,b] and Catherine Bowen[a,b]

[a]Faculty of Health Sciences, University of Southampton, Southampton, UK; [b]Arthritis Research UK Centre for Sport, Exercise and Osteoarthritis, University of Southampton, Southampton, UK; [c]Department of Physiotherapy, College of Health Sciences, Muscat, Oman

ABSTRACT

Background: Ankle sprain is a very common injury, yet uncertainty exists in what is appropriate time to return to play (RTP). Such guidance may inform treatment pathways and effective practice.
Objectives: To determine if consensus exist about potential influencing factors for time to RTP in conservatively treated ankle sprain.
Methods: We searched AMED, CINAHL Plus, Cochrane library, EMBASE, MEDLINE (EBSCO), SPOERDiscus, PsycINFO, PEDro, Scopus, unpublished literature and ongoing trials and Google Scholar from inception until April 2017. The quality of the eligible papers was assessed using the Downs and Black tool for randomized controlled trials (RCTs) and Critical Appraisal Skills Program (CASP) for observational studies.
Results: The initial search identified 1885 articles. After screening, 14 articles were included. Of these, 11 were RCTs and 3 were prospective observational studies. Individual treatment methods that resulted in a shorter time to RTP were functional treatment, compression stockings, anteroposterior joint mobilization, hyaluronic acid injection (HA), Jump Stretch Flex Band programme (JSFB) and diclofenac medication. Prognostic factors for determining time to RTP in the included prospective observational studies were measures of Global function, SF 36PF, athlete's ambulation status, weight-bearing activity scores and self-reported athletic ability.
Conclusion: To our knowledge, this is the first review to report influencing factors for time to RTP following conservatively treated ankle sprain. Findings from this review identified factors that influence time to RTP. However, caution should be taken in generalizing these results due to the heterogeneity of studies and inability to clearly define and list the criteria for safe RTP. The inclusion of factors such as age, sex, BMI, level of sport, injury related factors in future studies might help to understand the course of injury and therefore assist in constructing safer criteria.

ARTICLE HISTORY
Received 21 January 2018
Accepted 4 October 2018

KEYWORDS
Ankle sprain; influencing factors; return to sport; conservative treatment; athletes

1. Introduction

Ankle sprain is a traumatic injury that occurs to one or more of lateral ankle ligaments: anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament [1]. Based on the extent of ligamentous injury, ankle sprain injury is clinically graded as grade I (mild sprain), grade II (moderate sprain) and grade III (severe sprain) [2–4]. Grade I results in partial tear of anterior talofibular ligament (ATFL), grade II results in complete tear of ATFL and partial tear of Calcaneofibular ligament (CFL) and grade III results in complete tear of both ATFL and CFL with occasional tear of lateral joint capsule.

Ankle sprains are very common injuries amongst sport and non-sport people. The incidence rate was estimated to be 2.5 per 1000 person-years [5] and 3.29 per 1000 person-years [6] in the United States. In the UK, ankle sprain was found very prevalent injury that presents to emergency departments [7,8] with an incidence rate of 5.27 per 10,000 [8]. That exerts a large burden on the national economy as there is an estimation of 1.6 million ankle sprain patients' visits to physician offices and as much as 8000 hospital admissions in USA per year [9]. Moreover, about €187.2 million per year is spent on the management of sport-related ankle sprains in the Netherlands which results in a remarkable number of absence days from work and sports training and is directly associated with low work productivity [10–12].

Most ankle sprains recover spontaneously [13] however, many athletes develop long-term symptoms such as pain, swelling, loss of joint motion, reduced muscle strength, gait abnormalities, joint instability and arthritic changes [14–20]. It is currently unknown if premature return to play (RTP) contributes to this. Additionally, there appears to be no consistent advice on what constitutes an optimal threshold for return to sporting activities. It is also not clear what factors might contribute to the development of those chronic symptoms. Constructing evidence based guidance requires thorough understanding of the course of the ankle sprain injury including potential influencing factors for recovery [20]. Therefore, it is important to understand the association between athletes' characteristics and injury/activity related factors and RTP.

CONTACT Saed A. Al Bimani sab1g14@soton.ac.uk Faculty of Health Sciences, University of Southampton, Southampton, UK

The aim of this review was to determine if consensus exists about potential influencing factors for RTP in conservatively treated ankle sprain.

2. Materials and methods

One reviewer (SB) searched the following online databases from inception until May 2018: AMED – The Allied and Complementary Medicine Database, CINAHL Plus with Full Text, Cochrane library (http://www.cochranelibrary.com/), EMBASE, MEDLINE (EBSCO), PsycINFO, Physiotherapy Evidence Database (http://www.pedro.org.au/), SPORTDiscus and Scopus. A secondary search was performed to address publication bias by searching the Open Grey (to search for unpublished literature and ongoing trials) and Google Scholar. The reference list of all included articles were also reviewed to identify any possible additional publications. This systematic review was registered with the international database of prospectively registered systematic reviews in health and social care (PROSPERO), registration number CRD42017067839.

2.1. Generating a search strategy

Four expert professionals in physiotherapy (SB), podiatry (LG and CB) and sport science (MW) independently devised the main search terms. The Boolean operator 'AND' was used to combine the main search terms 'ankle', 'sprain' and 'return to play'. Appropriate synonyms were used for each of the main search terms and subsequently entered into the individual online databases (Appendix). A consensus meeting was held to address any inconsistencies and agree the final list of search terms. The search terms were formulated according to the research question. The same four reviewers discussed and agreed the inclusion criteria for selection of papers in this review.

This review was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [21] as illustrated in Figure 1. One reviewer (SB) conducted a systematic search, facilitated by a health sciences librarian (SD). All papers that investigated potential influencing factors on RTP following conservatively treated acute ankle sprain were retrieved. After searching all data sources, studies were transferred to EndNote bibliography software (Thomas Reuters EndNote X7.2.1) for screening and inclusion.

2.2. Duplicates

A total of 2991 articles were found after searching the targeted online databases and other sources including grey literature, Google Scholar and reference lists of included articles. Many articles were found in multiple databases therefore a duplicates check was performed in EndNote software where all results of the search were saved. After duplicates were removed, 1885 articles were considered for screening.

2.3. Eligibility criteria

Inclusion criteria were articles assessing factors that may influence RTP following conservatively treated acute ankle sprain; Any grade of ankle sprain; new and recurrent; athletes practicing any sport activity at any level; any age range; both male and female patients and full text articles published in English from inception until May 2018. Ankle sprain in this review is defined as a traumatic injury that occurred to one or more of lateral ankle ligaments: anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament. All types of study designs were considered to be included in this review. Articles were excluded if they did not include time to return to play (TTRTP) as an outcome measure at follow-up assessment and if they included participants following ankle surgery. In this review TTRTP is defined as number of days from injury until an athlete is back to sport activity. Animal and cadaver studies were also excluded.

Titles and abstracts were first screened by (SB) in order to identify relevant articles for full text review. Titles were first reviewed and irrelevant articles were immediately excluded. Abstracts were then reviewed when titles did not provide adequate information for either inclusion or exclusion of studies. A full text review was lastly performed to all articles that meet the inclusion criteria following title and abstract screening.

2.4. Quality assessment

The quality of the included articles was assessed using the Downs and Black tool for RCTs [22] and Critical Appraisal Skills Program (CASP) for observational studies [23]. Four reviewers in three independent groups (SB and LG), (SB and MW) and (SB and CB) assessed the methodological quality of each article using the Downs and Black for RCTs and CASP for observational studies. Each article was independently reviewed by one reviewer (SB) and verified by another reviewer from the same group (LG or MW or CB). A consensus meeting was held to resolve any disagreement between the reviewers. The quality of all eligible papers was summarized in a table format (Tables 1 and 2).

2.5. Data extraction

One reviewer (S.B.) extracted relevant data from all eligible papers ($n = 14$) onto a predefined form. The extracted data included study design, population, setting/recruitment, predictive/prognostic/influencing factors, outcome measure, follow up and results.

3. Results

After screening all papers and assessing their inclusion eligibility, a number of 14 articles were included in this review [24–37]. Of these, 11 articles were RCTs and 3 articles were prospective observational studies (Table 3).

3.1. Characteristics and quality of the included RCTs

The quality of the included studies, according to Downs and Black quality assessment tool, varied from moderate ($n = 5$) to good ($n = 6$). Main quality issues were: selection of study population, blinding, reliability of the results and power calculations of study samples. The investigated study populations were patients recruited from emergency department [24,25,27,28,33] and professional and recreational athletes [26,30–32,34,37]. Two articles were double blind [26,30], two articles were only assessor blind

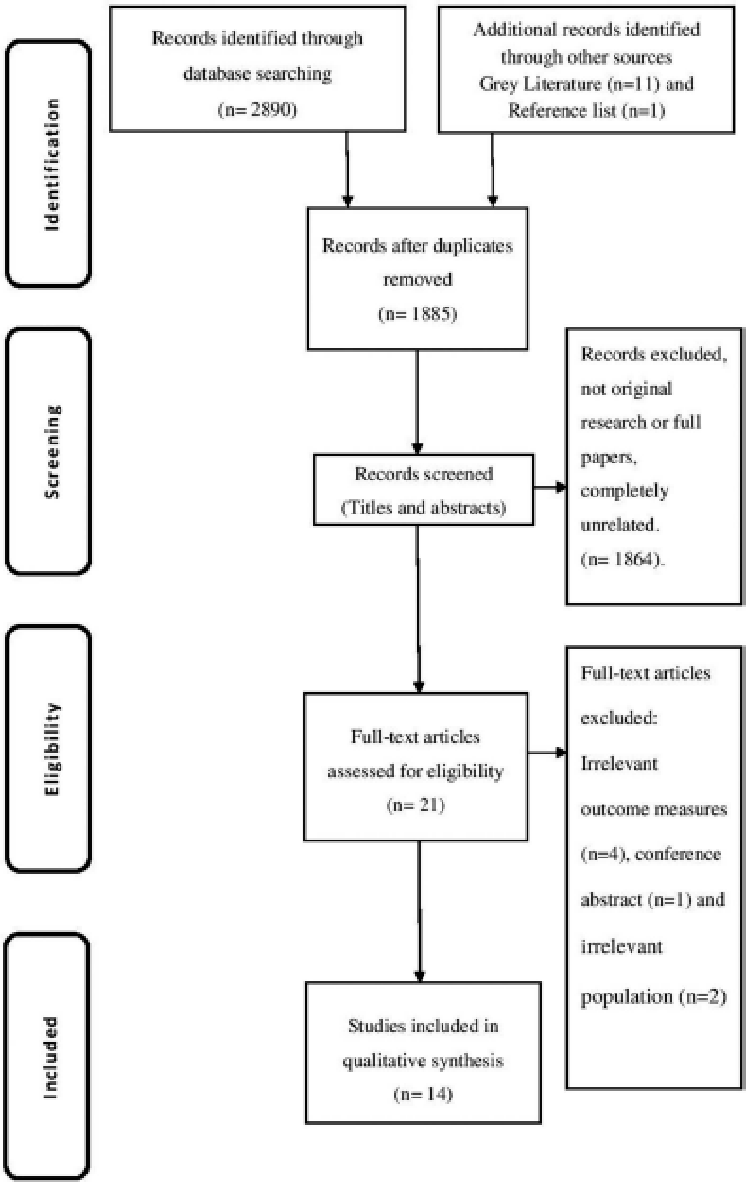


Figure 1. PRISMA flow diagram of selected studies.

[27,33] and four articles only patient blind [26,30–32]. The remaining articles did not perform any blinding [24,25,28,34,37]. Six studies provided information on calculation power for sample size [24,25,30–33]. Other studies did not provide any information about power calculation for the recruited sample [26–28,34,37]. All studies stated different definition and criteria for TTRTP which is the outcome of interest in this review.

3.2. Charactristics and quality of the included prospective observational studies

The quality scores for the included observational studies was 6–8/14 on CASP quality checklist. There is a high degree of heterogeneity between the included studies, in particular between the definition of outcome measure, which is TTRTP

Table 1. Downs and Black checklist scores of included randomised control trials.

	Downs and Black criteria	Ardevol et al [24]	Bendahou et al [25]	Duncan and Farr [26]	Green et al [27]	Karlsson et al [28]	Mendel et al [30]	Petrella et al [31]	Petrella et al [32]	Punt et al. [33]	Van der Linde and Oschman [37]	Wester et al [34]
1	Clear hypothesis/aim/objective	1	1	1	1	1	1	1	1	1	1	1
2	Outcomes described	1	1	1	1	1	1	1	1	1	1	1
3	Subjects described	1	1	1	1	1	1	1	1	1	0	1
4	Interventions described	1	1	1	1	1	1	1	1	1	1	1
5	Principal confounders in each group of subjects clearly described	2	2	2	1	2	1	1	1	2	0	0
6	Main findings clearly described	1	1	1	1	1	1	1	1	1	1	1
7	Measures of random variability	1	1	1	1	1	1	1	1	1	0	0
8	Important adverse effects reported	0	1	1	0	0	1	1	1	1	0	0
9	Characteristics of patients lost to follow-up been described	0	1	0	1	0	1	1	1	1	0	1
10	Reporting of probability values	1	1	1	0	0	1	1	1	1	1	0
11	Subjects asked to participate are representative of entire population	0	0	0	0	0	0	0	0	0	0	0
12	Included subjects are representative of entire population	0	0	0	0	0	0	0	0	0	0	0
13	Intervention was representative of that in use in the source population.	1	1	1	1	0	1	1	1	1	1	0
14	Subjects blinded to intervention	0	0	1	0	0	1	1	1	0	0	0
15	Assessors blinded to measurement	0	0	1	1	0	1	0	0	1	0	0
16	Planned analysis	1	1	1	1	1	1	1	1	1	1	1
17	Time period between the intervention and outcome the same for cases and controls	1	1	1	1	1	1	1	1	1	0	1
18	Appropriate statistics	1	1	1	1	1	1	1	1	1	1	1
19	Compliance with the intervention/s reliable?	0	1	1	1	0	0	1	1	0	0	0
20	Accuracy of outcome measures	1	1	1	1	1	0	1	1	1	1	1
21	All participants recruited from the same population	1	1	1	1	1	1	1	1	1	1	1
22	All participants recruited over the same period of time	1	1	1	1	1	1	1	1	1	0	0
23	Subjects randomised to intervention group	1	1	1	1	1	1	1	1	1	1	1
24	Concealed randomisation	0	0	1	0	0	0	1	1	0	0	1
25	Adequate adjustment for confounding in the analyses	0	1	1	1	0	1	1	1	0	0	0
26	Losses of patients to follow-up taken into account	0	1	0	1	1	1	1	1	1	0	0
27	Sufficient power calculations	0	1	0	0	0	1	1	1	1	0	0
Total score/28		17	23	23	20	16	22	24	24	22	11	13

2 (Yes), 1 (Yes or Partially in case 2 is available as an option), 0 (No)

Table 2. CASP checklist scores of the included observational studies.

	CASP criteria	McKeon et al [29]	Cross et al [36]	Wilson and Gansneder [35]
1	Clearly focused issue stated	1	1	1
2	Appropriate recruitment	0	n/c	0
3	Exposure accurately measured to minimise bias	1	1	1
4	Outcome accurately measured to minimise bias	1	1	1
5	Confounding factors identified	n/c	0	0
6	Confounding factors accounted	0	0	0
7	Subjects' follow up is complete	1	0	0
8	Subjects' follow-up is long enough	0	1	1
9	Clear results	1	0	1
10	Precise statistical results	0	1	1
11	Results are believable	0	0	0
12	Ability to generalise results to local population	1	0	0
13	Interpretation related to the existing evidence	1	1	1
14	Clear implications of this study for practice	1	0	n/c
	Quality score (QS)	8/14	6/14	7/14

1 yes, *0* no, *n/c* not clear

and follow up period. The main quality issues were use of poor statistical methods, lack of collinearly assessment, lack of linearity testing and low sample size. One study recruited athletes from high schools [29] whereas the other two studies recruited athletes who compete in the National Collegiate Athletic Association (NCAA) [35,36]. Study participants in all investigations were athletes who compete in different sports who had sustained primary ankle sprain. All studies had recruited athletes with approximate age range of 14–22 years. The sex ratio of participants was 2:1 men: women [29,35] and 1:2 men:women [36]. Two studies investigated both subjective prognostic factors (Self-reported Athletic Ability, global function, Short Form–36 Physical Function scale (SF36PF), visual analogue pain scale) and objective prognostic factors (measurement of joint swelling, range of motion and weight bearing activities, ankle muscles strength, ambulation status) [35,36]. The third study investigated history of injury comparing new versus recurrent ankle sprain as predictive factors [29].

3.3. Main findings

The included RCTs provided data for 897 patients with acute ankle sprain. The mean age across all of these studies ranged from 20 to 34 ± 11 years. The follow-up period ranged between 4 days and 23 months. The included RCTs showed a variety of treatment methods that resulted in a shorter time to RTP after acute ankle sprain (Tables 3 and 4).

3.4. RCTs

Treatment methods that resulted in a shorter time to RTP after acute ankle sprain included functional treatment [24,28], compression stockings [25], anteroposterior joint mobilization [27], periarticular injection with hyaluronic acid (HA) [31,32], diclofenac, 150 mg (75 mg twice daily) [26] and Jump Stretch Flex Band programme (JSFB) [37]. However, treating grade 1 ankle sprain with near-continuous live high-voltage pulsed current (HVPC), compared to placebo treatment resulted in longer TTRTP [30]. (Table 4).

3.5. Prospective observational studies

The prospective observational studies included in this review investigated the relationship between different prognostic factors and TTRTP. Findings showed that TTRTP was not influenced by either new or recurrent injuries [29]. However, measures of Global function, SF 36PF, athlete's ambulation status [36] with and weight-bearing activity scores and self-reported athletic ability [35] were strong predictors for TTRTP (Table 4).

3.6. Definition and criteria for RTP

All included studies used TTRTP as a main outcome measure for recovery after ankle sprain. However, they defined RTP differently in each individual studies (Table 5).

4. Discussion

The aim of this review was to determine if consensus exists about factors that may influence TTRTP after acute ankle sprain. To simplify the analysis and discussion, potential influencing factors that have been identified from the included articles were categorized into five domains: clinical assessment, functional assessment, treatment methods, medication and history of injury.

4.1. Clinical assessment

Clinical assessment refers to findings from subjective and objective examination such as intensity of pain, range of motion, muscle power etc. In this review, five clinical measures were identified: intensity of pain, oedema, range of motion, muscle power and severity of injury. However, only severity of injury, grade 1 treated with near-continuous live HVPC, was found to be a predictive factor for TTRTP after acute ankle sprain [30]. Interestingly, other clinical measures such as intensity of pain, oedema, range of motion and muscle power were not found to be predictive of TTRTP [35,36]. Others also found no strong association between ROM and vertical jump test and recovery time for participants with ankle syndesmosis and ankle sprain who did not recover by two weeks [40]. Pain and difference in muscle strength, compared to the other side, were found to be important criteria to decide safe RTP following hamstring strain [38,41,42]. Jacobsen, Witvrouw [42] found, combination of initial and follow up assessment of pain, muscle strength and playing the sport of football explain 97% of variance of TTRTP after hamstring injury. In ankle sprain, only a few clinical factors have been investigated. This review identified four clinical factors however, including other clinical factors in future studies might inform better practice by identifying influencing factors for RTP after ankle sprain. Inclusion of reliable clinical tests such as dorsiflexion lunge lest, star excursion balance test, Agility T-test and Sargent/vertical jump test in prospective studies is equally necessary [43]. In addition, well-designed future studies that endeavour to count for confounding factors may produce better results. In this review, Wilson and Gansneder conducted clinical assessment within three days of injury and that might have influenced the validity of their results [35]. In the first 3 days from injury, symptoms such as pain and swelling might have influenced the outcomes of the clinical assessments. Performing clinical assessments 3–5 days after injury produced better results with a sensitivity of 96% and specificity 84% [44,45].

4.2. Functional assessment

Functional assessment refers to measuring body functions, activities and participation in a particular context such as sport, commuting and activities of daily life [46]. This review identified four functional measures that have been used to indicate their effect on RTP after ankle sprain. Wilson and Gansneder [35] adopted a set of weight bearing activities that include 40-metre walk, 40-metre run, figure-8-run, single hop, cross-over hop and stairs hop. They also included self-reported athletic ability as measured by visual analogue scale (VAS). Whereas, others investigated global function and physical function (SF36F) [36]. All these measures were found to be predictive factors for TTRTP after ankle

Table 3. Summary of papers included in the review.

Study	Study design	Population/characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
Ardevol J, et al [24]	RCT	121 patients with grade 3 ankle sprain treated in emergency dept. Age under 35 years 93 men and 28 women	Treatment methods: 1.Immobilization 2. Functional treatment	1. Objective laxity 2. Subjective functional instability, swelling, pain and stiffness 3. Sporting level on return to physical activity. 4. Time before returning to sport	3,6 and 12 months	Functional group showed significantly earlier and better return to physical activity Functional treatment also showed better decrease in joint laxity. No intergroup differences were found in the re-injury rate.
Bendahou et al [25]	RCT	126 patients, 18 –55 years with recent (less than 48 h) ankle sprain seen in an emergency department. 66 men and 51 women	1.Compression stockings 2.Placebo Compression	1. Time to recovery of normal painless walking without requirement for analgesic drug. 2.Time to return to sport activity 3.Pain, analgesic consumption, and ankle oedema	90 days	No significant differences in pain, analgesic consumption, and bimalleloar and midfoot circumferences. Time to return to sport activity was significantly shorter in patients treated with compression stockings. Median time was 38(30–60) days in the compression-stocking group and 60 (35–81) days in the placebo group.
Cross et al [36]	Prospective observational	20 intercollegiate athletes from National Collegiate Athletic Association (NCAA) (7 men, 13 women; mean age = 19.2 ± 1.1 years	Visual analogue pain scale, global function question, Short Form-36 Physical Function scale (SF36PF), ankles active range of motion (AROM) and isometric strength	Number of days to return to sport (days)	Last participant returned to play on 40th day	Global function question, SF 36PF and athlete's ambulation status are strong predictors of TTRTP.
Duncan JJ and Farr JE [26]	RCT	139 patients with acute sprains and/or strains of the knee or ankle within the previous 36 h. Knee (n = 31), Ankle (n = 88) Mean age 25 years 85 men and 11 women	1.Diclofenac, 150 mg (75 mg twice daily) 2.Aspirin, 3.6 g (1.2 g three times daily)	1. Swelling and limitation of active range of motion and patient assessment of pain on active motion. 2.Days required to resume athletic activities	10 days	1. Insignificant difference between groups for swelling, limitation of range of motion and self-reported pain. 2.Diclofenac group resumed athletic activities in a mean of 4.7 days, compared with a mean of 5.9 days for patients in the aspirin group
Green et al [27]	RCT	41 subjects with acute ankle inversion sprains (undefined grade of injury) with less than 72 h from emergency dept. 26 men and 12 women Mean age experimental group (26.1 ± 2.0) and control (24.9 ± 1.6).	1.Anteroposterior mobilization (intervention) 2. A protocol of RICE (control).	1.Dorsi flexion and gait characteristics 2.Return to sport	14 days	1. Intervention group required fewer treatment sessions to achieve full pain-free dorsiflexion, had greater improvement in range of movement before and after each of the first 3 treatment sessions and had greater increases in stride speed during the first and third treatment sessions 2.Patients in intervention group, returned to sports (n = 13) after 12.2 days Patients in control group, returned to sports (n = 16) after 13.4 days.
Karlsson et al [28]	RCT	86 patients with acute (< 24 h) grade 2 or 3 lateral ligament ruptures 57 men and 29 women Mean age was 22 (16–38) years	1. Functional treatment using specially designed compression pads, elevation of the injured foot (24 h), repeated elastic wrapping (compression bandage followed by ankle tape), early full weight bearing and proprioceptive range-of-motion training. 2.Conventional treatment with an elastic bandage, partial weight bearing and crutches until the pain subsided	Return to sport Number of days	Mean follow-up period was 18 months.	1. Return to sports activities was significantly earlier in functional treatment group, 9.6 ± 4.8 days compared with 19.2 ± 9.5 days in conventional treatment group. 2. Mean sick leave was significantly shorter in functional treatment group; 5.6 ± 4.2 days compared with 10.2 ± 6.8 days in conventional treatment group.

(*Continued*)

Table 3. (Continued).

Study	Study design	Population/characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
Medina McKeon et al [29]	Observational	204 high school athletes with ankle sprain 140 men, 65 women	History of injury: New or recurrent injury	RTP intervals: same day return, next day return, 3-day return, 7-day return, 10-day return, 21-day return, '22-day return,	21 days	No significant difference ($p = 0.89$) between the time until RTP curves for new and recurrent ankle sprains
Mendel et al [30]	RCT	50 intercollegiate and professional athletes aged 17–33 years	1.Treatment ($n = 22$): Near-continuous live High-Voltage Pulsed Current (HVPC) 2.Control ($n = 28$): Placebo HVPC for 72 h post-injury in addition to routine acute and subacute care	Time lost to injury measured from time of injury until declared fit to play.		1. Overall, no different between treated and control groups. 2. Treated grade 1 sprains had longer TTRTP than control ($p = .049$). 3.No differences between groups for grade II sprains ($p = .079$)
Petrella et al [32]	RCT	158 competitive athletes with acute grade 1 or 2 lateral ankle sprain Mean age 26 ± 7 years hyaluronic acid (HA) and 24 ± 8 years for the placebo injection (PL) group	1.Periarticular injection with hyaluronic acid (HA) + standard of care RICE 2.Placebo injection (PL) + standard of care RICE treatment	1.Pain scale (VAS) (0–10 cm) on weight bearing and walking 20 m 2.Patient global assessment of ankle injury (5-point categorical scale) 3.Patient satisfaction with treatment (5-point categorical scale) 4.Time to return to pain-free and disability-free sport 5. Adverse events.	4, 8, 30 and 90 days	1. Significant reduction in VAS pain on weight bearing at day 8, 30 and 90 for HA compared with PL ($P < 0.05$). 2. Significant reduction in VAS pain on walking at day 8 for HA compared with PL ($P < 0.05$). 3. Significantly greater patient satisfaction for HA versus PL at days 4 ($P < 0.05$), 8 ($P < 0.001$), 30 ($P < 0.001$), and 90 (P, 0.05). 4. Patient global assessment of ankle injury was significantly better compared with baseline in the HA group at day 8, but this was not different between groups. 5. Time to pain-free and disability-free return to sport was 11 (± 8) versus 17 (± 8) days for HA and PL, respectively ($P < 0.05$).
Petrella et al [31]	RCT	Same as in Petrella et al 2007	Same as in Petrella et al 2007	Same as in Petrella et al 2007 Plus: 1.Recurrent ankle sprain 2.Total number of days missing from primary sport activity	4, 8, 30, 90 and 712	1. Significant reduction in VAS pain on both weight bearing and walking at all follow-up assessments for HA compared with PL ($P < 0.001$). 2. Time to pain-free and disability-free return to sport was 11 (± 8) versus 17 (± 8) days for HA and PL, respectively ($P < 0.05$). 3.At 24 months, in the PL versus HA group, there were 2 versus 0 lower limb fractures, 16 versus 7 s ankle sprains ($P < 0.05$), 3 versus 1 third ankle sprains, 4.Significantly greater number of days missing primary sport activity (41 versus 21; $P < 0.002$).
Punt et al [33]	RCT	Patients with mild (grade I) or moderate (grade II) lateral ankle sprain Aged from 18 to 64 years	1 Nintendo Wii Fit™ exercise therapy ($n = 30$) 2.Physical therapy group ($n = 30$) 3.Control group ($n = 30$), received no treatment	1. Foot and Ankle Ability Measure (FAAM) questionnaire. 2. VAS for pain at rest and while walking. 3.RTP 4.Patients' satisfaction 5. Subjective perception of the effectiveness of the allocated treatment.	6 weeks	1. No treatment effect difference between the groups at 6 weeks follow-up. 2. No difference in pain at baseline and at 6-week follow-up between the groups. 3.No difference in RTP between all groups 4.No differences between the groups for both variables – satisfaction and effectiveness

(Continued)

Table 3. (Continued).

Study	Study design	Population/characteristics of participants	Independent variables	Dependent variable/s	Follow-up	Results
Van der Linde and Shorter TTRTP with the JSFB	Oschman [37] programme	RCT	25 sport patients with acute lateral ankle sprain aged 18–40 years.	Jump Stretch Flex Band (JSFB) programme and conventional ankle rehabilitation programmes	1.The time from injury to return to sport 2.Means of swelling, thickness and appearance.	-
Wester et al [34]	RCT	61 active athletes more than 2 h a week with primary ankle sprains 19 women and 29 men with a mean age of 25 (+ 7.2)	1. Twelve week training program with wobble board 2.no training	1. Pain at rest, during walking, or during sports activities (yes/no). 2.Edema	1,6 and 12 weeks	1.No significant difference in oedema 2. No differences in the time which elapsed before patients were painless at walking, during running or at sports between the groups
Wilson et al [35]	Prospective multivariate design	21 intercollegiate athlete who compete in NCAA Division I sports 13 men and 8 women Mean age = 20.3 + 1.7 years	Joint swelling, ROM, and activity score by performing 6 weight-bearing activities and Self-reported Athletic Ability (VAS)	Disability duration (TTRTP).	–	Weight-bearing activity scores and self-reported athletic ability, were stronger predictors of TTRTP

Table 4. Summary of factors influencing TTRTP.

	Factors	Influencing/ predicting TTRTP
Clinical assessment	Intensity of pain [36]	No
	Oedema [35]	No
	Ankles active range of motion (AROM) [35,36]	No
	Isometric strength [36]	No
	Severity of injury, grade 1 treated with near-continuous live high-voltage pulsed current (HVPC) versus placebo HVPC for 72 h post-injury [30]	Yes, longer TTRTP
Functional assessment	Weight-bearing activities [35]	Yes, predictive
	Self-reported Athletic Ability (VAS) [35]	Yes, predictive
	Global function question [36]	Yes, predictive
	Physical function scale (SF36PF) [36]	Yes, predictive
Treatment methods	Functional treatment versus immobilization [24]	Yes, shorter TTRTP
	Compression stockings versus Placebo Compression [25]	Yes, shorter TTRTP
	Anteroposterior mobilization (intervention) versus a protocol of RICE (control) [27]	Yes, shorter TTRTP
	Functional treatment using specially designed compression pads, elevation of the injured foot (24 h), repeated elastic wrapping (compression bandage followed by ankle tape), early full weight-bearing and proprioceptive range-of-motion training versus conventional treatment with an elastic bandage, partial weight bearing and crutches until the pain subsided [28]	Yes, shorter TTRTP
	Nintendo Wii Fit™ exercise therapy (n = 30) versus physical therapy group (n = 30) versus control group (n = 30), received no treatment [33]	No
	Twelve week training program with wobble board versus no training [34]	No
	Near-continuous live High-Voltage Pulsed Current (HVPC) versus placebo HVPC for 72 h post-injury [30]	No
	Periarticular injection with hyaluronic acid (HA) + standard of care RICE versus placebo injection (PL) + standard of care (RICE) treatment [31,32]	Yes, shorter TTRTP
	Jump Stretch Flex Band (JSFB) programme versus conventional ankle rehabilitation programmes [37].	Yes, shorter TTRTP
	Time until start of treatment [30]	No
	Compliance (measured as a percentage of total treatment time) [30]	No
Medication	Diclofenac, 150 mg (75 mg twice daily) versus aspirin, 3.6 g (1.2 g three times daily) [26].	Yes, shorter TTRTP
	NSAID use [30]	No
History of injury:	New injury versus recurrent injury [29]	No

Table 5. Definition and criteria for RTP.

Study	Study design	Definition of ankle sprain	Definition of RTP after ankle sprain	Criteria for RTP
Ardevol J, et al [24]	RCT	First phase of a grade III tear of the ATFL or ATFL plus CFL (< 72 h)	Complete training session	No pain and/or swelling and/or stiffness
Bendahou et al [25]	RCT	Recent (< 48 h) ankle sprain	Return to normal painless sport activity	Not provided
Cross et al [36]	Prospective cohort study	Acute lateral ankle sprain (< 24 h)	return to full athletic participation without limitations	Successfully completed functional testing specific to their sports
Duncan JJ and Farr JE [26]	RCT	Acute sprains (< 36 h) with moderate or severe swelling, tenderness, and limitation of range of motion.	Full activity or playing fitness	Not provided
Green et al [27]	RCT	Acute ankle inversion sprains (< 72 h)	Return to sports	Not provided
Karlsson et al [28]	RCT	Grade 2 or 3 lateral ligament injury (< 24 h) with moderate to severe swelling and moderate to severe instability, both in the frontal and sagittal planes	Return to full sports activity, including jumping and running activities	Not provided
Medina McKeon et al [29]	Prospective cohort study	Injury to the lateral ligamentous or capsular tissue of the ankle.	Back to participation	Not provided
Mendel et al [30]	RCT	Grade 1 (mild) or 2 (moderate) lateral ankle sprain (< 25 h)	Fit to play	Not provided
Petrella et al [31]	RCT	Acute Grade 1 or 2 lateral ankle sprain (< 48 h)	Return to normal function/activity in sport	Pain-free and disability-free sport
Petrella et al [32]	RCT	Acute Grade 1 or 2 lateral ankle sprain (< 48 h)	Return to normal function/activity in sport	Pain-free and disability-free sport
Punt et al [33]	RCT	Mild (grade 1) or moderate (grade 2) lateral ankle sprain.	Being able to return to sport	Not provided
Van der Linde and Oschman [37]	RCT	Acute grade 1 and 2 first time lateral ankle ligament sprain	Return to competitive level of sport	Not provided
Wester et al [34]	RCT	Primary ankle sprains (stage 2)	Not provided	Painless during walking and during sports
Wilson et al [35]	Prospective cohort study	Grade 1 or 2 ankle inversion sprain	Return to full participation in practice or competition	Not provided

sprain. Functional assessments have been used as objective measurements to determine an athlete's ability to RTP [43]. Therefore, integrating functional measures when deciding safe RTP could be very important. For instance, the SF36 health survey questionnaire was found to be reliable and valid for use as a functional outcome measure for the general population in primary health care settings [47]. Using such easy patient self-administered outcome measures may help determine optimal recovery from injuries including ankle sprains. In addition, investigating those functional outcome measures in prospective studies as potential prognostic factors is recommended.

4.3. Treatment methods

Most articles included in this review examined the relationship between conservative treatment methods and RTP. They investigated a variety of conservative treatment methods such as functional treatment, immobilization, compression stockings, joint mobilization, Nintendo Wii Fit™ exercise therapy, wobble board, HVPC, JSFB and HA. No contradicting results were found in this review. Functional treatment was the only factor that has been investigated in more than one trial [24,28,37]. In those trials, it was found to shorten the duration for an athlete to return to sporting activities. Functional treatment was found to have superior results over other types of conservative treatments of ankle sprains [48–51]. It was concluded that treating ankle sprain with functional treatment rather than immobilization might lead to better results including shorter time to return to sporting and daily life activities [24,27,28,52]. In this review, shorter time to RTP was recorded in groups that have been provided with early mobilization and functional treatments [24,27,28,37]. These studies investigated patients with grades of ankle injury ranging from mild to severe. Two of them took account of testing joint instability to decide the severity of injury [24,28]. However, one study used ultrasound technique [37] and another study depended on palpating joint tenderness to diagnose the involvement of the different lateral ankle ligaments [27]. Testing the clinical joint instability is very important to characterize and eventually grade the severity of injury [2]. For instance, using a talar tilt test or stress radiographs may provide more information about the ligament laxity for laterally located ligaments and anterior draw test for anterior talofibular ligament, which in turn may support the findings of other clinical assessments. A clear criteria to differentiate the grades of injury of ankle sprain and their relationship with recovery is important in order to avoid unnecessary confusion. In addition, the amount of follow-up in Green, Refshauge [27] was 14 days, which might not be adequate to decide the recovery of ligament injury. Ideally, ligament healing takes at least 6 weeks to 3 months to occur and even longer to regain full strength and stability [53]. It might be difficult to determine the effect of specific treatment methods, at least in moderate to severe ligament injury, without considering adequate time for the injured ligament to repair.

Other treatment methods identified in this review were compression stockings [25] and HA [31,32]. TTRTP was significantly shorter in the group treated with compression stockings as compared with that treated with placebo compression. It is a common practice especially in the emergency department to provide patients with acute ankle sprain with compression stockings. However, there is lack of evidence to support their clinical application over other conservative treatment methods [54]. Previous studies that supported the use of compression stockings and elastic bandaging presented with poor quality of evidence, making it difficult to draw valid conclusions [55]. To our knowledge, only one study, which is included in this review, that investigated compression stocking on TTRTP after ankle sprain found it more effective than placebo compression [25]. It would be interesting to determine the effect of compression carried out with other common conservative treatments such as RICE, mobilization and exercises. Usual treatment program for ankle sprain consists of RICE and/or other treatment methods such as exercises and joint mobilization techniques [1].

Previous studies showed that Intraarticular injections with HA was effective in treating tennis elbow [56], non-radicular chronic lumbar pain [57] and after tendon surgery [58]. The current review included one study that compared the effectiveness of periarticular injection with hyaluronic acid with standard of care RICE and placebo injection with standard care [31,32]. Results showed significant improvement in all outcome measures including TTRTP. Despite the positive results, they should be interpreted with caution because they were drawn from a single study.

4.4. Medication

The use of non-steroidal anti-inflammatory drugs (NSAIDs) is widely used to reduce pain, swelling and improve function following different musculoskeletal conditions including ankle sprain [59]. Two studies were included in this review that investigated the effect of NSAIDs on TTRTP after ankle sprain injury [26,30]. Neither of which found a statistical association between the use of NSAIDs and TTRTP. Duncan and Farr found that although the group treated with diclofenac resumed sporting activity earlier than the other group the difference was not statistically significant [26]. The other study found no statistical difference between the two treatment groups in terms of the percentage of injury time when NSAIDs were taken [30]. Future investigations that address methodological issues identified in these two articles are warranted. Consideration of appropriate recruitment of participants and measurement of outcome measures in particular may produce better results.

4.5. History of injury

History of previous injury was considered a risk factor for many injuries including ankle injuries [60,61]. In basketball, ankle injury was found to be five times more in those players who had history of previous ankle injury [60]. This review included one study that prospectively investigated the effect of history of ankle sprain on RTP and found no significant difference between patients with new and recurrent ankle sprain [29]. Although that study collected data about sex, sport and referrals, they did not examine them for their influence on TTRTP. These potential confounders, sex, sport and referrals might have influenced the results. In addition to these factors, age, body mass index and health status can be also investigated for their relationship with RTP. These factors have been partly or collectively investigated for their relationship with RTP in other injuries such as anterior cruciate ligament [62,63] and hamstring strain [42,64].

4.6. Definition and criteria of RTP

In this review, all studies used TTRTP as an outcome measure to determine recovery threshold after ankle sprain. Most studies in this review did not provide a clear definition for RTP. For instance, it was defined as return to sports [27], Back to participation [29], fit to play [30] and being able to return to sport [33]. In addition, most studies in this review failed to provide a clear criteria for return to sport after ankle sprain [25–30,33,35]. Unclear definition and criteria for RTP has always created confusion and disagreement when assessing the readiness of an athlete to be allowed to resume sporting activity once again [20,39,43,65]. A consensus statement was made by an expert panel of a group of physicians in the US to address how an athlete should be returned to sporting activity after a specific injury [66]. They defined RTP as 'the decision for safe and timely return of an injured or ill athlete to practice or competition'. They provided a criteria for safe RTP that included the following:

- Restoration of sport-specific function to the injured part.
- Restoration of musculoskeletal, cardiopulmonary and psychological function, as well as overall health of the injured or ill athlete.
- Restoration of sport-specific skills
- Ability to perform safely with equipment modification, bracing, and orthoses.
- The status of recovery from acute or chronic illness and associated sequelae.
- Psychosocial readiness.
- The athlete poses no undue risk to themselves or the safety of other participants.
- Compliance with American federal, state, local and governing body regulations and legislation.

Unfortunately, most of those requirements were not considered in the articles that were included in this review. An athlete trainer or treating physiotherapist or patients themselves subjectively took most of decisions for RTP. Perhaps that is why most patients develop long-term complications such as chronic pain, swelling, restricted movements, chondral lesions, joint instability and re-sprains [15–18,20,67,68]. A narrative review provided evidence based guidelines for RTP for patients with ankle injuries including ankle sprains [43]. They concluded that testing balance and proprioception (The Star Excursion Balance Test), strength (Sargent/Vertical Jump Test), range of motion (The Dorsiflexion Lunge Test) and agility (Agility T-Test) along with psychological stress might assist in deciding the readiness to RTP. These recommendations were not implemented or tested in later trials. Future research should develop a clear and well-defined criteria for RTP after ankle sprain injury. In addition, RCTs should clearly describe the criteria that has been used to decide RTP in order to inform better practice.

5. Recommendations

The review systematically examined the available literature in order to inform the decision for RTP. There were many issues highlighted in this review such as the factors that influence RTP and the definition and criteria for RTP after ankle sprain. Many factors were identified, in this review, that decrease RTP such as intensity of pain, weight-bearing activities, self-reported athletic ability, global function question, physical function scale, functional treatment, compression stockings, anteroposterior mobilization, HA, JSFB and diclofenac medications. Those factors should be integrated and tested in future prospective studies. Testing the influence of these factors in presence of other demographic and clinical factors for example age, sex, BMI, sport type, training intensity, is also recommended to understand the whole picture of safe RTP. Future research should consider recruiting various age groups who practice different types of sports at different intensities in order to individualize RTP timelines for different sport populations. In addition, there should be a consensus about definition and criteria for RTP following conservatively treated ankle sprain. A unified and evidence based definition and criteria of RTP may help sport health teams, coaches, players and parents to take better decisions. Safe decisions for RTP may in turn improve current clinical practice and minimize unfavourable chronic complications. These recommendations are in line with findings from other narrative reviews that urged clinicians and researchers to develop clear definition and criteria for RTP after ankle sprain [39,43,65].

6. Strengths and potential limitations

To our knowledge, this is the first systematic review that has investigated the influencing factors for RTP after ankle sprain injury. We have critically appraised the quality of the included studies in order to produce robust evidence based results. A broad criteria for the data search was adopted by accessing different data sources such as online databases, grey literature, Google Scholar and reference list of the included studies. A multidisciplinary team that consisted of a physiotherapist, two podiatrists and a sport science researcher developed the search terms and strategy. In addition, two reviewers critically appraised each individual study to minimize risk of bias.

As any other review, some potential limitations need to be acknowledged. Although there was a broad search strategy, there might be a chance that some data was not accessed. One researcher (SB) conducted the search and identification of potential eligible studies. Introducing another person to verify the inclusion of studies at this stage was not possible due to limited resources. However, the search strategy was followed carefully in order to reduce any risk of selection bias.

Limitations in respect of the results of this review may include the heterogeneity of the included studies. Most studies in this review separately investigated influencing factors thus it was difficult to make a valid conclusion. Most studies failed to clearly define and list the criteria for RTP therefore it was not possible to accurately determine recovery threshold after treatment. Some studies in this review provided a very general statement about the definition and criteria for RTP, which was not adequate to make a conclusion about safe RTP after ankle sprain.

Methodological quality of future studies that investigate influencing factors of RTP following conservatively treated acute ankle sprain need to be improved. Lack of blinding might lead to selection bias and therefore lead to incorrect estimation of study results. Sample size seemed to be a major issue especially in the included observational studies and that may have affected their findings. Future studies with appropriate power calculation or estimate of sample size will reduce risk of bias and will eventually increase the validity of results. There were also confounders that have not been investigated and might have affected the results such as age, sex, BMI, history of injury and past sport activity. These factors might be important to consider in future observational studies in order to appropriately determine recovery threshold following acute ankle sprain.

7. Conclusion

Ankle sprain is a common injury among sport and non-sport populations, yet this review has found that no consensus exists on when to RTP. Whilst, caution should be taken when generalizing these results due to the heterogeneity of studies and inability to clearly define and list the criteria for safe RTP, it remains important that investigators and clinicians follow an agreed, validated definition and criteria for RTP for patients with ankle sprain injury to support patterns of care. Additionally, the majority of investigations in this review did not include information such as age, sex, BMI, level of sport or injury related factors. Inclusion of these in future work might help to understand the course of injury and therefore assist in constructing safer RTP criteria. Following clear and evidence-based RTP criteria may also help in reducing onset of chronic complication such as pain, restricted joint motion, instability and osteoarthritis thus promote better clinical practice.

Funding

This manuscript was not funded.

Declaration of interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties. Peer reviewers on this manuscript have no relevant financial relationships to disclose.

References

1. Kerkhoffs GM, van den Bekerom M, Elders LA, et al. Diagnosis, treatment and prevention of ankle sprains: an evidence-based clinical guideline. Br J Sports Med. 2012;46:854–860.
2. Ferran NA, Maffulli N. Epidemiology of sprains of the lateral ankle ligament complex. Foot Ankle Clinics North America. 2006;11:659–662.
3. Chorley JN, Hergenroeder AC. Management of ankle sprains. Pediatr Ann. 1997;26:56–64.
4. Lynch S, Renstrom P. Treatment of acute lateral ankle ligament rupture in the athlete: conservative versus surgical treatment. Sports Med. 1999;27:61–71.
5. Waterman BR, Owens BD, Davey S, et al. The epidemiology of ankle sprains in the United States. J Of Bone And Jt Surg Am Volume. 2010;92:2279–2284.
6. Shah S, Thomas AC, Noone JM, et al. Incidence and cost of ankle sprains in United States emergency departments. Sports Health. 2016;8:547–552.
7. Al Bimani S, Gates L, Warner M, et al. A retrospective study to identify prevalence and common causes of acute ankle sprain within the emergency department setting. Unpublished manuscript. 2017.
8. Bridgman SA, Clement D, Downing A, et al. Population based epidemiology of ankle sprains attending accident and emergency units in the West Midlands of England, and a survey of UK practice for severe ankle sprains. Emerg Med Journal: EMJ. 2003;20:508–510.
9. Praemer A, Furner S, Rice D. Musculoskeletal conditions in the United States. Rosemont (IL): American Academy of Orthopaedic Surgeons; 1999.
10. Fernandez WG, Yard EE, Comstock RD. Epidemiology of lower extremity injuries among U.S. high school athletes. Acad Emerg Med. 2007;14:641–645.
11. Hupperets MD, Verhagen EA, Heymans MW, et al. Potential savings of a program to prevent ankle sprain recurrence: economic evaluation of a randomized controlled trial. Am J Sports Med. 2010;38:2194.
12. Verhagen EAL, van Tulder M, van der Beek AJ, et al. An economic evaluation of a proprioceptive balance board training programme for the prevention of ankle sprains in volleyball. Br J Sports Med. 2005;39:111–115.
13. Aiken AB, Pelland L, Brison R, et al. Short-term natural recovery of ankle sprains following discharge from, emergency departments. J Orthop Sports Phys Ther. 2008;38:566.
14. Golditz T, Steib S, Pfeifer K, et al. Functional ankle instability as a risk factor for osteoarthritis: using T2-mapping to analyze early cartilage degeneration in the ankle joint of young athletes. Osteoarthritis And Cartilage/OARS, Osteoarthritis Research Society. 2014;22:1377–1385.
15. Hertel J. Functional instability following lateral ankle sprain. Sports Medicine (Auckland, NZ). 2000;29:361–371.
16. Takao M, Ochi M, Uchio Y, et al. Osteochondral lesions of the talar dome associated with trauma. Arthroscopy: J Of Arthroscopic Relat Surgery: Off Publ Of Arthrosc Assoc Of America And Int Arthrosc Assoc. 2003;19:1061–1067.
17. Gerber JP, Williams GN, Scoville CR, et al. Persistent disability associated with ankle sprains: a prospective examination of an athletic population. Foot Ankle Int. 1998;19:653–660.
18. Malliaropoulos N, Ntessalen M, Papacostas E, et al. Reinjury after acute lateral ankle sprains in elite track and field athletes. Am J Sports Med. 2009;37:1755–1761.
19. van Rijn RM. Review: many adults still have pain and subjective instability at 1 year after acute lateral ankle sprain. Evid Based Med. 2008a;13:187.
20. van Rijn RM, van Os AG, Bernsen RMD, et al. What is the clinical course of acute ankle sprains? A systematic literature review. Am J Med. 2008b;121:324–331.
21. Moher D, Liberati A, Tetzlaff J, et al., PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. J Clin Epidemiol. 2009;62:1006–1012.
22. Sara HD, Nick B. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Community Health. 1979;1998:377.
23. CASP Checklist. 2013. [cited May 2016]. Available from: http://www.casp-uk.net/

24. Ardevol J, Bolibar I, Belda V, et al. Treatment of complete rupture of the lateral ligaments of the ankle: a randomized clinical trial comparing cast immobilization with functional treatment. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of the ESSKA. 2002;10:371–377.
25. Bendahou M, Khiami F, Saidi K, et al. Compression stockings in ankle sprain: a multicenter randomized study. Am J Emerg Med. 2014;32:1005–1010.
26. Duncan JJ, Farr JE. Comparison of diclofenac sodium and aspirin in the treatment of acute sports injuries. Am J Sports Med. 1988;16:656–659.
27. Green T, Refshauge K, Crosbie J, et al. A randomized controlled trial of a passive accessory joint mobilization on acute ankle inversion sprains. Phys Ther. 2001;81:984–994.
28. Karlsson J, Eriksson BI, Sward L. Early functional treatment for acute ligament injuries of the ankle joint. Scand J Med Sci Sports. 1996;6:341–345.
29. McKeon JMM, Bush HM, Reed A, et al. Return-to-play probabilities following new versus recurrent ankle sprains in high school athletes. J Sci Med Sport. 2014;17:23–28.
30. Mendel FC, Dolan MG, Fish DR, et al. Effect of high-voltage pulsed current on recovery after grades I and II lateral ankle sprains. J Sport Rehabil. 2010;19:399–410.
31. Petrella MJ, Cogliano A, Petrella RJ. Original research: long-term efficacy and safety of periarticular hyaluronic acid in acute ankle sprain. Phys Sportsmed. 2009;37:64–70.
32. Petrella RJ, Petrella MJ, Cogliano A. Periarticular hyaluronic acid in acute ankle sprain. Clin J Sport Med. 2007;17:251–257.
33. Punt IM, Ziltener JL, Monnin D, et al. Wii Fit exercise therapy for the rehabilitation of ankle sprains: its effect compared with physical therapy or no functional exercises at all. Scand J Med Sci Sports. 2016;26:816–823.
34. Wester JU, Jespersen SM, Nielsen KD, et al. Wobble board training after partial sprains of the lateral ligaments of the ankle: a prospective randomized study. J Orthop Sports Phys Ther. 1996;23:332–336.
35. Wilson RW, Gansneder BM. Measures of functional limitation as predictors of disablement in athletes with acute ankle sprains. J Orthop Sports Phys Ther. 2000;30:528–535.
36. Cross KM, Worrell TW, Leslie JE, et al. The relationship between self-reported and clinical measures and the number of days to return to sport following acute lateral ankle sprains. J Orthop Sports Phys Ther. 2002;32:16–23.
37. Van der Linde E, Oschman Z. Comparative ultrasound study of acute lateral ankle ligament injuries rehabilitated with conventional and jump stretch flex band programmes. African Journal Physical, Health Education, Recreation Dance. 2011;17:591–602.
38. De Vos RJ, Reurink G, Goudswaard GJ, et al. Clinical findings just after return to play predict hamstring re-injury, but baseline MRI findings do not. Br J Sports Med. 2014;48:1377–1384.
39. Richie DH, Izadi FE. Return to play after an ankle sprain guidelines for the podiatric physician. Clin Podiatr Med Surg. 2015;32:195–+.
40. Sman AD, Hiller CE, Rae K, et al. Prognosis of ankle syndesmosis injury. Med Sci Sports Exerc. 2014;46:671–677.
41. Askling JN CM, Thorstensson A. A new hamstring test to complement the common clinical examination before return to sport after injury. Knee Surgery, Sports Traumatol, Arthroscopy. 2010;18:1798.
42. Jacobsen P, Witvrouw E, Muxart P, et al. A combination of initial and follow-up physiotherapist examination predicts physician-determined time to return to play after hamstring injury, with no added value of MRI. Br J Sports Med. 2016;50:1–10.
43. Clanton TO, Matheny LM, Jarvis HC, et al. Return to play in athletes following ankle injuries. Sports Health. 2012;4:471–474.
44. Aradi AJ, Wong J. Physical examination is sufficient for the diagnosis of sprained ankles. J Of Bone And Jt Surg Br Volume. 1997;79:1039–1040.
45. van Dijk CN, Mol BW, Lim LS, et al. Diagnosis of ligament rupture of the ankle joint. Physical examination, arthrography, stress radiography and sonography compared in 160 patients after inversion trauma. Acta Orthop Scand. 1996;67:566–570.
46. Towards a common language for functioning, disability and health ICF. WHO/EIP/GPE/CAS/01.3; 2002.
47. Brazier JE, Harper R, B Jones NM, et al. Validating the SF-36 health survey questionnaire: new outcome measure for primary care. Br Med J. 1992;305:160–164.
48. Lardenoye S, Theunissen E, Cleffken B, et al. The effect of taping versus semi-rigid bracing on patient outcome and satisfaction in ankle sprains: a prospective, randomized controlled trial. BMC Musculoskelet Disord. 2012;13:81.
49. Naeem M, Rahimnajjad MK, Rahimnajjad NA, et al. Assessment of functional treatment versus plaster of Paris in the treatment of grade 1 and 2 lateral ankle sprains. Journal Of Orthopaedics And Traumatology: Official Journal Of Italian Society Of Orthopaedics And Traumatology. 2015;16:41–46.
50. Prado MP, Mendes AAM, Amodio DT, et al. A comparative, prospective, and randomized study of two conservative treatment protocols for first-episode lateral ankle ligament injuries. Foot Ankle Int. 2014;35:201–206.
51. Lamb SE, Marsh JL, Hutton JL, et al. Mechanical supports for acute, severe ankle sprain: a pragmatic, multicentre, randomised controlled trial. Lancet. 2009;373:575–581.
52. Freeman M. Treatment of ruptures of the lateral ligament of the ankle. J Bone Joint Surgery (Am). 1965;47:661–668.
53. Hubbard TJ, Hicks-Little CA. Ankle ligament healing after an acute ankle sprain: an evidence-based approach. Journal Athletic Training (National Athletic Trainers' Association). 2008;43:523–529.
54. Pollard A, Cronin G. Compression bandaging for soft tissue injury of the ankle: a literature review. Emerg Nurse. 2005;13:20–25.
55. Hansrani V, Khanbhai M, Bhandari S, et al. The role of compression in the management of soft tissue ankle injuries: a systematic review. Eur J Orthop Surg Traumatol. 2015;25:987–995.
56. Petrella RJ, Cogliano A, Decaria J, et al. Management of Tennis Elbow with sodium hyaluronate periarticular injections. BMC Sports Sci Med Rehabil. 2010;2:4.
57. Fuchs S, Erbe T, Fischer H, et al. Intraarticular hyaluronic acid versus glucocorticoid injections for nonradicular pain in the lumbar spine. J Vasc Interv Radiol. 2005;16:1493–1498.
58. Abate M, Schiavone C, Salini V. The use of hyaluronic acid after tendon surgery and in tendinopathies. BioMed Res Int 2014. 2014.
59. van den Bekerom MPJ, Sjer A, Somford MP, et al. Non-steroidal anti-inflammatory drugs (NSAIDs) for treating acute ankle sprains in adults: benefits outweigh adverse events. Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal Of The ESSKA. 2015;23:2390–2399.
60. McKay GD, Goldie PA, Payne WR, et al. Ankle injuries in basketball: injury rate and risk factors. Br J Sports Med. 2001;35:103–108.
61. Swenson DM, Yard EE, Fields SK, et al. Patterns of recurrent injuries among US high school athletes, 2005-2008. Am J Sports Med. 2009;37:1586–1593.
62. Brophy RH, Schmitz L, Wright RW, et al. Return to play and future ACL injury risk after ACL reconstruction in soccer athletes from the Multicenter Orthopaedic Outcomes Network (MOON) group. Am J Sports Med. 2012;40:2517.
63. Muaidi QI, Nicholson LL, Refshauge KM, et al. Prognosis of conservatively managed anterior cruciate ligament injury: a systematic review. Sports Medicine (Auckland, NZ). 2007;37:703–716.
64. Moen MH, Reurink G, Weir A, et al. Predicting return to play after hamstring injuries. Br J Sports Med. 2014;48:1358–1363.
65. Anderson SJ. Acute ankle sprains: keys to diagnosis and return to play. Phys Sportsmed. 2002;30:29–35.
66. Herring SA, Bergfeld JA, Boyd J, et al. The team physician and return-to-play issues: A consensus statement. Med Sci Sports Exerc. 2002;34:1212–1214.
67. Petersen W, Rembitzki IV, Koppenburg AG, et al. Treatment of acute ankle ligament injuries: a systematic review. Arch Orthop Trauma Surg. 2013;133:1129–1141.
68. van Middelkoop M, van Rijn RM, Verhaar JAN, et al. Re-sprains during the first 3 months after initial ankle sprain are related to incomplete recovery: an observational study. J Physiother. 2012;58:181–188.

Appendix. Main terms and search strategy

1. AMED – The Allied and Complementary Medicine Database

#	Search Terms	
S1	TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR TI inversion	4,007
S2	*AB* Ankle OR *AB* (lateral N2 ligament) OR *AB* (ankle N1 joint*) or *AB* (inversion)	6,107
S3	S1 OR S2	7,588
S4	TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear* TI (ankle N1 (injur* or sprain*))	13,058
S5	*AB* Sprain* OR *AB* Strain* OR *AB* Rupture* OR *AB* injur* OR *AB* tear OR *AB* (ankle N1 (injur* or sprain*))	18,325
S6	S4 OR S5	23,745
S7	S3 AND S6	1,939
S8	TI (return* N3 (sport* OR activ* OR train* OR play* OR compet* OR participat*)) OR TI (disab* N3 duration*)	190
S9	*AB* (return* N3 (sport* OR activ* OR train* OR play* OR compet* OR participat*)) OR *AB* (disab* N3 duration*)	981
S10	TX (return* N3 (sport* OR play OR activit* OR train* OR compet* OR participat*))	944
S11	S8 OR S9 OR S10	1,061
S12	S7 AND S11	93
	Total articles: 93	

2. CINAHL Plus with Full Text

#	Search Terms	
S1	(MH 'Ankle') OR (MH 'Lateral Ligament, Ankle') OR (MH 'Ankle Joint') OR TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR *AB* Ankle OR *AB* (lateral N2 ligament) OR *AB* (ankle N1 joint*)	21,885
S2	(MH 'Rupture') OR (MH 'Sprains and Strains') OR TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear* OR *AB* Sprain* OR *AB* Strain* OR *AB* Rupture* OR *AB* injur* OR *AB* tear*	202,361
S3	S1 AND S2	5,667
S4	(MH 'Ankle Sprain') OR (MH 'Ankle injuries') OR (TI 'Ankle Sprain') OR (*AB* 'Ankle Sprain') OR (TI 'Ankle Injur*') OR (*AB* 'Ankle Injur*')	4301
S5	S3 OR S4	7,433
S6	TI (return* N3 (sport* OR activ* OR train* OR play* OR compet* OR participat*)	923
S7	*AB* (return* N3 (sport* OR play* OR activ* OR train* OR compet* OR participat*)	4,732
S8	((MH 'Recovery') OR (MH "Recovery, Exercise) OR (MH 'sports Re-Entry'))	24,106
S9	TI ((disab* N3 duration*)	29
S10	*AB* (disab* N3 duration*)	347
S11	TX (return* N3 (sport* OR play* OR activit* OR train* OR compet* OR participat*))	11,410
S12	S6 OR S7 OR S8 OR S9 OR S10 OR S11	35,417
S13	S5 AND S12	563
	Narrow by: English AND Academic Journals	458
	Total articles: 458	

3. EMBASE

#	Search Terms	
S1	ankle/or ankle lateral ligament/or ankle.ti,ab. OR (ankle adj joint$).ti,ab. OR (ankle adj lateral adj ligament).ti,ab.	71,815
S2	Sprain/OR ligament rupture/OR rupture/OR (Sprain$ OR Strain$ OR Rupture$ OR injur$ OR tear$).ti,ab. OR (inversion adj sprain$).ti,ab.	1,758,955
S3	S1 AND S2	14,749
S4	Ankle Injury/OR Ankle Sprain/OR (Ankle adj sprain$).ti,ab. OR (Ankle adjInjur$).ti,ab.	9843
S5	S3 OR S4	18,889
S6	(return$ adj3 (sport$ ORactivit$ OR train$ OR play$ ORcompet$ OR participat$)).ti,ab. OR exercise recovery/OR return to sport/OR (disab* N3 duration*).ti,ab.	16,556
S7	S4 AND S5	560
	Total articles: 560	

4. MEDLINE (EBSCO)

#	Search Terms	
S1	(MH 'Ankle') OR (MH 'Lateral Ligament, Ankle') OR (MH 'Ankle Joint') OR TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR *AB* Ankle OR *AB* (lateral N2 ligament) OR *AB* (ankle N1 joint*)	56,074
S2	(MH 'Rupture') OR (MH 'Sprains and Strains') OR TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear* OR *AB* Sprain* OR *AB* Strain* OR *AB* Rupture* OR *AB* injur* OR *AB* tear*	1,457,448
S3	S1 AND S2	12,514
S4	(MH 'Ankle injuries') or (TI 'Ankle Sprain*') or *AB* (Ankle N3 (Sprain* or Injur* or Injur* or tear or rupture* or inversion)) or ((TI "Ankle N3 (Sprain* or Injur* or tear or rupture* or inversion)) or (inversion N1 sprain*) OR *AB* (inversion N1 sprain*)	11,190
S5	S3 OR S4	17,335
S6	(TI return) N ((TI sport* or TI activ* or TI train* or TI play* or TI compet*) OR (*AB* sport* or *AB* activit* or *AB* train* or *AB* play* or *AB* compet*)) OR TI ((disab* N3 duration*) OR *AB* (disab* N3 duration*)	1,613
S7	(MH 'Recovery of function')	43,385
	TX ('return* to sport*') OR (return* N3 activit*)	10,963
S8	S6 OR S7	44,932
S11	S5 AND S10	701
	Narrow by: English AND Academic Journals	664
	Total articles: 664	

5. PsycINFO

#	Search Terms	
S1	DE 'Ankle' OR TI Ankle OR TI (lateral N2 ligament) OR TI (ankle N1 joint*) OR *AB* Ankle OR *AB* (lateral N2 ligament) OR *AB* (ankle N1 joint*)	2,313
S2	TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear* OR *AB* Sprain* OR *AB* Strain* OR *AB* Rupture* OR *AB* injur* OR *AB* tear*	107,907
S3	S1 AND S2	333
S4	(DE 'Recovery (Disorders)')	11,389
S5	(TI return*) N3 ((TI sport* OR TI activ* OR TI train* OR TI play* OR TI compet* OR participate*) OR TI ((disab* N3 duration*)	161
S6	(*AB* sport* OR *AB* activ* OR *AB* train* OR *AB* play* OR *AB* compet* OR participate*)) OR *AB* (disab* N3 duration*)	1,158,482
S7	TX (return* N3 (sport* OR play* OR activit* OR train* OR compet* OR participat*))	1,725
S8	S4 OR S5 OR S6 OR S7	1,167,025
S9	S3 AND S8	210
	Narrow by: English AND Academic Journals	146
	Total articles: 146	

6. Scopus

#	Search Terms	
S1	TITLE-ABS-KEY (ankle*) or (lateral W/2 ligament) OR (ankle W/1 joint*)	99,016
S2	TITLE-ABS-KEY (sprain*) OR (strain*) OR (rupture*) OR (injur*) OR (tear*)	6,751,390
S3	S1 AND S2	45,503
S4	TITLE-ABS-KEY (ankle W/1 (injur* or sprain*))	13,663
S5	S3 OR S4	14,503
S6	TITLE-ABS-KEY (('return to sport*') OR ((return) W/3 (sport* OR activ* OR train* OR play* OR compet*)))	15,730
S7	S5 AND S6	837
S8	Narrow by: English AND Academic Journals	573
	Total articles: 574	

7. Sports discus via EBSCOHost

#	Search Terms	
S1	SU Ankle ORTI Ankle OR ((TI lateral) N3 (TI ligament)) OR TI (inversion) OR *AB* Ankle OR ((*AB* lateral) N3 (*AB* ligament)) OR *AB* (inversion) OR SU Ankle Lateral Ligament	17,920
S2	(TI Sprain* OR TI Strain* OR TI Rupture* OR TI injur* OR TI tear*) OR (*AB* Sprain* OR *AB* Strain* OR *AB* Rupture* OR *AB* injur* OR *AB* tear) OR SU sprains OR SU Strain	104,193
S3	S1 AND S2	6,983
S4	TI (ankle N3 (injur* or sprain*)) OR *AB* (ankle N3 (injur* or sprain*))	3,726
S5	S3 OR S4	7,051
S6	(TI return*) N3 ((TI sport* OR TI activ* OR TI train* OR TI play* OR TI compet*) OR (*AB* sport* OR *AB* activit* OR *AB* train* OR *AB* play* OR *AB* compet*)) OR TI recovery OR *AB* recovery OR TI 'return to sport' OR *AB* 'return to sport' OR TI (disab* N3 duration*) OR *AB* (disab* N3 duration*)	24,748
S7	TX (return* N3 (sport* OR play OR activit* OR train* OR compet* OR participat*))	5,225
S6	S6 OR S7	28,266
S7	S5 AND S6	519
	Narrow by: English AND Academic Journals	387
	Total articles: 387	

8. Physiotherapy Evidence Database (http://www.pedro.org.au/)

#	Search Terms
S1	ankle* sprain* 'return to play*' simple search in titles and abstracts
	Total articles: 2

9. The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials (CENTRAL)

#	Search Terms
S1	'Sprain* AND ankle* AND ('return to play*' OR 'return to activit*') in Title, Abstract, Keywords in Trials
	Total articles: 6

10. Grey literature was also searched using openGREY

#	Search Terms
S1	'ankle sprain*'
	Total articles: 11

Field codes	Description
*	At the end of a term indicates that this term has been truncated (i.e. multiple endings)
ti,*ab*	Indicates a search for a term in title/abstract
/	MeSH heading
adj, N, NEAR	Words have to appear next to each other.
DE	Descriptors
TX	Search in text
SU	Subject (specific terms)
exp	Explode the subject heading, to retrieve more specific terms D

Appendix 27 Published study two

International Emergency Nursing xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

International Emergency Nursing

journal homepage: www.elsevier.com/locate/aaen

Characteristics of patients with ankle sprain presenting to an emergency department in the south of England (UK): A seven-month review

Saed A. Al Bimani[a,*], Lucy S. Gates[a], Martin Warner[a], Sean Ewings[b], Robert Crouch[c], Catherine Bowen[a]

[a] Faculty of Health Sciences, University of Southampton, Southampton, UK
[b] Statistical Sciences Research Institute, University of Southampton, Southampton, UK
[c] Emergency Department, Southampton General Hospital, Southampton, UK

ARTICLE INFO

Keywords:
Epidemiology
Ankle sprain
Prevalence
Cause of injury
Sport type
Injury prevention
Emergency department

ABSTRACT

Introduction: There is lack of evidence about ankle sprain patients presenting to emergency department (ED) in the UK. The study aim was to determine prevalence, demographic and clinical characteristics of patients attending to one ED. Knowing those characteristics may help setting prevention strategies and inform effective clinical practice.

Methods: A retrospective review of records from patients' database system was conducted between May and November 2015 (inclusive).

Results: 909 new patients with ankle sprain were recorded during the study period. Patients had a median age of 27 years (IQR 20). Men aged between 14 and 37 years had higher percentage of injuries compared to women of a similar age. Overall prevalence of injury was equally distributed between men and women. Most patients were sent to radiography department for ankle/foot X-ray (89%). Over half of patients (58%) were sent home with no follow-up treatment. A subsample (n = 106) from the original sample (n = 909) showed a variety of causes of injury such as tripping (29%), non-specific injury (26.4%), sports (26%), walking (12.2%) and other accidental causes (6%). Football was the most prevalent sport (13%).

Conclusions: Prevention strategies, appropriate assessment tools and tailored rehabilitation programs are warranted to reduce number of patients and potential chronic symptoms.

1. Introduction

Acute ankle sprain is an injury affecting the capsular ligament complex of the ankle joint within 72 h of occurrence [1]. A systematic review and meta-analysis of prospective epidemiological studies found ankle sprain a very common injury among sport and general populations with a pooled cumulative incidence rate of 11.55 per 1000 exposures [2]. They also calculated a higher incidence of ankle sprain in women compared with men (13.6 vs 6.94 per 1000 exposures), in children compared with adolescents (2.85 vs 1.94 per 1000 exposures), adolescents compared with adults (1.94 vs 0.72 per 1000 exposures) and indoor/court sports (7 per 1000 exposures). However, the impact and burden of this injury on the emergency department and emergency care is not thoroughly addressed.

In the US, epidemiological studies that investigated prevalence of ankle sprain in ED calculated a national incidence rate of 2.15 per 1000 person-years [3] and 3.29 per 1000 person-years [4]. A population based, of 1.1 million people, epidemiological study estimated the incidence rate in emergency departments to be 52.7 per 10,000 in four emergency departments in West Midlands of England, UK [3–5]. The main difference in methods of those epidemiological studies is that the UK study was conducted on 4 local EDs whereas the US studies were national reports.

The two national statistical reports from emergency departments across England do not provide specific information about ankle sprain injury admissions [6,7]. As such, it is difficult to appropriately determine the epidemiology of this injury and estimate related health care expenditures. Providing information about patients' demographic and clinical characteristics might be helpful for future research that is concerned with planning of prevention and intervention strategies. In addition, high incidence of ankle sprains demands thorough understanding of patients' characteristics and injury/activity related factors that might affect the recovery following conservative management. In order to prevent further injury, it is very important to identify factors

* Corresponding author at: Faculty of Health Sciences, University of Southampton, University Road, Southampton SO17 1BJ, UK.
E-mail address: sab1g14@soton.ac.uk (S.A. Al Bimani).

https://doi.org/10.1016/j.ienj.2018.05.008
Received 24 November 2017; Received in revised form 30 April 2018; Accepted 31 May 2018
1755-599X/ © 2018 Published by Elsevier Ltd.

Please cite this article as: Al Bimani, S., International Emergency Nursing (2018), https://doi.org/10.1016/j.ienj.2018.05.008

that are associated with that injury [8].

The increased prevalence of ankle sprain exerts a large burden on the national economy; an estimated €187.2 million per year spent on the management of sport-related ankle sprains in the Netherlands [9]. Some of these costs cover patients' assessment procedures including ankle and foot X-rays. A multicentre trial in the US estimated a mean of 70.20 US dollars (SD 52.1) in medical charges for patients who had their ankle and foot x-rays taken in the emergency department. In the UK, it was hypothesized that annual costs for providing external supports for severe ankle sprain is £3 million for boots, £1.5 million for braces and £0.1 million for tubigrip [5]. In the UK, there is a lack of evidence on the demographic and clinical characteristics of patients with ankle sprains, which once determined may inform the economic impact of this injury.

Therefore, the aim of this study was to determine prevalence, demographic and clinical characteristics of patients attending to a UK emergency department. In addition, it aimed to characterize those patients by their common causes of injury and sport type.

2. Methods

2.1. Design

A retrospective review of patients' records from the electronic patient database was conducted between May and November 2015. This method is commonly used for large samples of patients in the emergency department [10]. The study was approved by The University of Southampton (ref: 18515) as well as from Health Research Authority (HRA) (ref: 202053) and it complied with STROBE guidelines [11].

2.2. Setting

The study was conducted in an emergency department in a large industrial and coastal city in the South of England. This department provides assessment and treatment for patients with serious injuries. It manages in excess of 100,000 patients a year, serving a population of approximately 1.9 million in which 42% of them aged 20–44 years [12]. The department consists of a number of discrete areas: Majors (where patients who have presented with significant illness or injury are assessed), a resuscitation room, a Minor injury/illness receiving area, two clinical decision units and a paediatric emergency department within the overall unit.

2.3. Sample

The sample consisted of the medical records of patients that attended the emergency department with acute ankle sprain. Both men and women aged 14 and above were included in the review as the incidence of ankle sprain increases remarkably between the ages of 14 and 19 years [3–5]. Patients with injuries/diseases other than acute ankle sprain were immediately excluded.

2.4. Data collection

Patient records were obtained from the electronic patient database. Patient records were identified by combining the diagnostic codes: "lower limb-ankle" and "sprain" in the electronic database (Phase 1). At this stage, all eligible records that met the inclusion criteria were identified within the electronic database (Fig. 1). Then, relevant information of study variables were only selected: age, sex, attendance outcome, arrival date and time and radiography referrals. Then anonymity coding for each record was assigned to maintain confidentiality and privacy of patients' records and to comply with ethics requirements. A random number was allocated to each individual record. All these steps including identifying eligible records and specification of study variables were conducted electronically. Then the anonymised data was transferred into an Excel database (Microsoft Office Excel 2013; Microsoft Corporation, Redmond, WA, USA).

From the total number of patient records that was identified in phase 1, a subsample was randomly selected to determine common causes of injury and sport type (Phase 2). The selected records were printed and manually reviewed in order to obtain information about common causes of injury and sport type. Details on cause of injury and sport type could not be collected directly from the electronic patient database as they cannot be identified through the automated search. These two variables could only be identified by conducting a manual search of each individual patient record.

A stratified random sampling method was used to select the subsample. Firstly, the total number of patient records was divided into 4 separate age groups: teenagers (14–17 years), young adulthood (18–35 years), middle age (36–55 years) and older adulthood (56 years and over). This age clustering was reported in literature to ensure that the analysis includes all age ranges in the study population [13].

The sample size of the subsample was determined based on the practicalities of conducting a manual review. It was calculated based on restricting the width of an exact binomial confidence interval for a proportion to be no wider than 20% (i.e., ± 10%) [14]. Therefore, a number of 106 patient records were found adequate and selected for manual review.

2.5. Statistical analysis

Data was analysed by Microsoft Excel (2013) and SPSS statistical package software (version 21; SPSS Incorporation). For phase 1, descriptive statistics were used to summarise prevalence, age, sex, attendance outcome, arrival date and time, and radiography referrals; for phase 2, descriptive statistics were used to summarise cause of injury and sport type. Means and standard deviations (SD) were presented for continuous variables, and frequencies and percentages were presented for categorical variables. For non-normally distributed data, median and interquartile range (IQR) were used.

3. Results

During study period, 55,891 patients attended the emergency department. Out of those patients, a total of 909 new cases of ankle sprain (original sample) were identified. Prevalence of injury was equally distributed between men and women (49.6% and 50.3% respectively). Patients had a median of 27 years (IQR 20) and a peak at 19–23 years old (Fig. 2). Men aged between 14 and 37 years accounted for a higher percentage of injuries (56%) compared to women of a similar age (44%), whereas women accounted for a higher percentage of injuries in those over 35 years as compared to their counterparts (59% and 41% respectively). Most patients were sent to radiography department for ankle and foot X-ray (89%). Over half of patients (58%) were sent home with no follow-up treatment. Twenty two percent (n = 200) were referred to the emergency department review or physiotherapy clinic, 15% (n = 132) were discharged with GP follow up, 2% (n = 20) were admitted to the hospital, 2% (n = 17) referred to fracture clinic, 1% (n = 7) were referred to other out-patient clinic, 0.3% (n = 3) were referred to other health care professional and 0.2% (n = 2) left the department before being treated. The busiest day was Sunday with a peak at 157 patients. The lowest number of patients (n = 95) attended on Saturday (Fig. 3). In terms of monthly attendances, the number of patients per month was higher in May n = 141), July (n = 157) and September (n = 152).

The subsample (n = 106) that was selected from the original sample (n = 909) showed a variety of causes of injury such as tripping (29%), non-specific injury (26.4%), playing sports (26%), walking (12.2%) and other accidental causes (6%) (Fig. 4). Football was the most prevalent sport (Fig. 5).

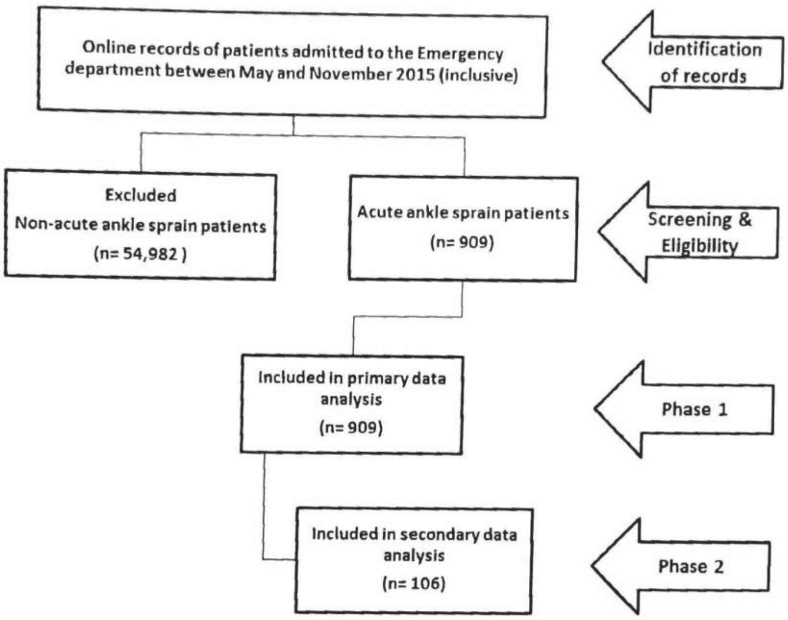


Fig. 1. Process of screening and inclusion of patient records.

4. Discussion

To our knowledge, this is the first study in a decade and the first in the south of England (UK) that illustrates both demographic and clinical characteristics of patients reporting to an emergency department with acute ankle sprain.

4.1. Prevalence

This study identified 909 cases of ankle sprain attending an emergency department between May and November 2015. There was no definite increasing or decreasing trend in number of patients from May (end of spring) to November (end of autumn). In the UK, two statistical reports the first by Health and Social Care Information Centre [7] and the second report presented by House of Commons Library [6] provided detailed statistics about patient admissions to emergency departments

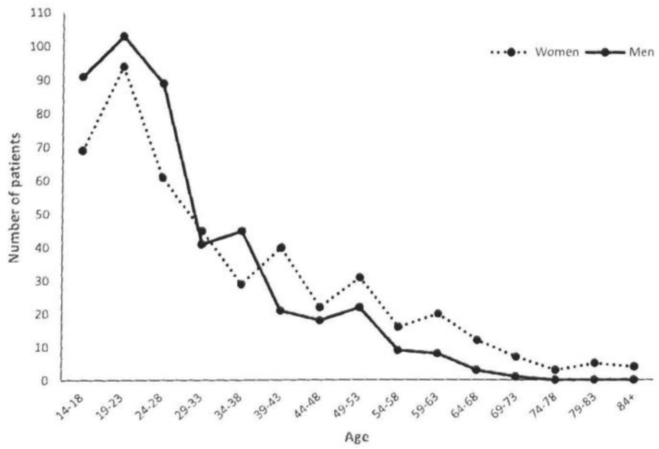


Fig. 2. Age-sex specific rates of ankle sprain patients.

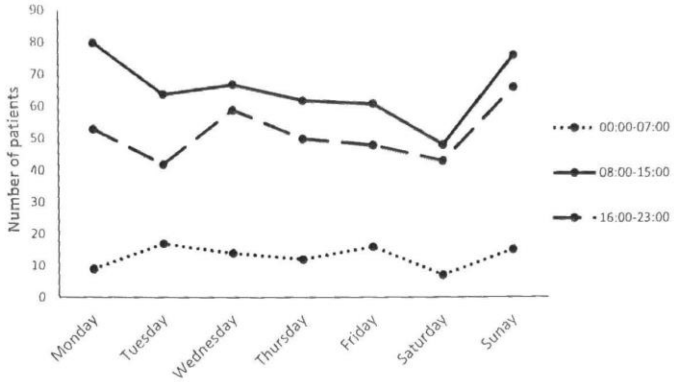


Fig. 3. Attendances of ankle sprain patients per hour and days.

across England. Across the financial year 2014/15 (April 2014-March 2015), they documented 367,093 patients presented with sport injuries [7] and 688,000 with ligament injury/sprain [6]. This study focused on investigating the epidemiology specific to acute ankle sprain whereas they presented data for a whole set of injuries such as "sport injuries" and "ligament injury/ sprain".

4.2. Age

This study included a wide age range from 14 to 92 years. Over half of ankle sprain injuries (65%) occurred in young patients aged between 14 and 35 years. The peak prevalence of ankle sprains was found to be between 19 and 23 years old (22%). Similar results were seen in patients who had attended emergency departments in the US [3] and in the UK [5,15,16].

In our study, we observed that prevalence of ankle sprain increased with age in patients between 14 and 23 years old. Similarly in the UK, studies showed an increase in incidence of ankle injuries, including ankle sprain, with age in football academies players aged between 9 and 18 years old [16] and 9 to 16 years old [15]. Perhaps the distinguishable proportional increase in incidence of injury in relation with age in young players can be explained by older boys having more speed, strength and may generate more tackling force during sport activities [17]. It could be also due to the fact that a large percentage (42%) of the population where the ED is located are between 20 and 44 years [12]. The increase in incidence of ankle sprains in younger populations suggests that those who set training programs, schools' administration, sport medical teams and sport academies should take precautionary measures to reduce the occurrence of this injury.

4.3. Sex

Prevalence of ankle sprain for men and women in this study was relatively equal (49.6% and 50.3% respectively). Similar percentages (men, 50.3% and women, 49.7%) were noted in patients attending emergency department in the US [3]. Current literature is divided on

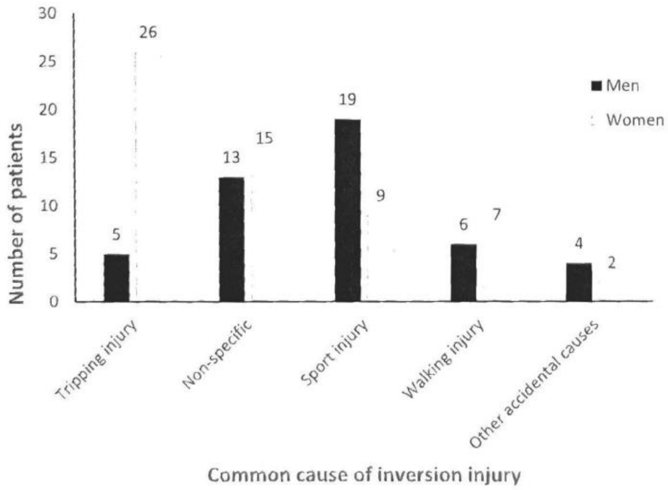


Fig. 4. Common cause of inversion injury (n = 106).

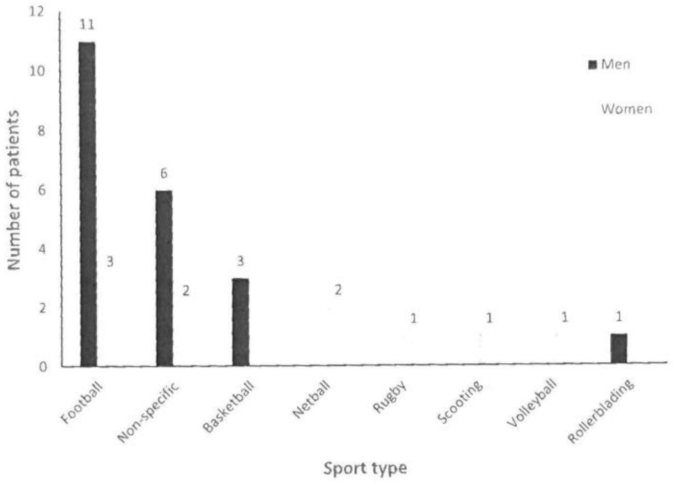


Fig. 5. Sport type of patients who reported sport as cause of injury (n = 106).

the role of sex on sport injuries including ankle sprains. Some studies indicated that women had more prevalence of sport injuries including ankle sprain [18,19]. Others found no significant differences between men and women [5].

In this study, younger men (14–37 years old) accounted for a higher number of injuries (n = 324) compared to women of the same age (n = 269). In contrast, in older ages (38–92), the number of women with ankle sprain was higher (n = 189) compared to men (n = 127). Previous studies showed similar age-sex trends between men and women [5]. It might be that men at younger ages generate more tackling force especially in contact sports and cause more sport injuries [17]. Furthermore, a fluctuating hormonal cycle in women at older ages may be associated with joint laxity thus their ligaments more susceptible to injury [20]. Across all England, about 56% of people aged between 16 and 25 years take part in sports at least once a week [21]. In addition, younger men are much more likely to participate in sports than women are (41% and 32% respectively); however, this difference declines with age. Potentially that may explain the increased prevalence of acute ankle sprain in younger men as compared to women. More research focused on determining the association between age and sex in individuals with ankle sprain in order to develop appropriate prevention programs tailored to individual age and sex groups would be useful.

4.4. *Attendance outcome*

We recorded a total number of 528 (58%) patients that were sent home with no follow-up appointments. This percentage is relatively similar to that observed by Chorley [22] as 50% of their patients were sent home with "as needed" follow up referrals. As a routine practice in the emergency settings and at the time of discharge, patients are given discharge written instruction sheet that covers self-management care following ankle sprain [22]. This instruction sheet includes information about patient-oriented care such as rest, ice, compression, elevation (RICE), range of motion exercises, strengthening exercises, proprioception exercises and/ or medication. However, it did not provide clear clinical guidelines for recovery threshold and return to work and sporting activity, leaving patients potentially susceptible to recurrent injuries and chronic symptoms. Inclusion of such information is very important as there is no guaranteed contact with those patients once they are discharged from the ED. Some patients may resume their normal sport/ work/ daily living activities without being fully recovered.

4.5. *Attendance month, day and time*

Most patients in the current study attended the emergency department during May, July and September. Other studies have shown mixed results on monthly rates of ankle sprain injuries. An epidemiological study reported that ankle sprain injuries in English football leagues increase in July, August and September and decline in following months [23]. Others showed higher number of ankle sprain injuries in July, November, February and April, whereas the least number of injuries were recorded in September, January and May [24]. However, these studies, including ours, showed an overall increase of ankle sprains in summer as compared to winter. As our study included all patients who attended the emergency department including those who participate in recreational sports, it could be hypothesized that sport activities are more practiced in summer, as compared to winter.

In terms of days of the week, Sunday was the busiest day of the week with 157 (17%) ankle sprain attendances. Saturday is the quietest day of the week with a number of 98 (11%) ankle sprain attendances. In terms of single hour of the day, 11 am on Sunday had the maximum number of attendances (1.7%) followed by the same hour on Thursday (1.6%). Similar results showed higher number of ankle sprain attendances to an emergency department in Norway during weekends ($p < 0.001$) with 20.2% occurring on Sundays [25].

4.6. *Radiography referrals*

As a routine assessment in emergency departments, the Ottawa Ankle rules (OAR) are frequently used as a valid clinical measure to identify patients who may have ankle fracture [26]. They were found useful in reducing the number of X-rays, which in turn may reduce length of stay and waiting times in emergency departments [27]. However, we observed that 808 patients (89%) diagnosed with ankle sprain were referred to the radiology department for ankle and foot and radiographs. This is a substantial number of patients who had ankle/ foot x-rays taken compared to those who did not. Others have also noted a high percentage (95%) of ankle and foot radiographs taken for individuals attending an ED with ankle sprain in Malta [28]. Therefore, a clinical query could be asked whether those patients who were sent to radiology department fulfilled the criteria of OAR for ankle and foot X-ray. A previous clinical audit reported that two patients that were not referred to the radiography department fulfilled the OAR criteria for ankle and foot fractures [28]. Of those who were sent to radiology department, 19.4% did not fulfil OAR criteria for ankle fractures and 32.4% did not fulfil OAR criteria for foot fractures. These results clearly illustrate inconsistency in clinical practice more specifically using OAR as a clinical screening tool in the emergency department. Borg and Pickard [28] recommend an implementation strategy for OAR to be used in emergency departments that in turn, according to their results, may reduce unnecessary radiographs by about 22%. Others also recorded an overall reduction of 26.4% in inappropriate practice including failure to follow OAR guidelines [29]. In terms of average medical charges per patient, a potential saving of $90 can be achieved by reducing the number of ankle and foot X-rays for patients admitted to emergency departments with ankle sprain [29].

The high number of radiography referrals in the current study highlights an important clinical question as to whether all referrals to radiography, for ankle injuries such as these, are essential. It would be useful to know if OAR tools are used in ankle sprain to aid the decision of onward to the radiography department. This was outside the scope of the current study, however may be a useful clinical investigative consideration for future.

4.7. Common cause of injury and sport type

A subsample of records of 106 patients were manually reviewed to identify a common cause of injury for acute ankle sprain and type of sport. Tripping was reported as the most common cause of injury (29%) whereas sport accounted for 26%. We found that there is high number of patients (26.4%) for whom cause of injury was not specified although the mechanism of injury, inversion, is recorded. Although evidence showed that ankle sprain is a common injury in sports such as football [15,30], we were unable to appropriately categorise type of sport because data was missing in some records of the subsample (26%). It is possible that there might be more people who had their injuries during sport activity but this was not captured in the current record system.

4.8. Limitations

Potential limitations exist within this investigation and thus findings should be interpreted within the context of those limitations. The review highlighted that there were large number of cases sent to the radiology department. The necessity for these radiographs in the current data was not evaluated as we only selected to manually review 10% of patients' records from total study population. It would be more appropriate if we calculated how many patients were sent to the radiology department and did not have ankle and foot fractures. The only way to investigate both the accuracy of initial diagnosis and number of unnecessary radiographs is to review all records. Unfortunately, this was beyond the scope of the current study. However, this could be a potential area of research in future.

The included cases in this study were assigned a diagnosis by combining two elements: diagnostic area (lower limb-ankle) and local diagnosis description (sprain). These two elements are diagnosis codes in the online record system. However, some of the cases were not valid ankle sprain and the diagnosis did not correlate with what had been written in the patient notes. This was discovered during manual review of the clinical notes of some patients in the subsample. They were recorded as "ruptured right calf" and "fracture distal tip of plantar". The only method to verify the correct diagnosis is to go through all patient notes, which was again beyond the scope of this study. Despite this, we assumed all other information that was retrieved from the online patient records system is correct and included in the analysis. In addition, we were unable to appropriately categorise cause of injury and sport type because it is not documented in about one quarter of all records of the subsample. It is possible that there might be more people who had their injuries during sport activity but this was not captured in the current record system of the emergency department because of incomplete documentation of history of injury. This information is important in order to identify individuals at risk of ankle sprain and set relevant prevention programs. We agree with a previous review that quality review of patient records in the emergency department is highly recommended [5]. We also acknowledge that data is a snapshot of a certain number of months (May to November); therefore, the results might not be representative for every season of the year.

5. Conclusion

The current study highlighted some important clinical aspects that need to be investigated to improve current practice relative to management of acute ankle sprain in an emergency department. It is important that complete and consistent information about diagnosis, causes of injury and sport type be collected upon arrival of patients to an ED. Keeping records that include disease-specific statistics that cover both demographic and clinical characteristics of admitted patients may identify those at risk of this injury. This would also help clinicians and sport clubs medical teams to set prevention programs for those individuals. In addition, the use of clinical assessment tools for ankle sprains such as OAR should be audited to potentially reduce unnecessary radiographic investigations. Future research should focus on investigating the use of OAR to reduce the burden for referrals to radiography department. Future research could also focus more on determining those at risk of ankle sprain injury and subsequent economic impact and the most effective management of this injury.

Conflict of interest

None.

Ethical statement

The study was approved by The University of Southampton (ref: 18515) as well as from Health Research Authority (HRA) (ref: 202053).

Funding sources

None.

References

[1] Kerkhoffs GMMJ, Handoll HHG, de BR, Rowe BH, Strujis PAA. Surgical versus conservative treatment for acute injuries of the lateral ligament complex of the ankle in adults. Cochrane Database Syst Rev 2007;2.

[2] Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. Sports Med (Auckland, N.Z.) 2014;44(1):123–40.

[3] Waterman BR, Owens BD, Davey S, Zacchilli MA, Belmont Jr. PJ. The epidemiology of ankle sprains in the United States. J Bone Joint Surg. American Volume 2010;92(13):2279–84.

[4] Shah S, Thomas AC, Noone JM, Blanchette CM, Wikstrom EA. Incidence and cost of ankle sprains in United States emergency departments. Sports Health 2016;8(6):547–52.

[5] Bridgman SA, Clement D, Downing A, Walley G, Phair I, Maffulli N. Population based epidemiology of ankle sprains attending accident and emergency units in the West Midlands of England, and a survey of UK practice for severe ankle sprains. Emergency Med J: EMJ 2003;20(6):508–10.

[6] **Carl B. Accident and emergency statistics. House of Commons Library, 2015.**

[7] **Hospital Episode Statistics Analysis, Accident and Emergency Attendances in England – 2013–14. Health and Social Care Information Centre, 2015.**

[8] Meeuwisse WH. Assessing causation in sport injury: a multifactorial model. Clin J Sport Med 1994;4(3):166–70.

[9] Verhagen EAL, van Tulder M, van der Beek AJ, Bouter LM, van Mechelen W. An economic evaluation of a proprioceptive balance board training programme for the prevention of ankle sprains in volleyball. Brit J Sport Med 2005;39(2):111–5.

[10] Gilbert EH, Lowenstein SR, Koziol-McLain J, Barta DC, Steiner J. Chart reviews in emergency medicine research: where are the methods? Ann Emerg Med 1996;27(3):305–8.
[11] Vol Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ 2007;335(7624):806–8.
[12] Census Information. 2011 Census information. Hampshire, UK: Research and Intelligence; 2013.
[13] Petry NM. A comparison of young, middle-aged, and older adult treatment-seeking pathological gamblers. Gerontologist 2002;42(1):92–9.
[14] Morisette JT, Khorram S. Exact binomial confidence interval for proportions. Photogrammetric Eng Rem Sens 1998;64(4):281–3.
[15] Cloke DJ, Spencer S, Hodson A, Deehan D. The epidemiology of ankle injuries occurring in English Football Association academies. Brit J Sport Med 2009;43(14):1119–25.
[16] Cloke DJ, Ansell P, Avery P, Deehan D. Ankle injuries in football academies: a three-centre prospective study. Brit J Sport Med 2011;45(9):702–8.
[17] Caine D, Maffulli N, Caine C. Epidemiology of injury in child and adolescent sports: injury rates, risk factors, and prevention. Clin Sports Med 2008;27(1):19–50.
[18] Beynnon BD, Wacek PM, Murphy D, Alosa D, Paller D. First-time inversion ankle ligament trauma the effects of sex, level of competition, and sport on the incidence of injury. Am J Sport Med 2005;33(10):1485–91.
[19] Leininger RE, Knox CL, Comstock RD. Epidemiology of 1.6 million pediatric soccer-related injuries presenting to US emergency departments from 1990 to 2003. Am J Sport Med 2007;35(2):288–93.
[20] Heitz NA, Eisenman PA, Beck CL, Walker JA. Hormonal changes throughout the menstrual cycle and increased anterior cruciate ligament laxity in females. J Athl Training 1999;34(2):144–9.
[21] **Sport England, Who play sports? National picture, 2016.**
[22] Chorley JN. Ankle sprain discharge instructions from the emergency department. Pediatr Emerg Care 2005;21(8):498–501.
[23] Woods C, Hawkins RD, Maltby S, Hulse M, Thomas A, Hodson A. The Football Association Medical Research Programme: an audit of injuries in professional football–analysis of hamstring injuries. Brit J Sport Med 2004;38(1):36–41.
[24] Walden M, Hagglund M, Ekstrand J. Time-trends and circumstances surrounding ankle injuries in men's professional football: an 11-year follow-up of the UEFA Champions League injury study. Brit J Sport Med 2013;47(12):748–53.
[25] Maehlum S, Daljord OA. Acute sports injuries in Oslo: a one-year study. Brit J Sport Med 1984;18(3):181.
[26] Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. BMJ (Clin Res Ed) 2003;326(7386):417.
[27] Curr S, Xyrichis A. Does nurse-led initiation of Ottawa ankle rules reduce ED length of stay? Int Emerg Nurs 2015;23(4):317–22.
[28] Borg M, Pickard AC. Audit on the use of radiography and the management of ankle sprains in A&E. Malta Med J 2008;20(4):12–4.
[29] **Stiell I, Wells G, Laupacis A, Brison R, Verbeek R, Vandemheen K, Naylor CD. Multicentre Trial To Introduce The Ottawa Ankle Rules For Use Of Radiography In Acute Ankle Injuries. British Medical Association, 1995.**
[30] Nelson AJ, Collins CL, Yard EE, Fields SK, Comstock RD. Ankle injuries among United States high school sports athletes, 2005–2006. J Athl Training 2007;42(3):381–7.

Appendix 28 Poster presented in Podiatry College Conference 2016 in Glasgow (Study one)

Health Sciences

UNIVERSITY OF Southampton

Prognostic factors for return to play following conservatively treated acute ankle sprain: a systematic review

Al Bimani, S *§, Gates, L*§, Warner, M*§ and Bowen, C *§

*Faculty of Health Sciences, University of Southampton, Southampton, UK

§Arthritis Research UK Centre for Sport, Exercise and Osteoarthritis

Introduction

- Ankle sprains are very common injuries amongst sports and non-sports people with an incidence rate estimated to be one ankle per player per year across English Football Association academies [1].
- To date, there is limited evidence for guidance and timing for return to play following conservatively treated acute ankle sprains [2].
- Various authors in narrative reviews highlighted that athletes, club medical teams and the club management, require appropriate guidance about the approximate time that an athlete takes to return to sporting activity in order to eliminate any disagreement and poor decision [3-5].
- Constructing evidence-based guidance requires thorough understanding of the course of the ankle sprain injury including potential prognostic factors for recovery [2].

Aims

To determine if consensus exists about potential prognostic factors that are associated with return to play in conservatively treated acute ankle sprain.

Methods

Search Strategy

We searched: DelphiS and EMBASE (Table 1), unpublished literature and ongoing trials and two main ankle and foot injury sport-related journals.

Table 1 Search terms

Classification	Search terms
Anatomical location	Ankle* OR foot OR feet
Injury	"ligament sprain*" OR "ligament rupture*" OR "ligament injur*" OR "ligament tear*" OR "inversion injur*" OR "inversion sprain*" OR sprain*
Study design	predict* OR prognos* OR probab* OR prospect* OR relat* OR correlat*, "risk factor*"
Outcome measure	"return to play*" OR "return to sport*" OR "return to activit*" OR recover* OR RTP OR "return-to-play*" OR TTRTP OR "return to train*" OR "Return to compet*" OR football* Or Basketball* OR Baseball* OR Volleyball* OR soccer* OR wrestl* OR softball* OR hokey OR rugby OR tennis OR run* OR sport* OR athlete*

Eligibility criteria

- Studies assessing factors associated with return to play following conservatively treated acute ankle sprain
- Any grade of acute ankle sprain (new and recurrent)
- Athletes practising any sport activity at any level
- Both male and female patients
- Age 14 and above
- Full text studies published in English from inception until May 2016.

The included papers were assessed using the Critical Appraisal Skills Program (CASP)

Results

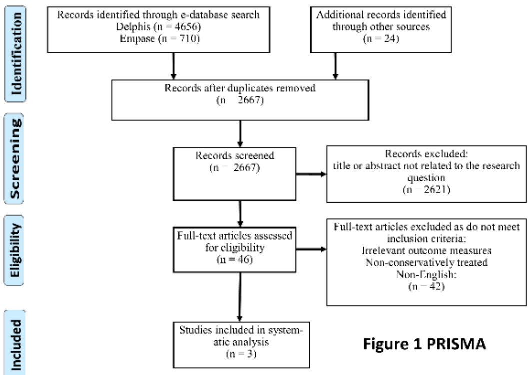


Figure 1 PRISMA

Main findings

- Three studies were included in this review (Figure 1)
- Return to play was not influenced by either new or recurrent injuries [6]
- Measures of Global function, SF 36PF, athlete's ambulation status [7] and weight-bearing activity scores and self-reported athletic ability [8] were strong predictors of return to play.
- Patients' demographic factors such as age, gender and BMI or history of injury were not investigated as potential predictors in any of the included studies.

Conclusions

- This is first systematic review to report prognostic factors for return to play following conservatively treated acute ankle sprain.
- Consensus from three studies was not viable and future prospective studies may consider recruiting bigger samples and investigating other demographic and history of injury as potential predictors for return to play.

References

1. Cloke DJ, Spencer S, Hodson A and Deehan D (2009) The epidemiology of ankle injuries occurring in English Football Association academies. *British Journal Of Sports Medicine* 43(14): 1119-1125
2. Van Rijn RM (2008) Review: many adults still have pain and subjective instability at 1 year after acute lateral ankle sprain. *Evidence Based Medicine* 13(6): 187-187
3. Anderson SJ (2002) Acute ankle sprains: keys to diagnosis and return to play. *The Physician And Sportsmedicine* 30(12): 29-35
4. Clanton TO, Matheny LM, Jarvis HC and Jeronimus AB (2012) Return to play in athletes following ankle injuries. Sports Health 4(6): 471-474
5. Richie DH and Izadi FE (2015) Return to Play After an Ankle Sprain. Guidelines for the Podiatric Physician. *Clinics in Podiatric Medicine and Surgery* 32: 195-215
6. Medina McKeon JM, Bush HM, Reed A, Whittington A, Uhl TL and McKeon PO (2014) Return-to-play probabilities following new versus recurrent ankle sprains in high school athletes. *Journal Of Science And Medicine In Sport / Sports Medicine Australia* 17(1): 23-28
7. Cross KM, Worrell TW, Leslie JE and Khalid RV (2002) The relationship between self-reported and clinical measures and the number of days to return to sport following acute lateral ankle sprains. *Journal of Orthopaedic & Sports Physical Therapy* 32(1): 16-23 8p
8. Wilson RW and Gansneder BM (2000) Measures of functional limitation as predictors of disablement in athletes with acute ankle sprains. *The Journal Of Orthopaedic And Sports Physical Therapy* 30(9): 528-535

Prof Catherine Bowen is Chair of the College of Podiatry Research and Development Committee, Chair of the abstract review panel and Deputy Editor UK for the Journal of Foot and Ankle Research. It is College of Podiatry policy that reviewers are removed from the peer review and decision-making processes for abstracts they have co-authored. The remaining authors declare no conflicts of interest in relation to this work

Appendix 29 Poster presented at Southampton Medical and Health Research Conference 2017 (Study two)

Health Sciences

UNIVERSITY OF Southampton

A cross sectional study to identify prevalence and common causes of acute ankle sprain within the emergency department setting.

Saed Al Bimani[1,2,3], Lucy Gates[1,2], Martin Warner[1,2], Sean Ewings[1,4], Robert Crouch[1,5] and Catherine Bowen[1,2]

1. Faculty of Health Sciences, University of Southampton, Southampton, UK; 2. Arthritis Research UK Centre for Sport, Exercise and Osteoarthritis; ; 3. Department of Physiotherapy, Institute of Health Sciences, Muscat, Oman, 4. Southampton Statistical Sciences Research Institute, University of Southampton, Southampton UK, 5. Emergency Department, University Hospital Southampton, Southampton, UK

Background

Ankle sprain is a very common injury in emergency departments with an incidence rate estimated to be 52.7 per 10 000 in the UK[1] and 206 per 100,000 in the US[2]. However, there is lack of annual national statistics and research on the epidemiology of ankle sprains across UK which makes it is difficult to appropriately determine the incidence and estimate related health care expenditures. Knowing patients' demographic and clinical characteristics might inform future research that is concerned with planning of preventative strategies. This is the first study in a decade and the first in the south of England that illustrates both demographic and clinical characteristics of patients reporting to a UK emergency department with acute ankle sprain.

Aims

1. To determine prevalence, demographic and clinical characteristics of patients with acute ankle sprain.
2. To characterize patients by attendance outcome and their common cause of injury and sport type.

Methods

- A retrospective review of records from patients' database system (Symphony) was conducted. Patients admitted to the emergency department of Southampton General Hospital with acute ankle sprain between May and November 2015 were included.
- Patients were included if they were diagnosed with acute ankle sprain and aged 14 and above.
- The diagnostic code consists of two main components: lower limb-ankle and sprain.
- In addition to the main search, a manual review of a subsample (n=106) from the retrieved records was conducted to determine common cause of injury and sport type.

Results

- A total of 909 new patients with acute ankle sprain were recorded during the study period.
- Patients had a median of 27 years (IQR 20) with a peak at 19-23 years old **(Figure 1).**
- Prevalence of injury was equally distributed between men and women (49.6% and 50.3% respectively).
- Younger men (14-37 years) accounted for higher percentage of injuries compared to younger women whereas between 38 and 92 years, older women accounted for higher number of injuries.
- Most patients were sent to for ankle/ foot x-ray (89%).
- Just over half of patients (58%) were sent home with no follow-up treatment **(Figure 2).**
- A subsample (n=106) that was selected from the original sample (n=909) showed a variety of causes for injury such as tripping (29%), non-specific injury (26.4%), playing sports (26%), walking (12.2%) and other accidental causes (6%).
- Football was the most prevalent sport. It was not possible to appropriately categorise type of sport as this information was missing in 26% records of the subsample **(Figure 3).**

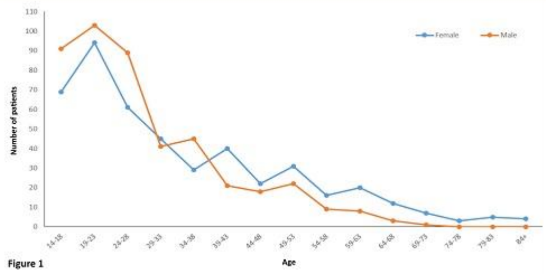


Figure 1

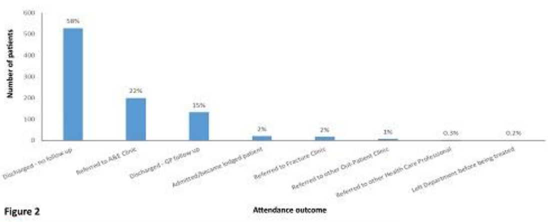


Figure 2

Conclusions

Ankle injury presenting to emergency department is higher in young patients (14-35 years). Prevention strategies, appropriate assessment tools and tailored rehabilitation programs should be implemented to reduce number of patients and latent potential chronic symptoms[1,2,3,4]. Future research should focus more on determining economic impact of this injury more specifically in younger populations.

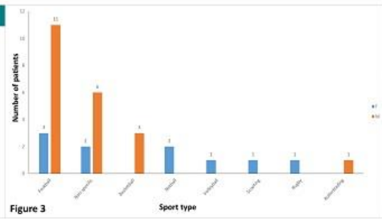


Figure 3

References

1. Bridgman SA, Clement D, Downing A, Walley G, Phair I and Maffulli N (2003) Population based epidemiology of ankle sprains attending accident and emergency units in the West Midlands of England, and a survey of UK practice for severe ankle sprains. *Emergency Medicine Journal: EMJ* 20(6): 508-510
2. Waterman BR, Owens BD, Davey S, Zacchilli MA and Belmont PJ, Jr. (2010) The epidemiology of ankle sprains in the United States. *The Journal Of Bone And Joint Surgery. American Volume* 92(13): 2279-2284
3. Soomro N, Sanders R, Hackett D, Hubka T, Ebrahimi S, Freeston J and Cobley S (2016) The Efficacy of Injury Prevention Programs in Adolescent Team Sports. *Am. J. Sports Med.* 44(9): 2415-2424
4. Hootman JM, Dick R and Agel J (2007) Epidemiology of Collegiate Injuries for 15 Sports: Summary and Recommendations for Injury Prevention Initiatives. *Journal of Athletic Training (National Athletic Trainers' Association)* 42(2): 311-31

Corresponding Author:
Saed Al Bimani,
Email: sab1g14@soton.ac.uk

Glossary of terms

B

Binkley's lower extremity functional scale: A scale to measure "patients' initial function, ongoing progress, and outcome" for a wide range of lower-extremity conditions

C

Conservative treatment: An approach to treating different injuries/ diseases using non-surgical interventions.

D

Demographic factors: Socioeconomic characteristics of a population expressed statistically, such as age, sex, education level, income level, marital status, occupation etc.

L

Lateral ankle sprain: A traumatic injury affecting lateral capsular ligament complex of the ankle joint within 72 hours of occurrence (Kerkhoffs et al. 2012).

N

Negative Binomial Regression: A type of generalised linear regression methods used for modelling count variables, usually for over-dispersed count outcome variables.

R

Residual symptoms: Long term clinical symptoms that persist after an injury.

Return to play: Return of sportspeople to practice or competition following an injury.

T

Time to return to play: Time taken by sportspeople from onset of injury until they return to regular sport practice or competition

References

Aagaard H and Jorgensen U (1996) Injuries in elite volleyball. *Scandinavian Journal of Medicine and Science in Sports* 6(4): 228-232

Aagaard H, Scavenius M and Jorgensen U (1997) An epidemiological analysis of the injury pattern in indoor and in beach volleyball. / Analyse epidemiologique des types de blessures en volley-ball de plage et volley-ball en salle. *International Journal of Sports Medicine* 18(3): 217-221

Abate M, Schiavone C and Salini V (2014) The Use of Hyaluronic Acid after Tendon Surgery and in Tendinopathies. *BioMed Research International* 2014

Aharonoff GB, Koval KJ, Skovron ML and Zuckerman JD (1997) Hip fractures in the elderly: predictors of one year mortality. *Journal of Orthopaedic Trauma* 11(3): 162-165

Aiken AB, Pelland L, Brison R, Pickett W and Brouwer B (2008) Short-term natural recovery of ankle sprains following discharge from, emergency departments. *Journal of Orthopaedic and Sports Physical Therapy* 38(9): 566

Al Bimani S, Gates L, Warner M, Crouch R and Bowen C (2018a) Characteristics of patients with ankle sprain presenting to an emergency department in the south of England (UK): A seven-month review. *International Emergency Nursing* 41: 38-44

Al Bimani SA, Gates LS, Warner M and Bowen C (2018b) Factors influencing return to play following conservatively treated ankle sprain: a systematic review. *Physician and Sportsmedecine* 47(1): 31-46

Anandacoomarasamy A and Barnsley L (2005) Long term outcomes of inversion ankle injuries. *British Journal of Sports Medicine* 39(3): e14-e14

Andersen M and Williams J (1988) A model of stress and athletic injury: Prediction and prevention. *Journal of Sport and Exercise Psychology* 10: 294-306

Andersen TE, Floerenes TW, Arnason A and Bahr R (2004) Video Analysis of the Mechanisms for Ankle Injuries in Football. *American Journal of Sports Medicine* 32(90010): 69S-79

Anderson SJ (2002) Acute ankle sprains: keys to diagnosis and return to play. *The Physician And Sportsmedicine* 30(12): 29-35

Aradi AJ and Wong J (1997) Physical examination is sufficient for the diagnosis of sprained ankles. *The Journal Of Bone And Joint Surgery. British Volume* 79(6): 1039-1040

Ardern CL, Glasgow P, Schneiders A, Witvrouw E, Clarsen B, Cools A, Gojanovic B, Griffin S, Khan KM, Moksnes H, Mutch SA, Phillips N, Reurink G, Sadler R, Silbernagel KG, Thorborg K, Wangensteen A, Wilk KE and Bizzini M (2016) 2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern. *British Journal of Sports Medicine* 50(14): 853-864

Ardevol J, Bolibar I, Belda V and Argilaga S (2002) Treatment of complete rupture of the lateral ligaments of the ankle: a randomized clinical trial comparing cast immobilization with functional treatment. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA* 10(6): 371-377

Arnason A, Sigurdsson SB, Gudmundsson A, Holme I, Engebretsen L and Bahr R (2004) Risk factors for injuries in football. *The American Journal of Sports Medicine* 32(1 Suppl): 5S-16S

Aromataris E and Riitano D (2014) Constructing a search strategy and searching for evidence. A guide to the literature search for a systematic review. *American Journal of Nursing* 14(5): 49-56

Atkinson R and Flint F (2001) Accessing Hidden and Hard-to-Reach Populations: Snowball Research Strategies. *Social Research Update* (33)

Austin PC and Steyerberg EW (2015) The number of subjects per variable required in linear regression analyses. *Journal of Clinical Epidemiology* 68(6): 627-636

Aveyard H (2002) Implied consent prior to nursing care procedures. *Journal of Advanced Nursing* 39: 201–207

Bachmann LM, Kolb E, Koller MT, Steurer J and ter Riet G (2003) Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. *BMJ (Clinical Research Ed.)* 326(7386): 417-417

Backous DD, Friedl KE, Smith NJ, Parr TJ and Carpine WD, Jr. (1988) Soccer injuries and their relation to physical maturity. *American Journal Of Diseases Of Children (1960)* 142(8): 839-842

Bairstow PJ, Persaud J, Mendelson R and Nguyen L (2010) Reducing inappropriate diagnostic practice through education and decision support. *International Journal For Quality In Health Care: Journal Of The International Society For Quality In Health Care / Isqua* 22(3): 194-200

Barget E and Chavinier-Rela S (2017) The Analysis of Amateur Sports Clubs Funding: A European Perspective. *Athens Journal of Sports* 4(1): 7-34

Barss P, Smith GS, Baker SP and MohanD. (1998) *Injury prevention. An international perspective—epidemiology, surveillance, and policy*. New York, NY: Oxford University Press

Bauman J (2005) Returning to play: the mind does matter. *Clin J Sport Med.* 15: 432–435

Bekris E, Pidoulas G, Pidoulas P, Gissis I, Katis A and Komsis S (2018) Examination of Physical Fitness Parameters Between Professional and Amateur Greek Soccer Players During the Transition Period. *Journal of Strength and Conditioning Research*

Belson K (2009) *Universities Cutting Teams as They Trim Their Budgets*. Yhe New York Times. Available from: https://www.nytimes.com/2009/05/04/sports/04colleges.html [Accessed 25/7/2019]

Bendahou M, Khiami F, Saidi K, Blanchard C, Scepi M, Riou B, Besch S and Hausfater P (2014) Compression stockings in ankle sprain: a multicenter randomized study. *American Journal of Emergency Medicine* 32(9): 1005-1010

Bennell KL and Crossley K (1996) Musculoskeletal injuries in track and field: incidence, distribution and risk factors. *Australian Journal of Science and Medicine in Sport* 28(3): 69-75

Bennett WF (1994) Lateral ankle sprains. Part I: Anatomy, biomechanics, diagnosis, and natural history. *Orthopaedic Review* 23(5): 381-7

Bergés IM, Ottenbacher KJ, Smith PM, Smith D and Ostir G (2006) Perceived pain and satisfaction with medical rehabilitation after hospital discharge. *Clinical Rehabilitation* 20(8): 724-730

Bernard HR (2011) *Research Methods in Anthropology (5th ed)*. Alta Mira Press

Berson BL, Rolnick AM, Ramos CG and Thornton J (1981) An epidemiologic study of squash injuries. *The American Journal of Sports Medicine* 9(2): 103-106

Beumer A, van Hemert WLW, Swierstra BA, Jasper LE and Belkoff SM (2003) A biomechanical evaluation of the tibiofibular and tibiotalar ligaments of the ankle. *Foot and Ankle International* 24(5): 426-429

Beynnon BD, Renström PA, Alosa DM, Baumhauer JF and Vacek PM (2001) Ankle ligament injury risk factors: a prospective study of college athletes. *Journal of Orthopaedic Research* 19: 213-220

Beynnon BD, Renström PA, Alosa DM, Baumhauer JF and Vacek PM (2001) Ankle ligament injury risk factors: a prospective study of college athletes. *Journal of Orthopaedic Research* 19(2): 213-20

Beynnon BD, Renstrom PA, Haugh L, Uh BS and Barker H (2006) A prospective, randomized clinical investigation of the treatment of first-time ankle sprains. *American Journal of Sports Medicine* 34(9): 1401-1412

Beynnon BD, Wacek PM, Murphy D, Alosa D and Paller D (2005) First-Time Inversion Ankle Ligament Trauma The Effects of Sex, Level of Competition, and Sport on the Incidence of Injury. *American Journal of Sports Medicine* 33(10): 1485-1491

Bielska IA, Wang X, Lee R and Johnson AP (2017) The health economics of ankle and foot sprains and fractures: A systematic review of English-language published papers Part 2: The direct and indirect costs of injury. *The Foot* 39: 115-121

Birrer RB, Fani-Salek MH, Totten VY, Herman LM and Politi V (1999) Managing ankle injuries in the emergency department. *The Journal Of Emergency Medicine* 17(4): 651-660

Blagojevic M, Jinks C, Jeffery A and Jordan KP (2010) Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. *Osteoarthritis and Cartilage* 18(1): 24-33

Bleakley CM, McDonough SM, MacAuley DC and Bjordal J (2006) Cryotherapy for acute ankle sprains: a randomised controlled study of two different icing protocols. *British Journal of Sports Medicine* 40(8): 700-5; discussion 705

Blomberg HK (1997) Orienteering competition injuries: Injuries incurred in the Finnish Jukola and Venla relay competitions. *British Journal of Sports Medicine* 31(3): 205-208

Borg M and Pickard AC (2008) Audit on the use of radiography and the management of ankle sprains in A&E. *Malta Medical Journal* 20(4): 12-14

Bowling A (2014) *Research methods in health : investigating health and health services* (4th Edition). Maidenhead: Open University Press

Boyatzis RE (1998) *Transforming qualitative information: Thematic analysis and code development*. CA: Sage: Thousand Oaks

Boyce SH, Quigley MA and Campbell S (2005) Management of ankle sprains: a randomised controlled trial of the treatment of inversion injuries using an elastic support bandage or an Aircast ankle brace. *British Journal of Sports Medicine* 39(2): 91-96

Bradnock B, Law HT and Roscoe K (1996) A quantitative comparative assessment of the immediate response to high frequency ultrasound and low frequency ultrasound ("longwave therapy") in the treatment of acute ankle sprains [corrected] [published erratum appears in PHYSIOTHERAPY 1996 Mar;82(3):216]. *Physiotherapy* 82(2): 78-84

Braun BL (1999) Effects of ankle sprain in a general clinic population 6 to 18 months after medical evaluation. *Archives of Family Medicine* 8(2): 143-148

Braun V and Clarke V (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology* 3: 77–101

Braun V, Clarke V and Rance N (2015) How to use thematic analysis with interview data IN: Vossler A and Moller N (eds) *The counselling and psychotherapy research book*. London: Sage

Brazier JE, Harper R, B Jones NM, O'Cathain A, Thomas KJ, Usherwood T and Westlake L (1992) Validating the SF-36 health survey questionnaire: new outcome measure for primary care. *British Medical Journal* 305: 160-164

Brewer BW (2009) Injury prevention and rehabilitation IN: Brewer BW (ed) *Sport psychology*. Chichester, UK: Wiley-Blackwell 83-9

Bridgman SA, Clement D, Downing A, Walley G, Phair I and Maffulli N (2003) Population based epidemiology of ankle sprains attending accident and emergency units in the West Midlands of England, and a survey of UK practice for severe ankle sprains. *Emergency Medicine Journal: EMJ* 20(6): 508-510

Brockett CL and Chapman GJ (2016) Biomechanics of the ankle. *Orthopaedics and Trauma* 30(3): 232-238

Brophy RH, Schmitz L, Wright RW, Dunn WR, Parker RD, Andrish JT, McCarty EC and Spindler KP (2012) Return to play and future ACL injury risk after ACL reconstruction in soccer athletes From the Multicenter Orthopaedic Outcomes Network (MOON) Group. *American Journal of Sports Medicine* 40(11): 2517

Browne K, Roseman D, Shaller D and Edgman-Levitan S (2010) Analysis & commentary: measuring patient experience as a strategy for improving primary care. *Health Affairs* 29(5): 921-92520439881

Bruce KJ, JOHN CW, DANIEL SM and GORDON JW (2007) WILLINGNESS TO PAY FOR AMATEUR SPORT AND RECREATION PROGRAMS. *Contemporary Economic Policy*

Brynhildsen J, Ekstrand J, Jeppsson A and Tropp H (1990a) Previous injuries and persisting symptoms in female soccer players. *International Journal of Sports Medicine* 11(6): 489-92

Brynhildsen J, Ekstrand J, Jeppsson A and Tropp H (1990b) Previous injuries and persisting symptoms in female soccer players. *International Journal of Sports Medicine* 11(6): 489-492

Burney SM (2008) *Inductive & Deductive Research Approach. Department of Computer Science University of Karachi. [Online]*. Available from:

file:///C:/Users/sab1g14/Downloads/INDUCTIVEDEDUCTIVERESEARCHAPPROACH06032008.pdf [Accessed 27/01/2019]

Buss DD, Min R, Skyhar M, Galinat B, Warren RF and Wickiewicz TL (1995) Nonoperative treatment of acute anterior cruciate ligament injuries in a selected group of patients. *American Journal of Sports Medicine* 23(2): 160-165

C.M. Askling JN, A. Thorstensson (2010) A new hamstring test to complement the common clinical examination before return to sport after injury. *Knee Surgery, Sports Traumatol, Arthroscopy* 18: 1798-

Caine D, Maffulli N and Caine C (2008) Epidemiology of Injury in Child and Adolescent Sports: Injury Rates, Risk Factors, and Prevention. *Clinics in Sports Medicine* 27(1): 19-50

Campbell DT and Fiske DW (1959) Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin* 56(2): 81-105

Cancelliere C, HincapiéD CA, Keightley M, Godbolt AG, Côté P, Kristman VL, Stålnacke BM, Carroll LJ, Hung R, Borg J, Nygren-de Boussard C, Coronado VG, Donovan D and Cassidy JD (2013) Systematic Review of Prognosis and Return to Play After Sport Concussion: Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Archives of Physical Medicine and Rehabilitation* 95(3): S210-S229

Caplan N and Kader DF (2014) *Knee injury patterns among men and women in collegiate basketball and soccer: NCAA data and review of literature*. Springer-Verlag London Ltd

Carl B (2015) *Accident and Emergency Statistics*. House of Commons Library

Carlson MDA and Morrison RS (2009) Study Design, Precision, and Validity in Observational Studies. *Journal of Palliative Medicine* 12(1)

Cereatti A, Ripani F and Margheritini F (2010) Pathophysiology of Ligament Injuries *Sports Rehabilitation and Injury Prevention*. John Wiley & Sons

Chad D, McEvoy CD, Alan L, Morse Stephen L and Shapiro SL (2013) Factors Influencing Collegiate Athletic Department Revenues. *Journal of Issues in Intercollegiate Athletics* 249-267

Chamberlain CS, Brounts SH, Sterken DG, Rolnick KI, Baer GS and Vanderby R (1985) Gene profiling of the rat medial collateral ligament during early healing using microarray analysis. *Journal of Applied Physiology* 111(2): 552-65

Chevalier P (2003) The rules of Ottawa to exclude a fractured ankle. *Journal of Evidence-Based Medicine* 2(8): 133-135

Chomiak J, Junge A, Peterson L and Dvorak J (2000) Severe injuries in football players. Influencing factors. *The American Journal of Sports Medicine* 28(5 Suppl): S58-S68

Chorley JN (2005) Ankle sprain discharge instructions from the emergency department. *Pediatric Emergency Care* 21(8): 498-501

Chorley JN and Hergenroeder AC (1997) Management of ankle sprains. *Pediatric Annals* 26(1): 56-64

Cieza A, Kirchberger I, Biering-Sørensen F, Baumberger M, Charlifue S, Post MW, Campbell R, Kovindha A, Ring H, Sinnott A, Kostanjsek N and Stucki G (2010) ICF Core Sets for individuals with spinal cord injury in the long-term context. *Spinal Cord* 48(4): 305-12

Cieza A, Stucki G, Weigl M, Disler P, Jäckel W, van der Linden S, Kostanjsek N and de Bie R (2004) ICF Core Sets for low back pain. *Journal of Rehabilitation Medicine* 44 Suppl: 69-74

Clanton TO, Matheny LM, Jarvis HC and Jeronimus AB (2012) Return to play in athletes following ankle injuries. *Sports Health* 4(6): 471-474

Clark C, Carr ECJ and Khattab A (2015) Pain poses a significant health burden in those with Joint Hypermobility Syndrome. *British Journal of Pain* 9(2)

Cloke DJ, Ansell P, Avery P and Deehan D (2011) Ankle injuries in football academies: a three-centre prospective study. *British Journal of Sports Medicine* 45(9): 702-708

Cloke DJ, Spencer S, Hodson A and Deehan D (2009) The epidemiology of ankle injuries occurring in English Football Association academies. *British Journal of Sports Medicine* 43(14): 1119-1125

Coggon D, Rose GA and Barker DJP (2003) *Epidemiology for the uninitiated* (5th Edition). London: BMJ Books

Cohen R, Baluch B and Duffy L (2018) Personality differences amongst drag racers and archers: implications for sport injury rehabilitation. *Journal of Exercise Rehabilitation* 14(5): 783–790

Colville MR, Marder RA, Boyle JJ and Zarins B (1990) Strain measurement in lateral ankle ligaments. *The American Journal of Sports Medicine* 18(2): 196-200

Confederation N (2017) *NHS statistics, facts and figures*. Available from: https://www.nhsconfed.org/resources/key-statistics-on-the-nhs]

Cook CE, Learman KE, O'Halloran BJ, Showalter CR, Kabbaz VJ, Goode AP and Wright AA (2013) Which prognostic factors for low back pain are generic predictors of outcome across a range of recovery domains? *Physical Therapy* 93(1): 32-40

Cook DJ, Mulrow CD and Haynes RB (1997) Systematic Reviews: Synthesis of Best Evidence for Clinical Decisions. *Annals of Internal Medicine* 126: 376-380

Cooke MW, Marsh JL, Clark M, Nakash R, Jarvis RM, Hutton JL, Szczepura A, Wilson S and Lamb SE (2009) Treatment of severe ankle sprain: a pragmatic randomised controlled trial comparing the clinical effectiveness and cost-effectiveness of three types of mechanical ankle support with tubular bandage. The CAST trial. *Health Technology Assessment (Winchester, England)* 13(13): iii

Corbin J and A. S (1990) *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theor*. CA: Sage

Cosby NL, Koroch M, Grindstaff TL, Parente W and Hertel J (2011) Immediate effects of anterior to posterior talocrural joint mobilizations following acute lateral ankle sprain. *Journal of Manual & Manipulative Therapy (Maney Publishing)* 19(2): 76-83

Cote DJ, Prentice WE, Jr., Hooker DN and Shields EW (1988) Comparison of three treatment procedures for minimizing ankle sprain swelling. *Physical Therapy* 68(7): 1072-1076

Creighton DW, Shrier I, Shultz R, Meeuwisse WH and Matheson GO (2010) Return-to-Play in Sport: A Decision-based Model. *Clinical Journal of Sport Medicine* 20: 379–385

Cresswell JW and Plano Clark VL (2011) *Designing and conducting mixed method research (2nd ed.)*. Thousand Oaks,CA: Sage

Creswell JW (2013) *Controversies in Mixed Methods Research*. London: Sage

Creswell JW and Plano Clark V (2011) *Designing and Conducting Mixed Methods Research (2nd ed.)*.)London: Sage

Creswell JW and Plano Clark VL (2007) *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications

Critical Appraisal Skills Programme (2013) *CASP Checklist*. Available from: http://www.casp-uk.net/ [Accessed May 2016]

Croisier JL (2004) Factors associated with recurrent hamstring injuries. *Sports Medicine* 34(10): 681-695

Cross KM, Worrell TW, Leslie JE and Van Veld KR (2002) The relationship between self-reported and clinical measures and the number of days to return to sport following acute lateral ankle sprains. *The Journal Of Orthopaedic And Sports Physical Therapy* 32(1): 16-23

Crossman J (1997) Psychological rehabilitation from sports injuries. *Sports Medicine* 23: 333–9.

Crow G and Wiles R (2008) Managing anonymity and confidentiality in social research: the case of visual data in Community research. 2008 Edition: ESRC Natioal Center for Research Methods

Crow J, Pizzari T and Buttifant D (2011) Literature Review: Muscle onset can be improved by therapeutic exercise: A systematic review. *Physical Therapy in Sport* 12: 199-209

Dancey CP, Reidy JG and Rowe R (2012) *Statistics for the health sciences: A non-mathematical introduction*. London: SAGE

Daniel DM, Stone ML, Dobson BE, Fithian DC, Rossman DJ and Kaufman KR (1994) Fate of the ACL-injured patient: a prospective outcome study. *American Journal of Sports Medicine* 22(5): 632-644

David O, James BC, Christina RV, Fiona ES, Anne W, Yasemin G, Alessandra V, Finbarr CM, Margot AG, Cameron and Kurrle (2007) Strategies to Prevent Falls and Fractures in Hospitals and Care Homes and Effect of Cognitive Impairment: Systematic Review and Meta-Analyses. *BMJ: British Medical Journal* (7584): 82

de Bie RA, de Vet HCW, Lenssen TF, van den Wildenberg F, Kootsra G and Knipschild PG (1998) Low-level laser therapy in ankle sprains: A randomized clinical trial. *Archives of Physical Medicine and Rehabilitation* 79(11): 1415-1420

de Noronha M, Refshauge KM, Herbert RD, Kilbreath SL and Hertel J (2006) Do voluntary strength, proprioception, range of motion, or postural sway predict occurrence of lateral ankle sprain? *British Journal of Sports Medicine* 40(10): 824-8

De Vos RJ, Reurink G, Goudswaard GJ, Moen MH, Weir A and Tol JL (2014) Clinical findings just after return to play predict hamstring re-injury, but baseline MRI findings do not. *British Journal of Sports Medicine* 48: 1377-1384

Dennis RJ, Finch CF, McIntosh AS and Elliott BC (2008) Use of field-based tests to identify risk factors for injury to fast bowlers in cricket. *British Journal of Sports Medicine* 42(6): 477-482

Denzin NK and Lincoln Y (2003) *The Landskape of Qualitative research: theories and issues (2nd Ed)*. London: Sage

Department of Health and Human Services (2011) An Introduction to Applied Epidemiology and Biostatistics *Principles of Epidemiology in Public Health Practice* (Third Edition Edition).

Doherty C, Bleakley C, Delahunt E and Holden S (2017) Treatment and prevention of acute and recurrent ankle sprain: an overview of systematic reviews with meta-analysis. *British Journal of Sports Medicine* 51(2): 113-125

Doherty C, Bleakley CM, Hertel J, Caulfield B, Ryan J and Delahunt E (2015) Laboratory measures of postural control during the star excursion balance test after acute first-time lateral ankle sprain. *JOURNAL OF ATHLETIC TRAINING* 50(6): 651–664

Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J and Bleakley C (2014) The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. *Sports Medicine (Auckland, N.Z.)* 44(1): 123-140

Dreinhöfer K, Stucki G, Ewert T, Huber E, Ebenbichler G, Gutenbrunner C, Kostanjsek N and Cieza A (2004) ICF Core Sets for osteoarthritis. *Journal of Rehabilitation Medicine* 44 Suppl: 75-80

Dubin JC, Comeau D, McClelland RI, Dubin RA and Ferrel E (2011) Lateral and syndesmotic ankle sprain injuries: a narrative literature review. *Journal of Chiropractic Medicine* 10(3): 204-219

Dubravcic-Simunjak S, Pecina M, Kuipers H, Moran J and Haspl M (2003) The incidence of injuries in elite junior figure skaters. *American Journal of Sports Medicine* 31(4): 511-517

Duncan JJ and Farr JE (1988) Comparison of diclofenac sodium and aspirin in the treatment of acute sports injuries. *American Journal of Sports Medicine* 16(6): 656-659

Dunn W (1997) The impact of sensory processing abilities on the daily lives of young children and their families. *Infants and Young Children* 9: 23–35

Edwards P, Roberts I, Clarke M, DiGuiseppi C, Pratap S, Wentz R and Kwan I (2002) Increasing response rates to postal questionnaires: systematic review. *Britsh Medical Journal* 324: 1183

Egol KA, Tejwani NC, Walsh MG, Capla EL, Koval KJ, Egol KA, Tejwani NC, Walsh MG, Capla EL and Koval KJ (2006) Predictors of short-term functional outcome following ankle fracture surgery. *Journal of Bone & Joint Surgery, American Volume* 88(5): 974-979

Eisenhart AW, Gaeta TJ and Yens DP (2003) Osteopathic manipulative treatment in the emergency department for patients with acute ankle injuries. *The Journal Of The American Osteopathic Association* 103(9): 417-421

eLearn Center (UOC) (2013) *Research Paradigms:Ontology's, Epistemologies & Methods*. Available from: http://www.slideshare.net/eLearnCenter/research-methods-uoc-2013 [Accessed 05th September 2016]

Emery CA, Cassidy JD, Klassen TP, Rosychuk RJ and Rowe BH (2005) Effectiveness of a home-based balance-training program in reducing sports-related injuries among healthy adolescents: a cluster randomized controlled trial. *CMAJ: Canadian Medical Association Journal* 172(6): 749-754

Engstrom BKO and Renstrom AFH (1998) How can injuries be prevented in the World Cup soccer athlete? *Clinics in Sports Medicine* 17(4): 755-768

Entwistle VA, Renfrew MJ, Yearley S, Forrester J and Lamont T (1998) Lay perspectives: advantages for health research. *British Medical Journal,* 316: 463-466

Ericksen H and Gribble PA (2012) Sex differences, hormone fluctuations, ankle stability, and dynamic postural control. *Journal Of Athletic Training* 47(2): 143-148

Fang HC, Hu CH and Miltner LJ (1937) Experimental joint sprain pathologic study. *Archives of Surgery* 35: 234

Feger MA, Herb CC, Fraser JJ, Glaviano N and Hertel J (2015) Supervised rehabilitation versus home exercise in the treatment of acute ankle sprains: a systematic review. *Clinics in Sports Medicine* 34(2): 329-346

Fernandez WG, Yard EE and Comstock RD (2007) Epidemiology of lower extremity injuries among U.S. high school athletes. *Academic Emergency Medicine* 14(7): 641-645

Ferran NA and Maffulli N (2006) Epidemiology of Sprains of the Lateral Ankle Ligament Complex. *Foot and Ankle Clinics of North America* 11: 659-662

Field A (2013) *Dicovering statistics using IBM SPSS statistics (4th Ed)*. London: SAGE

Fong DT-P, Hong Y, Chan L-K, Yung PS-H and Chan K-M (2007) A systematic review on ankle injury and ankle sprain in sports. *Sports Medicine (Auckland, N.Z.)* 37(1): 73-94

Ford IW, Eklund RC and Gordon S (2000) An examination of psychosocial variables moderating the relationship between life stress and injury time-loss among athletes of a high standard. *J Sports Sci* 18(5): 301–312

Francis JJ, Johnston M, Robertson C, Glidewell L, Entwistle V, Eccles MP and Grimshaw JM (2010) Whatis an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology and Health* 25: 1229–45

Frank C (2004) Ligament structure, physiology and function. *Journal of Musculoskelet Neuronal Interact* 4(2): 199-201

Frank C, Shrive N and Bray R (1992) Ligament healing: a review of some current clinical and experimental concepts. *Iowa Orthopedic Journal* 12: 21-8

Frank C, Shrive N, Hiraoka H, Nakamura N, Kaneda Y and Hart D (1999) Optimization of the biology of soft tissue repair. *Journal of Science and Medicine in Sport* 2(3): 190-210

Freeman M (1965) Treatment of ruptures of the lateral ligament of the ankle. The Journal of

Bone and Joint Surgery

(AM) 47: 661-668

Frost SCL and Amendola A (1999) Is stress radiography necessary in the diagnosis of acute or chronic ankle instability? *Clinical Journal of Sport Medicine* 9(1): 40-45

Fuchs S, Erbe T, Fischer H and Tibesku CO (2005) Intraarticular Hyaluronic Acid versus Glucocorticoid Injections for Nonradicular Pain in the Lumbar Spine. *Journal of Vascular and Interventional Radiology* 16(11): 1493-8

Fuller CW, Molloy MG, Bagate C, Bahr R, Brooks JHM, Donson H, Kemp SPT, McCrory P, McIntosh AS, Meeuwisse WH, Quarrie KL, Raftery M and Wiley P (2007) Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *British Journal of Sports Medicine* 41(5): 328-331

Galvin R (2015) How many interviews are enough? Do qualitative interviews in building energy consumption research produce reliable knowledge? *Journal of Building Engineering* 1: 2–12

Garrick JG (1977) The frequency of injury, mechanism of injury, and epidemiology of ankle sprains. *American Journal of Sports Medicine* 5(6): 241-2

Gerber JP, Williams GN, Scoville CR, Arciero RA and Taylor DC (1998) Persistent disability associated with ankle sprains: a prospective examination of an athletic population. *Foot and Ankle International* 19(10): 653-660

Gerrard DF, Waller A and Bird YN (1994) The New Zealand rugby injury and performance project: II. Previous injury experience of a rugby-playing cohort. *British Journal of Sports Medicine* 28(4): 229-33

Geyh S, Cieza A, Schouten J, Dickson H, Frommelt P, Omar Z, Kostanjsek N, Ring H and Stucki G (2004) ICF Core Sets for stroke. *Journal of Rehabilitation Medicine* 44 Suppl: 135-41

Gilbert EH, Lowenstein SR, Koziol-McLain J, Barta DC and Steiner J (1996) Chart reviews in emergency medicine research: Where are the methods? *Annals of Emergency Medicine* 27(3): 305-8

Glazer DD (2009) Development and preliminary validation of the InjuryPsychological Readiness to Return to Sport. *JOURNAL OF ATHLETIC TRAINING* 44: 185–189

Goddard W and Melville S (2004) *Research Methodology: An Introduction (2nd ed)*. Blackwell Publishing

Goldberg B, Rosenthal PP and Nicholas JA (1984) Injuries in youth football. *Physician Sportsmed* 12(8): 122–132

Golditz T, Steib S, Pfeifer K, Uder M, Gelse K, Janka R, Hennig FF and Welsch GH (2014) Functional ankle instability as a risk factor for osteoarthritis: using T2-mapping to analyze early cartilage degeneration in the ankle joint of young athletes. *Osteoarthritis And Cartilage / OARS, Osteoarthritis Research Society* 22(10): 1377-1385

GomezI R, GusmãoII S, SilvaI J and BastosIII M (2007) Interlaminar epidural corticosteroid injection in the treatment of lumbosciatic pain: a retrospective analysis. *Arquivos de Neuro-Psiquiatria* 65(4b): 1172-1176

Goodare H and Smith R (1995) The rights of patients in research. *British Medical Journal* 310: 1277-1278

Gould D, Dieffenbach K and Moffett A (2010) Psychological Characteristics and Their Development in Olympic Champions. *Journal of Applied Sport Psychology* 14(3)

Granito V and Carroll J (2000) Psychological response to athletic injury: Themes from intercollegiate athletes. Paper presented at Association for the Advancement of Applied Sport Psychology Conference Nashville, TN

Green SB (1991) How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research* 26: 499-510

Green T, Refshauge K, Crosbie J and Adams R (2001) A randomized controlled trial of a passive accessory joint mobilization on acute ankle inversion sprains. *Physical Therapy* 81(4): 984-994

Greenbank P (2003) The role of values in educational research: the case for reflexivity. *British Educational Research Journal* 29(6)

Gribble PA, Hertel J and Plisky P (2012) Using the Star Excursion Balance Test to Assess Dynamic Postural-Control Deficits and Outcomes in Lower Extremity Injury: A Literature and Systematic Review. *Journal of Athletic Training (Allen Press)* 47(3): 339-357

Guest G, Bunce A and Johnson L (2006) How many interviews are enough? An experiment with data saturation and variability. *Field Methods* 18: 59–82

Guest G, MacQueen KM and Namey EE (2012) *Applied thematic analysis*. Thousand Oaks, CA: Sage

Guillo S, Bauer T, Lee JW, Takao M, Kong SW, Stone JW, Mangone PG, Molloy A, Perera A, Pearce CJ, Michels F, Tourné Y, Ghorbani A and Calder J (2013) Consensus in chronic ankle instability: aetiology, assessment, surgical indications and place for arthroscopy. *Orthopaedics & Traumatology, Surgery & Research: OTSR* 99(8 Suppl): S411-S419

Guillodo Y, Simon T, Le Goff A and Saraux A (2013) Interest of rehabilitation in healing and preventing recurrence of ankle sprains. *Annals of Physical and Rehabilitation Medicine* 56(7/8): 503-514

Ham-Baloyi W and Jordan P (2016) Systematic review as a research method in post-graduate nursing education. *Health SA Gesondheid* 21: 120-128

Han L, Zhang C, Liu B, Ting H and Wang J (2012) A Meta-analysis of treatment methods for acute ankle sprain. *Pakistan Journal of Medical Sciences* 28(5): 895-899

Hansrani V, Khanbhai M, Bhandari S, Pillai A and McCollum CN (2015) The role of compression in the management of soft tissue ankle injuries: a systematic review. *European Journal of Orthopaedic Surgery & Traumatology* 25(6): 987-995

Harper MC (1992) Stress radiographs in the diagnosis of lateral instability of the ankle and hindfoot. *Foot and Ankle* 13(8): 435-438

Harrell Jr FE (2001) *Regression modeling strategies*. New York: Springer-Verlag

Harriss DJ and Atkinson G (2015) Ethical Standards in Sport. *International Journal of Sports Medicine* 36: 1–4

Hartling L, Brison RJ, Crumley ET, Klassen TP and Pickett W (2004) A systematic review of interventions to prevent childhood farm injuries. *Pediatrics* 114(4): E483-E496

Hauser R, Dolan EE, Phillips HJ, Newlin AC, Moore RE and Woldin BA (2013) Ligament Injury and Healing: A Review of Current Clinical Diagnostics and Therapeutics. *The Open Rehabilitation Journal,* 6: 1-20

Heitz NA, Eisenman PA, Beck CL and Walker JA (1999) Hormonal changes throughout the menstrual cycle and increased anterior cruciate ligament laxity in females. *Journal of Athletic Training (National Athletic Trainers' Association)* 34(2): 144-149

Hennink MM (2007) *International focus group research : a handbook for the health and social sciences*. Cambridge: Cambridge University Press

Herring SA, Bergfeld JA, Boyd J, Duffey T, Fields KB, Grana WA, Indelicato P, Kibler WB, Pallay R, Putukian M and Sallis RE (2002) The team physician and return-to-play issues: A consensus statement. *Medicine and Science in Sports and Exercise* 34(7): 1212-1214

Hertel J (2000) Functional instability following lateral ankle sprain. *Sports Medicine (Auckland, N.Z.)* 29(5): 361-371

Hertel J, Denegar CR, Buckley WE, Sharkey NA and Stokes WL (2001) Effect of rearfoot orthotics on postural sway after lateral ankle sprain. *Archives of Physical Medicine and Rehabilitation* 82(7): 1000-1003

Hewett TE (2000) Neuromuscular and hormonal factors associated with knee injuries in fe-male athletes. Strategies for intervention. *Sports Medicine* 29(5): 313-327

Hignett S (2003) Systematic review of patient handling activities starting in lying, sitting and standing positions. *Journal of Advanced Nursing* 41(6): 545-552

Hilbe JM (2011) *Negative binomial regression* (2nd Edition). Cambridge: Cambridge University

Hollis JM, Blasier RD and Flahiff CM (1995) Simulated lateral ankle ligamentous injury. Change in ankle stability. *The American Journal of Sports Medicine* 23(6): 672-677

Holme E, Magnusson SP, Becher K, Bieler T, Aagaard P and Kjaer M (1999) The effect of supervised rehabilitation on strength, postural sway, position sense and re-injury risk after acute ankle ligament sprain. *Scandinavian Journal of Medicine and Science in Sports* 9(2): 104-109

Holmer P, Sondergaard L, Konradsen L, Torben Nielsen P and Nannestad Jorgensen L (1994) Epidemiology of sprains in the lateral ankle and foot. *Foot and Ankle International* 15(2): 72-74

Hootman JM, Dick R and Agel J (2007) Epidemiology of Collegiate Injuries for 15 Sports: Summary and Recommendations for Injury Prevention Initiatives. *Journal of Athletic Training (National Athletic Trainers' Association)* 42(2): 311-319

Hosea TM, Carey CC and Harrer MF (2000) The gender issue: epidemiology of ankle injuries in athletes who participate in basketball. *Clinical Orthopaedics and Related Research* 372: 45-49

Hospital Episode Statistics Analysis (2015) *Accident and Emergency Attendances in England - 2013-14*. Health and Social Care Information Centre

Hubbard TJ and Hicks-Little CA (2008) Ankle Ligament Healing After an Acute Ankle Sprain: An Evidence-Based Approach. *Journal of Athletic Training (National Athletic Trainers' Association)* 43(5): 523-529

Hultman K, Fältström A and Öberg U (2010) The effect of early physiotherapy after an acute ankle sprain. *Advances in Physiotherapy* 12(2): 65-73

Hupperets MD, Verhagen EA, Heymans MW, Bosmans JE, Van Tulder MW and Van Mechelen W (2010) Potential savings of a program to prevent ankle sprain recurrence: Economic evaluation of a randomized controlled trial. *American Journal of Sports Medicine* 38(11): 2194

Hupperets MDW, Verhagen EALM and van Mechelen W (2009) Effect of unsupervised home based proprioceptive training on recurrences of ankle sprain: randomised controlled trial. *BMJ (Clinical Research Ed.)* 339: b2684-b2684

Hutchinson MR and Ireland ML (1995) Knee injuries in female athletes. *Sports Medicine* 19: 288–302

Involve (2014) *About invlove*. Available from: www.invo.org.uk [Accessed 14/01/2018]

Invovle (2019) *What is public involvement in research?* Available from: http://www.invo.org.uk/find-out-more/what-is-public-involvement-in-research-2/ [Accessed 28/01/2019]

Jack EA (1950) Experimental rupture of the medial collateral ligament of the knee. *The Journal of bone and joint surgery* 32(B): 306

Jacob SA and Ferguson SP (2012) Writing interview protocols and conducting interviews: Tips for students new to the field of qualitative research. *The Qualitative Report* 17(42): 1-10

Jacobsen P, Witvrouw E, Muxart P, Tol JL and Whiteley R (2016) A combination of initial and follow-up physiotherapist examination predicts physician-determined time to return to play after hamstring injury, with no added value of MRI. *British Journal of Sports Medicine* 50(7): 1-10

Jick TD (1979) Mixing Qualitative and Quantitative Methods : Triangulation in Action. *Administrative Science Quarterly* 24(4): 602–611

Joffe H (2012) Thematic analysis IN: Harper D and Thompson AR (eds) *Qualitative research methods in mental health and psychotherapy*. Chichester, West Sussex, UK: Wiley-Blackwell

Johnson RB and Onwuegbuzie AJ (2004) Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher* 33(7): 14–26

Johnson U (1996) The multiply injured versus the first-time-injured athlete during rehabilitation: A comparison of nonphysical characteristics. *Journal of Sport Rehabilitation*

5: 293-304

Jones RE (1980) Common athletic injuries in women. *Comprehensive Therapy* 6: 47–49

Joseph RP, Keller C and Ainsworth BE (2016) Recruiting Participants into Pilot Trials: Techniques for Researchers with Shoestring Budgets. *Californian journal of health promotion* 14(2): 81-89

Kable AK, Pich J and Maslin-Prothero SE (2012) A structured approach to documenting a search strategy for publication: A 12 step guideline for authors. *Nurse Education Today* 32(8): 878-886

Kamien PM, Hydrick JM, Replogle WH, Go LT and Barrett GR (2013) Age, graft size, and Tegner activity level as predictors of failure in anterior cruciate ligament reconstruction with hamstring autograft. *The American Journal of Sports Medicine* 41(8): 1808-1812

Kannus P and Renström P (1991) Treatment for acute tears of the lateral ligaments of the ankle. Operation, cast, or early controlled mobilization. *The Journal Of Bone And Joint Surgery. American Volume* 73(2): 305-312

Karlsson J, Eriksson BI and Sward L (1996) Early functional treatment for acute ligament injuries of the ankle joint. *Scandinavian Journal of Medicine and Science in Sports* 6(6): 341-345

Kelikian AS (2011) *Sarrafian's anatomy of the foot and ankle : descriptive, topographic, functional* (3rd Edition). Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins

Kemler E, Thijs K, Badenbroek I, van de Port I, Hoes A and Backx F (2016) Long-term prognosis of acute lateral ankle ligamentous sprains: high incidence of recurrences and residual symptoms. *Family Practice* 33(6): 596–600

Kenow LJ (2014) *Making Return-to-Play Decisions in Competitive Sport: Challenges, Coping, and Preparation among Athletic Trainers.* Unpublished PhD thesis THE UNIVERSITY OF MINNESOTA University

Kerkhoffs GM, van den Bekerom M, Elders LA, van Beek PA, Hullegie WA, Bloemers GM, de Heus EM, Loogman MC, Rosenbrand KC, Kuipers T, Hoogstraten JW, Dekker R, Ten Duis HJ, van Dijk CN, van Tulder MW, van der Wees PJ and de Bie RA (2012) Diagnosis, treatment and prevention of ankle sprains: an evidence-based clinical guideline. *British Journal of Sports Medicine* 46(12): 854-860

Kerkhoffs GMMJ, Handoll HHG, de BR, Rowe BH and Strujis PAA (2007) Surgical versus conservative treatment for acute injuries of the lateral ligament complex of the ankle in adults. *Cochrane Database of Systematic Reviews* (2)

Kim Y (2010) The Pilot Study in Qualitative Inquiry: Identifying Issues and Learning Lessons for Culturally Competent Research. *Qualitative Social Work* 10(2): 190-206

Kitchen CM (2009) Nonparametric vs parametric tests of location in biomedical research. *American Journal of Ophthalmology* 147(4): 571-472

Kitchenham B (2004) *Procedures for Performing Systematic Reviews*. Available from: [http://csnotes.upm.edu.my/kelasmaya/pgkm20910.nsf/0/715071a8011d4c2f482577a700386d3a/$FILE/10.1.1.122.3308[1].pdf](http://csnotes.upm.edu.my/kelasmaya/pgkm20910.nsf/0/715071a8011d4c2f482577a700386d3a/$FILE/10.1.1.122.3308[1].pdf) [Accessed 23 August 2016]

Knoll T, Omar MI, Maclennan S, Hernández V, Canfield S, Yuan Y, Bruins M, Marconi L, Van Poppel H, N'Dow J and Sylvester R (2017) Key Steps in Conducting Systematic Reviews for Underpinning Clinical Practice Guidelines: Methodology of the European Association of Urology. *European Urology* pii: S0302-2838(17): 30709-1

Konradsen L, Bech L, Ehrenbjerg M and Nickelsen T (2002) Seven years follow-up after ankle inversion trauma. *Scandinavian Journal of Medicine and Science in Sports* 12(3): 129-135

Kovaleski JE, Gurchiek LR, Heitman RJ, Hollis JM and Pearsall AW (1999) Instrumented measurement of anteroposterior and inversion-eversion laxity of the normal ankle joint complex. *Foot and Ankle International* 20(12): 808-814

Kristianslund E, Bahr R and Krosshaug T (2011) Kinematics and kinetics of an accidental lateral ankle sprain. *Journal of Biomechanics* 44(14): 2576-2578

Kuhn TS (1962) *The Structure of Scientific Revolution* (2nd Edition). Chicago: University of Chicago Press

Kus S, Oberhauser C and Cieza A (2012) Validation of the brief International Classification of Functioning, Disability, and Health (ICF) core set for hand conditions. *Journal of Hand Therapy* 25(3): 274-86

Lamb SE, Marsh JL, Hutton JL, Nakash R and Cooke MW (2009) Mechanical supports for acute, severe ankle sprain: a pragmatic, multicentre, randomised controlled trial. *Lancet* 373(9663): 575-581

Lambers K, Ootes D and Ring D (2012) Incidence of patients with lower extremity injuries presenting to US emergency departments by anatomic region, disease category, and age. *Clinical Orthopaedics and Related Research* 470(1): 284-290

Langford JL, Webster KE and Feller JA (2009) A prospective longitudinal study to assess psychological changes following anterior cruciate ligament reconstruction surgery. *British Journal of Sports Medicine* 43: 377–378

LaPrade RF and Burnett QM (1994) Femoral intercondylar notch stenosis and correlation to anterior cruciate ligament injuries: A prospective study. *American Journal of Sports Medicine* 22: 198–203

Lardenoye S, Theunissen E, Cleffken B, Brink PR, de Bie RA and Poeze M (2012) The effect of taping versus semi-rigid bracing on patient outcome and satisfaction in ankle sprains: a prospective, randomized controlled trial. *BMC Musculoskeletal Disorders* 13: 81-81

Larsen E, Jensen PK and Jensen PR (1999) Long-term outcome of knee and ankle injuries in elite football. *Scandinavian Journal of Medicine and Science in Sports* 9(5): 285-289

Lauder TD, Baker SP, Smith GS and Lincoln AE (2000) Sports and physical training injury hospitalizations in the Army. *American Journal of Preventive Medicine* 18(Supplement 1): 118-128

Lawson AE (2015) Hypothetico-deductive Method. *Encyclopedia of Science Education.* AZ, USA: Arizona State University

Leanderson J and Wredmark T (1995) Treatment of acute ankle sprain: comparison of a semi-rigid ankle brace and compression bandage in 73 patients. *Acta Orthopaedica Scandinavica* 66(6): 529-531

Leddy JJ, Kesari A and Smolinski RJ (2002) Implementation of the Ottawa ankle rule in a university sports medicine center. *Medicine and Science in Sports and Exercise* 34(1): 57-62

Leech NL and Onwuegbuzie AJ (2011) Beyond Constant Comparison Qualitative Data Analysis: Using NVivo. *School Psychology Quarterly* 26(1): 70 – 84

Leininger RE, Knox CL and Comstock RD (2007) Epidemiology of 1.6 Million Pediatric Soccer-Related Injuries Presenting to US Emergency Departments From 1990 to 2003. *American Journal of Sports Medicine* 35(2): 288-293

Lenhart A, Ling R, Campbell S, Purcell K, Pew I and American Life P (2010) Teens and Mobile Phones: Text Messaging Explodes as Teens Embrace It as the Centerpiece of Their Communication Strategies with Friends. Pew Internet & American Life Project

Loughborough University (2018) *Dozens of British sports concerned about a future without central Government support*. Available from: https://www.lboro.ac.uk/media-centre/press-releases/2018/april/uk-sport-funding-cuts/ [Accessed 25/7/2019]

Lutter JM and Lee V (1993) The Athletic Female IN: AJ P (ed) *Exercise in pregnancy*. Champaign IL: Human Kinetics Publishers 81–102

Lynch S and Renstrom P (1999) Treatment of Acute Lateral Ankle Ligament Rupture in the Athlete: Conservative Versus Surgical Treatment. *Sports Medicine* 27(1): 61-71

Lyons E and Coyle A (2016) *Analysing qualtitative data in psychology (2nd Ed)*. London: Sage

Mai N and Cooper L (2009) Assessment of ankle injuries. *The Journal Of School Nursing: The Official Publication Of The National Association Of School Nurses* 25(1): 34-39

Mailuhu AKE, Oei EHG, van Putte-Katier N, van Ochten JM, Bindels PJE, Bierma-Zeinstra SMA and van Middelkoop M (2017) Clinical and radiological predictors for persistent complaints five years after a lateral ankle sprain: A long-term follow-up study in primary care. *Journal of Science and Medicine in Sport* S1440-2440(17): 30946-5

Mainwaring L (1999) Restoration of self: A model for the psychological response of athletes to severe knee injuries. *Canadian Journal of Rehabilitation* 12(3): 145-156

Malliaropoulos N, Ntessalen M, Papacostas E, Longo UG and Maffulli N (2009) Reinjury after acute lateral ankle sprains in elite track and field athletes. *The American Journal of Sports Medicine* 37(9): 1755-1761

Mankovsky AB, Mendoza-Sagaon M, Cardinaux C, Hohlfeld J and Reinberg O (2002) Evaluation of scooter-related injuries in children. *Journal of Pediatric Surgery* 37: 755-759

Mann CJ (2003) Observational research methods. Research design II: cohort, cross sectional, and case-control studies. *Emergency Medicine Journal* 20(1): 54-60

Mason M (2010) *Sample size and saturation in PhD studies using qualitative interviews.* Available from: http://nbn-resolving.de/urn:nbn:de:0114 [Accessed 31/01/2019]

Mays N and Pope C (2000) Qualitative research in health care. Assessing quality in qualitative research. *BMJ* 320(7226): 50-2

McCann R, Kosik K, Terada M and Gribble P (2018) Residual Impairments and Activity Limitations at Return to Play from a Lateral Ankle Sprain. *International Journal of Athletic Therapy & Training* 23: 83-88

McCarty EC, Ritchie P, Gill HS and McFarland EG (2004) Shoulder instability: return to play. *Clinics in Sports Medicine* 23(3): 335-351

McKay GD, Goldie PA, Payne WR and Oakes BW (2001) Ankle injuries in basketball: injury rate and risk factors. *British Journal of Sports Medicine* 35(2): 103-108

McKeon JMM, Bush HM, Reed A, Whittington A, Uhl TL and McKeon PO (2014) Return-to-play probabilities following new versus recurrent ankle sprains in high school athletes. *Journal of Science and Medicine in Sport* 17(1): 23-28

Mclafferty E and Farley A (2006) Analysing qualitative research data using computer software. *Nursing Times* 102(24): 34-36

McNamara C (2009) *General guidelines for conducting interviews*. Available from: http://managementhelp.org/evaluatn/intrview.htm [Accessed 29/01/2019]

Medina McKeon JM, Bush HM, Reed A, Whittington A, Uhl TL and McKeon PO (2014) Return-to-play probabilities following new versus recurrent ankle sprains in high school athletes. *Journal Of Science And Medicine In Sport / Sports Medicine Australia* 17(1): 23-28

Meeuwisse WH (1994) Assessing Causation in Sport Injury: A Multifactorial Model. *Clinical Journal of Sport Medicine* 4(3): 166-170

Mendel FC, Dolan MG, Fish DR, Marzo J and Wilding GE (2010) Effect of High-Voltage Pulsed Current on Recovery After Grades I and II Lateral Ankle Sprains. *Journal of Sport Rehabilitation* 19(4): 399-410

Mendelsohn ES, Hoshino CM, Harris TG and Zinar DM (2013) The effect of obesity on early failure after operative syndesmosis injuries. *Journal of Orthopaedic Trauma* 27(4): 201-206

Meredith PJ, Rappel G, Strong J and Bailey KJ (2015) Sensory sensitivity and strategies for coping with pain. *American Journal of Occupational Therapy* 69(4)

Messer AB and Jain TK (2017) Is ankle taping an appropriate intervention for preventing lateral ankle sprains? A systematic review. *Journal of Orthopaedic & Sports Physical* 47(1): A123–A124

Miller BS, Downie BK, Johnson PD, Schmidt PW, Nordwall SJ, Kijek TG, Jacobson JA and Carpenter JE (2012) Time to return to play after high ankle sprains in collegiate football players: a prediction model. *Sports Health* 4(6): 504-509

Miranda H, Viikari-Juntura E, Martikainen R, Takala EP and Riihimäki H (2001) A prospective study of work related factors and physical exercise as predictors of shoulder pain. *Occupational and Environmental Medicine* 58(8): 528-534

Moen MH, Reurink G, Weir A, Tol JL, Maas M and Goudswaard GJ (2014) Predicting return to play after hamstring injuries. *British Journal of Sports Medicine* 48(18): 1358-1363

Mohamad Shariff H, Ashril Y and Mohamed Razif MA (2013) Pattern of muscle injuries and predictors of return-to-play duration among Malaysian athletes. *Singapore Medical Journal* 54(10): 587-91.

Mohanty S, Mishra N, Patil P and Desale A (2016) Functional Evaluation of Patients Undergoing Multiple Joint Replacements: A Retrospective Study of 50 Patients with a Minimum of Six Months of Follow-up. *Cureus* 8(10): e830

Moher D, Liberati A, Tetzlaff J, Altman DG and PRISMA Group (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Journal Of Clinical Epidemiology* 62: 1006-1012

Morisette JT and Khorram S (1998) Exact binomial confidence interval for proportions. *PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING* 64(4): 281-283

Morrey MA, Stuart MJ, Smith AM and Wiese-Bjornstal DM (1999) A longitudinal examination of athletes' emotional and cognitive responses to anterior cruciate ligament injury. *Clin J Sport Med.* 9: 63–9

Morrow SL (2007) Qualitative research in counselling psychology: Conceptual foundations. *Journal of Counseling Psychology* 35(2): 209-235

Mountcastle SB, Posner M, Kragh Jr JF and Taylor DC (2007) Gender Differences in Anterior Cruciate Ligament Injury Vary With Activity Epidemiology of Anterior Cruciate Ligament Injuries in a Young, Athletic Population. *American Journal of Sports Medicine* 35(10): 1635-1643

Muaidi QI, Nicholson LL, Refshauge KM, Herbert RD and Maher CG (2007) Prognosis of conservatively managed anterior cruciate ligament injury: a systematic review. *Sports Medicine (Auckland, N.Z.)* 37(8): 703-716

Murtaugh K (2001) Injury patterns among female field hockey players. *Medicine and Science in Sports and Exercise* 33(2): 201-7

Naeem M, Rahimnajjad MK, Rahimnajjad NA, Idrees Z, Shah GA and Abbas G (2015) Assessment of functional treatment versus plaster of Paris in the treatment of grade 1 and 2 lateral ankle sprains. *Journal Of Orthopaedics And Traumatology: Official Journal Of The Italian Society Of Orthopaedics And Traumatology* 16(1): 41-46

NCI (2015) *NCI Dictionary of Cancer Terms*. Available from: https://www.cancer.gov/publications/dictionaries/cancer-terms?cdrid=561718 [Accessed 16/01/2018]

Nelson AJ, Collins CL, Yard EE, Fields SK and Comstock RD (2007) Ankle injuries among United States high school sports athletes, 2005-2006. *JOURNAL OF ATHLETIC TRAINING* 42(3): 381-387

Neuendorf KA (2019) Content analysis and thematic analysis IN: Brough P (ed) *Research methods for applied psychologists: Design, analysis and reporting*. New York: Routledge 211-223

NHS England (2018) *Allocations*. Available from: https://www.england.nhs.uk/allocations/]

Nixon HL (1992) A social network analysis of influences on athlete to play with pain and injuries. *Journal of Sport and Social Issues* 16: 127-135

Nordin M and Frankel V (2001) *Basic biomechanics of the musculoskeletal system*. Lippincott Williams & Wilkins

Northumbria University (2018) *Northumbria University axes elite sports teams amid cuts*. Available from: https://www.bbc.com/news/uk-england-tyne-44778994]

Nyanzi CS, Langridge J, Heyworth JRC and Mani R (1999) Randomized controlled study of ultrasound therapy in the management of acute lateral ligament sprains of the ankle joint. *Clinical Rehabilitation* 13(1): 16-22

Nygaard OP, Kloster R and Solberg T (2000) Duration of leg pain as a predictor of outcome after surgery for lumbar disc herniation: a prospective cohort study with 1-year follow up. *Journal of Neurosurgery* 92(2 Suppl): 131-4

O'Connor SR, Bleakley CM, Tully MA and McDonough SM (2013) Predicting functional recovery after acute ankle sprain. *PloS One* 8(8): e72124-e72124

O’Connor SR, Bleakley CM, Tully MA and McDonough SM (2013) Predicting Functional Recovery after Acute Ankle Sprain. *PloS One* 8(8): 1-1

O’Reilly M and Parker N (2012) Unsatisfactory saturation’’: A critical exploration of the notion of saturated sample sizes in qualitative research. *Qualitative Research* 13: 190–97

Oakley AG (1998) Methodology and people's ways of knowing: Some problems with feminism and the paradigm debate in social science. *Sociology of Health and Illness* 32: 707–31

Ohman A (2005) Qualitative methodology for rehabilitation research. *Journal Of Sport Rehabilitation* 37(5): 273-80

Oliver S (1995) How can health service users contribute to the NHS research and development agenda? *British Medical Journal* 310: 1318-1320

Orchard J and Best TM (2002) The management of muscle strain injuries: an early return versus the risk of recurrence. (Guest editorial). *Clinical Journal of Sport Medicine* 12(1): 3-5

Orchard J, T.M B and Verrall GM (2005) Return to Play Following Muscle Strains. *Clinical Journal of Sport Medicine* 15((6): 436-41

Orchard J, Wood T, Seward H and Broad A (1998) Comparison of injuries in elite senior and junior Australian football. *Journal of Science and Medicine in Sport* 1(2): 82-88

Pain M and Kerr JH (2004) Extreme risk taker who wants to continue taking part in high risk sports after serious injury. *British Journal of Sports Medicine* 38(3): 337-9

Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N and Hoagwood K (2015) Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health* 42(5): 533-44

Parekh S (2017) Optimal Time to Return to Play and Performance After Jones Fracture Surgery in the National Football League. *Foot & Ankle Orthopaedics* 2(3)

Patton MQ (2002) *Qualitative Research & Evaluation Methods (3rd ed.)*. London: Sage Publications, Inc

Pearce N (2012) Classification of epidemiological study designs. *International Journal of Epidemiology* 41(2): 393–397

Perron M, Moffet H, Nadeau S, Hébert LJ and Belzile S (2014) Persistence of long term isokinetic strength deficits in subjects with lateral ankle sprain as measured with a protocol including maximal preloading. *Clinical Biomechanics* 29: 1151-1157

Peters S, Johnston V, Hines S, Ross M and Coppieters M (2006) Prognostic factors for return-to-work following surgery for carpal tunnel syndrome: a systematic review. *JBI Database System Rev Implement Rep* 14(9): 135-216

Petersen W, Rembitzki IV, Koppenburg AG, Ellermann A, Liebau C, Brüggemann GP and Best R (2013) Treatment of acute ankle ligament injuries: a systematic review. *Archives of Orthopaedic and Trauma Surgery* 133(8): 1129-1141

Petrella MJ, Cogliano A and Petrella RJ (2009) Original Research: Long-Term Efficacy and Safety of Periarticular Hyaluronic Acid in Acute Ankle Sprain. *Physician and Sportsmedicine* 37(1): 64-70

Petrella RJ, Cogliano A, Decaria J, Mohamed N and Lee R (2010) Management of Tennis Elbow with sodium hyaluronate periarticular injections. *BMC Sports Science, Medicine and Rehabilitation* 2(1): 4

Petrella RJ, Petrella MJ and Cogliano A (2007) Periarticular hyaluronic acid in acute ankle sprain. *Clinical Journal of Sport Medicine* 17(4): 251-257

Petrie TA (1992) Psychosocial antecedents of athletic injury: the effects of life stress and social support on female collegiate gymnasts. *Behavioral Medicine* 18(3): 127–138

Petrie TA (1993) Coping skills, competitive trait anxiety, and playing status: moderating effects on the life stress-injury relationship. *Journal of Sport & Exercise Psychology* 15(3): 261–274

Petry NM (2002) A comparison of young, middle-aged, and older adult treatment-seeking pathological gamblers. *Gerontologist* 42(1): 92-99

Pijnenburg ACM, Van Dijk CN, Bossuyt PMM and Marti RK (2000) Treatment of ruptures of the lateral ankle ligaments: A meta-analysis. *Journal Of Bone And Joint Surgery-American Volume* 82A(6): 761-773

Podlog L and Eklund RC (2006) A longitudinal investigation of competitive athletes' return to sport following serious injur. *Journal of Applied Sport Psychology* 18: 44-68

Pole C and Lampard R (2002) *Practical Social Investigation –Qualitative and Quantitative Methods in Social Research*. Harlow: Pearson Education

Pollard A and Cronin G (2005) Compression bandaging for soft tissue injury of the ankle: a literature review. *Emergency Nurse* 13(6): 20-5

Porth C (2006) Inflammation, Tissue Repair, and Fever IN: Sommer CV and Parth CM (eds) *Essential of Pathophysiology-Concepts of Altered States*. 150-167 Available from: http://fac.ksu.edu.sa/sites/default/files/ch09_0.pdf [Accessed 20/4/2020]

Postle K, Pak D and Smith TO (2012) Effectiveness of proprioceptive exercises for ankle ligament injury in adults: A systematic literature and meta-analysis. *Manual Therapy* 17(4): 285-291

Powell JW and Barber-Foss KD (2000) Sex-related injury patterns among selected high school sports. / Types de blessures selon le sexe lors d'activites sportives au lycee. *American Journal of Sports Medicine* 28(3): 385-391

Prado MP, Mendes AAM, Amodio DT, Camanho GL, Smyth NA and Fernandes TD (2014) A comparative, prospective, and randomized study of two conservative treatment protocols for first-episode lateral ankle ligament injuries. *Foot and Ankle International* 35(3): 201-206

Praemer A, Furner S and Rice D (1999) *Musculoskeletal conditions in the United States. Rosemont (IL)*. American Academy of Orthopaedic Surgeons

Prentice WE (2014) *Principles of athletic training: A competency-based approach (15th ed.)*. New York: McGraw-Hill

Prescott P and Soeken K (1989) The Potential Uses of Pilot Work. *Nursing Research* 38(1): 60–2

Price RJ, Hawkins RD, Hulse MA and Hodson A (2004) The Football Association medical research programme: an audit of injuries in academy youth football. *British Journal of Sports Medicine* 38(4): 466-471

Procter P and Paul J (1982) Ankle joint biomechanics. . *Journal of Biomechanics* 15: 627-634

Punt IM, Ziltener JL, Laidet M, Armand S and Allet L (2015) Gait and physical impairments in patients with acute ankle sprains who did not receive physical therapy. *PM R* 7(1): 34–41

Punt IM, Ziltener JL, Monnin D and Allet L (2016) Wii Fit exercise therapy for the rehabilitation of ankle sprains: Its effect compared with physical therapy or no functional exercises at all. *Scandinavian Journal of Medicine and Science in Sports* 26(7): 816-823

Randall RM, Saluan P, Ballock RT, Messner W, Brigati D, Chambers R and Goodwin R (2017) Return to Play After Common Pediatric Fractures: Is There Consensus? *Journal of Orthopaedics, Rheumatology and Sports Medicine*

2(1): 115

Reilly KA, Barker KL and Shamley D (2006) Review: A systematic review of lateral wedge orthotics—how useful are they in the management of medial compartment osteoarthritis? *The Knee* 13: 177-183

Renstrom P, Wertz M, Incavo S, Pope M, Ostgaard HC, Arms S and Haugh L (1988) Strain in the lateral ligaments of the ankle. *Foot and Ankle* 9(2): 59-63

Richie DH and Izadi FE (2015) Return to Play After an Ankle Sprain. Guidelines for the Podiatric Physician. *Clinics in Podiatric Medicine and Surgery* 32: 195-215

Richmond SA, Fukuchi RK, Ezzat A, Schneider K, Schneider G and Emery CA (2013) Are joint injury, sport activity, physical activity, obesity, or occupational activities predictors for osteoarthritis? A systematic review. *The Journal Of Orthopaedic And Sports Physical Therapy* 43(8): 515-B19

Ritchie J and Lewis J (2003) *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. London: Sage Publications

Rocinski TJ, Hooker DN, Prentice WE, Shields EW and Cote-Murray DJ (1991) The effects of intermittent compression on edema in postacute ankle sprains. *The Journal Of Orthopaedic And Sports Physical Therapy* 14(2): 65-69

Roos KG, Kerr ZY, Mauntel TC, Djoko A, Dompier TP and Wikstrom EA (2017) The epidemiology of lateral ligament complex ankle sprains in national collegiate athletic association sports. *American Journal of Sports Medicine* 45: 201–209

Ryan GW and Bernard HR (2000) Data management and analysis methods IN: Denzin NK and Lincoln YS (eds) *Handbook of Qualitative Research (2nd ed)*. Thousand Oaks, CA: Sage 769-802

Safai P (2003) Healing the body in the “Culture of Risk”: Examining the negotiation of treatment between sport medicine clinicians and injured athletes in Canadian intercollegiate sport. *Sociology of Sport Journal* 20: 127-146

Safran MR, Benedetti RS, Bartolozzi ARI and Mandelbaum BR (1999) Lateral ankle sprains: a comprehensive review Part 1: etiology, pathoanatomy, histopathogenesis, and diagnosis. *Medicine and Science in Sports and Exercise* 31(7): S429-S437

Sandberg R, Balkfors B, Nilsson B and Westlin N (1987) Operative versus non-operative treatment of recent injuries to the ligaments of the knee. A prospective randomized study. *Journal of Bone and Joint Surgery - Series A* 69(8): 1120-1126

Sandon A, Werner S and Forssblad M (2015) Factors associated with returning to football after anterior cruciate ligament reconstruction. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal Of The ESSKA* 23(9): 2514-2521

Sara HD and Nick B (1998) The Feasibility of Creating a Checklist for the Assessment of the Methodological Quality Both of Randomised and Non-Randomised Studies of Health Care Interventions. *Journal of Epidemiology and Community Health (1979-)* (6): 377

Sarrafian S (1993) Biomechanics of the subtalar joint complex. . Paper presented at Clinical Orthopaedics and Related Research

Sauer HD, Jungfer E and Jungbluth KH (1978) Experimental studies on tensile strength of the ligamental apparatus of the human ankle joint. *Hefte zur Unfallheilkunde* (131): 37-42

Scase E, Magarey ME, Chalmers S, Heynen M, Petkov J and Bailey S (2012) The epidemiology of injury for an elite junior Australian Football cohort. *Journal of Science and Medicine in Sport* 15(3): 207-212

Scheuringer M, Stucki G, Huber EO, Brach M, Schwarzkopf SR, Kostanjsek N and Stoll T (2005) ICF Core Set for patients with musculoskeletal conditions in early post-acute rehabilitation facilities. *Disability and Rehabilitation* 27(7/8): 405 – 410

Schlussel MM, Keene DJ, Collins GS, Bostock J, Byrne C, Goodacre S, Gwilym S, Hagan DA, Haywood K, Thompson J, Williams MA and Lamb SE (2018) Development and prospective external validation of a tool to predict poor recovery at 9 months after acute ankle sprain in UK emergency departments: the SPRAINED prognostic model. *BMJ Open* 8(11)

Schmidt FL (1971) The relative efficiency of regression and simple unit predictor weights in applied differential psychology. *Educational and Psychological Measurement* 31(3): 699-714

Seah R and Mani-Babu S (2011) Managing ankle sprains in primary care: what is best practice? A systematic review of the last 10 years of evidence. *British Medical Bulletin* 97(1): 105-135

Seil R, Rupp S, Tempelhof S and Kohn D (1998) Sport injuries in team handball. A one-year prospective study of sixteen men's senior teams of a superior nonprofessional level. *American Journal of Sports Medicine* 26(5): 681-687

Seyedmehdi M, Attarchi M, Ghaffari M, Mohammadi S, Darnahal M and Sadeghi Z (2015) Prognostic factors for return to work after low-back disc herniation surgery. *Asia-Pacific Journal of Public Health* 27(2): NP1775-84

Shah S, Thomas AC, Noone JM, Blanchette CM and Wikstrom EA (2016) Incidence and Cost of Ankle Sprains in United States Emergency Departments. *Sports Health* 8(6): 547-552

Shelbourne KD, Facibene WA and Hunt JJ (1997) Radiographic and intraoperative intercondylar notch width measurements in men and women with unilateral and bilateral anterior cruciate ligament tears. *Knee Surgery, Sports Traumatology, Arthroscopy* 5: 229–233

Shrier I (1995) TREATMENT OF LATERAL COLLATERAL LIGAMENT SPRAINS OF THE ANKLE - A CRITICAL-APPRAISAL OF THE LITERATURE. *Clinical Journal of Sport Medicine* 5(3): 187-195

Shrive N, Chimich D, Marchuk LL, Wilson J, Brant R and Frank C (1995) Soft-tissue “flaws” are associated with material properties of the healing rabbit medial collateral ligament. *Journal of Orthopaedic Research* 13: 923-9

Sibold J, Howard A and Zizzi S (2011) A comparison of psychosocial and orthopedic data in injured college athletes: A novel application of hurdle regression. Athletic Insight. *The Online Journal of Sport Psychology* 3(2): 153-164

Silverman D (2006) *Interpreting Qualitative Data – Methods for Analyzing Talk, Text and Interaction.* London: Sage Publications

Silverman D (2017) *Doing qualitative research 5th ed*. London: SAGE

Skovron ML, Koval KJ, Aharonoff GB and Zuckerman JD (1997) Outcome assessment after fracture in the elderly. *Instructional Course Lectures* 46: 439-443

Slimani M, Bragazzi NL, Znazen H, Paravlic A, Azaiez F and Tod D (2018) Psychosocial predictors and psychological prevention of soccer injuries: a systematic review and meta-analysis of the literature. *Physical Therapy in Sport* 32: 293-300

Sman AD, Hiller CE, Rae K, Linklater J, Black DA and Refshauge KM (2014) Prognosis of ankle syndesmosis injury. *Medicine and Science in Sports and Exercise* 46(4): 671-677

Smith A, Scott S, O’Fallon M and Young M (1990) Emotional responses of athletes to injury. *Mayo Clinic Proceedings* 65: 38-50

Smith AM (1996) Psychological impact of injuries in athletes. *Sports Medicine* 22: 391–405

Smith JA and Osborn M (2009) Interpretative phenomenological analysis IN: Smith JA, Flowers P and Larkin M (eds) *Interpretative phenomenological analysis: theory, method and research*. Los Angeles: SAGE 53-80

Smith T, Walker J and Russell N (2007) Outcomes of medial patellofemoral ligament reconstruction for patellar instability: a systematic review. *Knee Surgery, Sports Traumatology, Arthroscopy* 15(11): 1301-1314

Smith TO, Easton V, Bacon H, Jerman E, Armon K, Poland F and Macgregor AJ (2014) The relationship between benign joint hypermobility syndrome and psychological distress: a systematic review and meta-analysis. *Rheumatology* 53(1): 114-122

Social Media (2019) *Most Popular Social Networks in the UK*. Available from: https://social-media.co.uk/list-popular-social-networking-websites [Accessed 31/01/2019]

Song J and Chung K (2010) Observational Studies: Cohort and Case-Control Studies. *Plastic and Reconstructive Surgery* 126(6): 2234-2242

Soomro N, Sanders R, Hackett D, Hubka T, Ebrahimi S, Freeston J and Cobley S (2016) The Efficacy of Injury Prevention Programs in Adolescent Team Sports. *American Journal of Sports Medicine* 44(9): 2415-2424

Sports England (2016) Who play sports? National picture.

Stasinopoulos D (2004) Comparison of three preventive methods in order to reduce the incidence of ankle inversion sprains among female volleyball players. *British Journal of Sports Medicine* 38(2): 182-185

Stergioulas A (2004) Low-level laser treatment can reduce edema in second degree ankle sprains. *Journal of Clinical Laser Medicine and Surgery* 22(2): 125-128

Stiell IG, Greenberg GH, McKnight RD, Nair RC, McDowell I and Worthington JR (1992) A study to develop clinical decision rules for the use of radiography in acute ankle injuries. *Annals of Emergency Medicine* 21(4): 384-390

Stormont DM, Morrey BF, An KN and Cass JR (1985) Stability of the loaded ankle. Relation between articular restraint and primary and secondary static restraints. *The American Journal of Sports Medicine* 13(5): 295-300

Strauss A and Corbin J (1990) *Basics of qualitative research: grounded theory procedures and techniques*. London: Sage Publications

Stucki G, Cieza A, Geyh S, Battistella L, Lloyd J, Symmons D, Kostanjsek N and Schouten J (2004) ICF Core Sets for rheumatoid arthritis. *J Rehabil Med.* 44 Suppl: 87-93

Swenson DM, Yard EE, Fields SK and Comstock RD (2009) Patterns of recurrent injuries among US high school athletes, 2005-2008. *The American Journal of Sports Medicine* 37(8): 1586-1593

Takao M, Ochi M, Uchio Y, Naito K, Kono T and Oae K (2003) Osteochondral lesions of the talar dome associated with trauma. *Arthroscopy: The Journal Of Arthroscopic & Related Surgery: Official Publication Of The Arthroscopy Association Of North America And The International Arthroscopy Association* 19(10): 1061-1067

Tassignon B, Verschueren J, Delahunt E, Smith M, Vicenzino B, Verhagen E and Meeusen R (2019) Criteria-Based Return to Sport Decision-Making Following Lateral Ankle Sprain Injury: a Systematic Review and Narrative Synthesis. *Sports Medicine* 49(4): 601-619

Taylor DC, Dalton JD, Seaber AV and Garrett WE (1993) Experimental muscle strain injury: Early functional and structural deficits and the increased risk for reinjury. *The American Journal of Sports Medicine* 21(2): 190-194

Teddlie C and Tashakkori A (2009) *Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioural Science*. London: Sage

Thacker SB, Stroup DF, Branche CM, Gilchrist J, Goodman RA and Weitman EA (1999) The prevention of ankle sprains in sports: a systematic review of the literature. / Prevention des entorses de la cheville en sport. *American Journal of Sports Medicine* 27(6): 753-760

The Cochrane Collaboration (2005) *the Glossary of the Cochrane Reviewers' Handbook*. Available from: http://www.cochrane.org/resources/handbook [Accessed 23 August 2016]

Thompson J, Byrne C, Williams M, Keene D, Schlussel M and Lamb S (2017) Prognostic factors for recovery following acute lateral ankle ligament sprain: a systematic review. *BMC Musculoskeletal Disorders* 18: 421

Tiling T, Bonk A, Höher J and Klein J (1994) [Acute injury to the lateral ligament of the ankle joint in the athlete]. *Der Chirurg; Zeitschrift Für Alle Gebiete Der Operativen Medizen* 65(11): 920-933

Tohyama H, Beynnon BD, Renström PA, Theis MJ, Fleming BC and Pope MH (1995) Biomechanical analysis of the ankle anterior drawer test for anterior talofibular ligament injuries. *Journal of Orthopaedic Research* 13(4): 609-614

Tohyama H, Yasuda K, Ohkoshi Y, Beynnon BD and Renstrom PA (2003) Anterior drawer test for acute anterior talofibular ligament injuries of the ankle. How much load should be applied during the test? / Evaluation des tiroirs anterieurs pour des blessures au ligament peroneo-astragalien anterieur de la cheville: quelle charge peut-elle etre appliquee lors du test ? *American Journal of Sports Medicine* 31(2): 226-232

Tooth LR, Ottenbacher KJ, Smith PM, Illig SB, Linn RT, Gonzales VA and Granger CV (2003) Effect of functional gain on satisfaction with medical rehabilitation after stroke. *American Journal of Physical Medicine and Rehabilitation* 82(9): 692-699

Tranfield D, Denyer D and Smart P (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management* 14: 207-222

Tripepi G, .Jager KJ, Dekker FW, Wanner C and Zoccali C (2008) Bias in clinical research. *Kidney International* 73(2): 148-153

Trochim W (2006) *Probability Sampling*. Available from: http://www.socialresearchmethods.net/kb/sampprob.php [Accessed 27/12/2016]

Tropp H, Odenrick P and Gillquist J (1985) Stabilometry recordings in functional and mechanical instability of the ankle joint. *International Journal of Sports Medicine* 6(3): 180-182

Truyols-DomÍNguez S, Salom-Moreno J, Abian-Vicen J, Cleland JA and FernÁNdez-De-Las-PeÑAs C (2013) Efficacy of Thrust and Nonthrust Manipulation and Exercise With or Without the Addition of Myofascial Therapy for the Management of Acute Inversion Ankle Sprain: A Randomized Clinical Trial. *Journal of Orthopaedic and Sports Physical Therapy* 43(5): 300-309

Tsang KKW, Hertel J and Denegar CR (2003) Volume decreases after elevation and intermittent compression of postacute ankle sprains are negated by gravity-dependent positioning. *Journal of Athletic Training (National Athletic Trainers' Association)* 38(4): 320-324

University Hospital Southampton NHS Foundation Trust *Southampton General Hospital*. Available from: http://www.uhs.nhs.uk/Ourhospitals/SGH/SouthamptonGeneralHospital.aspx [Accessed 24/12/2017]

Van den Bekerom M, Oosra RJ, Alvarez PG and Van Dijk CN (2008) The anatomy in relation to injury of the lateral collateral ligamnets of the ankle: A current concept review. *Clinical Anatomy* 21: 619-626

van den Bekerom MPJ, Kerkhoffs GMMJ, McCollum GA, Calder JDF and van Dijk CN (2013) Management of acute lateral ankle ligament injury in the athlete. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal Of The ESSKA* 21(6): 1390-1395

van den Bekerom MPJ, Sjer A, Somford MP, Bulstra GH, Struijs PAA and Kerkhoffs GMMJ (2015) Non-steroidal anti-inflammatory drugs (NSAIDs) for treating acute ankle sprains in adults: benefits outweigh adverse events. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal Of The ESSKA* 23(8): 2390-2399

van den Bekerom MPJ, Struijs PAA, Blankevoort L, Welling L, van Dijk N and Kerkhoffs GMMJ (2012) What Is the Evidence for Rest, Ice, Compression, and Elevation Therapy in the Treatment of Ankle Sprains in Adults? *Journal Of Athletic Training* 47(4): 435-443

van der Horst N, van de Hoef S, Reurink G, Huisstede B and Backx F (2016) Return to Play After Hamstring Injuries: A Qualitative Systematic Review of Definitions and Criteria. *Sports Medicine* 46(6): 899-912

Van der Linde E and Oschman Z (2011) Comparative ultrasound study of acute lateral ankle ligament injuries rehabilitated with conventional and jump stretch flex band programmes. *African Journal for Physical, Health Education, Recreation and Dance* 17(4): 591-602

van der Wees PJ, Hendriks EJM, Jansen MJ, van Beers H, de Bie RA and Dekker J (2007) Adherence to physiotherapy clinical guideline acute ankle injury and determinants of adherence: a cohort study. *BMC Musculoskeletal Disorders* 8

van Dijk CN, Mol BW, Lim LS, Marti RK and Bossuyt PM (1996) Diagnosis of ligament rupture of the ankle joint. Physical examination, arthrography, stress radiography and sonography compared in 160 patients after inversion trauma. *Acta Orthopaedica Scandinavica* 67(6): 566-570

van Middelkoop M, van Rijn RM, Verhaar JAN, Koes BW and Bierma-Zeinstra SMA (2012) Re-sprains during the first 3 months after initial ankle sprain are related to incomplete recovery: an observational study. *Journal of Physiotherapy* 58: 181-188

van Rijn RM (2008a) Review: many adults still have pain and subjective instability at 1 year after acute lateral ankle sprain. *Evidence Based Medicine* 13(6): 187-187

van Rijn RM, van Ochten J, Luijsterburg PAJ, van Middelkoop M, Koes BW and Bierma-Zeinstra SMA (2010a) Effectiveness of additional supervised exercises compared with conventional treatment alone in patients with acute lateral ankle sprains: systematic review. *British Medical Journal* 341

van Rijn RM, van Ochten J, Luijsterburg PAJ, van Middelkoop M, Koes BW and Bierma-Zeinstra SMA (2010b) Effectiveness of additional supervised exercises compared with conventional treatment alone in patients with acute lateral ankle sprains: systematic review. *BMJ (Clinical Research Ed.)* 341: c5688-c5688 van Rijn RM, van Os AG, Bernsen RMD, Luijsterburg PA, Koes BW and Bierma-Zeinstra SMA (2008b) What is the clinical course of acute ankle sprains? A systematic literature review. *The American Journal Of Medicine* 121(4): 324-331.e6

van Rijn RM, van Os AG, Kleinrensink G-J, Bernsen RMD, Yerhaar JAN, Koes BW and Bierma-Zeinstra SMA (2007a) Supervised exercises for adults with acute lateral ankle sprain: a randomised controlled trial. *British Journal of General Practice* 57(543): 793-800

van Rijn RM, van Os AG, Kleinrensink GJ, Bernsen RM, Verhaar JA, Koes BW and Bierma-Zeinstra SM (2007b) Supervised exercises for adults with acute lateral ankle sprain: a randomised controlled trial. *British Journal of General Practice* 57(543): 793-800

Vassar M and Holzmann M (2013) The retrospective chart review: important methodological considerations. *J Educ Eval Health Prof* 10(12)

Verhagen EA, Van der Beek AI, Bouter LM, Bahr RM and Van Mechelen W (2004) A one season prospective cohort study of volleyball injuries. *British Journal of Sports Medicine* 38(4): 477-81

Verhagen EAL, van Tulder M, van der Beek AJ, Bouter LM and van Mechelen W (2005) An economic evaluation of a proprioceptive balance board training programme for the prevention of ankle sprains in volleyball. *British Journal of Sports Medicine* 39(2): 111-115

Verrall GM, Slavotinek JP, Barnes PG, Fon GT and Esterman A (2006) Assessment of Physical Examination and Magnetic Resonance Imaging Findings of Hamstring Injury as Predictors for Recurrent Injury. *Journal of Orthopaedic and Sports Physical Therapy* 36(4): 215-224

Vogt WP (1999) *Dictionary of Statistics and Methodology : A Nontechnical Guide for the Social Sciences*. London: Sage

Vuurberg G, Hoorntje A, Wink LM, van der Doelen BFW, van den Bekerom MP, Dekker R, van Dijk CN, Krips R, Loogman MCM, Ridderikhof ML, Smithuis FF, Stufkens SAS, Verhagen EALM, de Bie RA and Kerkhoffs GMMJ (2018) Diagnosis, treatment and prevention of ankle sprains: update of an evidence-based clinical guideline. *British Journal of Sports Medicine* 52(15): 956

Wang JH, Jeong JS and Park WH (2011) Orthopedic disease and sports medicine related to lower limbs. *JOURNAL OF THE KOREAN MEDICAL ASSOCIATION* 54(7): 715-724

Warren P, Gabbe BJ, Schneider-Kolsky M and Bennell KL (2010) Clinical predictors of time to return to competition and of recurrence following hamstring strain in elite Australian footballers. *British Journal of Sports Medicine* 44(6): 415-419

Waterman BR, Owens BD, Davey S, Zacchilli MA and Belmont PJ, Jr. (2010) The epidemiology of ankle sprains in the United States. *The Journal Of Bone And Joint Surgery. American Volume* 92(13): 2279-2284

Watts BL and Armstrong B (2001) A randomised controlled trial to determine the effectiveness of double Tubigrip in grade 1 and 2 (mild to moderate) ankle sprains. *Emergency Medicine Journal* 18(1): 46-50

Wei F, Fong DT-P, Chan K-M and Haut RC (2015) Estimation of ligament strains and joint moments in the ankle during a supination sprain injury. *Computer Methods In Biomechanics And Biomedical Engineering* 18(3): 243-248

West R and Fu F (2005) Soft-tissue physiology and repair IN: AR V (ed) *Orthopaedic Knowledge Update 8. Chapter 2, Rosemont, IL:* . American Academy of Orthopaedic Surgeons 15-27

Wester JU, Jespersen SM, Nielsen KD and Neumann L (1996) Wobble board training after partial sprains of the lateral ligaments of the ankle: a prospective randomized study. *Journal of Orthopaedic and Sports Physical Therapy* 23(5): 332-336

White PF, Kehlet H, Neal JM, Schricker T, Carr DB and Carli F (2007) The role of the anesthesiologist in fast-track surgery: from multimodal analgesia to perioperative medical care. *Anesthesia and Analgesia* 104(6): 1380-96

White W, McCollum G and Calder J (2016) Return to sport following acute lateral ligament repair of the ankle in professional athletes. *Knee Surgery, Sports Traumatology, Arthroscopy* 24(4): 1124-1129

Whitman JM, Cleland JA, Mintken PE, Keirns M, Bieniek ML, Albin SR, Magel J and McPoil TG (2009) Predicting short-term response to thrust and nonthrust manipulation and exercise in patients post inversion ankle sprain. *The Journal Of Orthopaedic And Sports Physical Therapy* 39(3): 188-200

WHO (2002) *Towards a Common Language for Functioning, Disability and Health ICF*. WHO/EIP/GPE/CAS/01.3.]

WHO (2016) *Epidimiology*. Available from: http://www.who.int/topics/epidemiology/en/]

Wicks AC and Freeman RE (1998) Organization Studies and the New Pragmatism: Positivism, Anti-Positivism, and the Search for Ethics. *Organization Science* 9(2): 123-251

Wiesler ER, Hunter D, Martin D, Curl WW and Hoen H (1996) Ankle flexibility and injury patterns in dancers. *American Journal of Sports Medicine* 24(6): 754-7

Wikipedia (2019) *Social media*. [Accessed 31/01/2019]

Wilkerson GB and Horn-Kingery HM (1993) Treatment of the inversion ankle sprain: comparison of different modes of compression and cryotherapy. *The Journal Of Orthopaedic And Sports Physical Therapy* 17(5): 240-246

Wilkerson GB, Pinerola JJ and Caturano RW (1997) Invertor Versus Evertor Peak Torque and Power Deficiencies Associated With Lateral Ankle Ligament Injury. *Journal of Orthopaedic and Sports Physical Therapy* 26(2): 78

Willems TM, Witvrouw E, Delbaere K, Philippaerts R, De Bourdeaudhuij I and De Clercq D (2005) Intrinsic risk factors for inversion ankle sprains in females--a prospective study. *Scandinavian Journal of Medicine and Science in Sports* 15(5): 336-345

Williams JM and Andersen MB (1998) Psychosocial antecedents of sport injury: review and critique of the stress and injury model. *Journal of Applied Sport Psychology* 10(1): 5–25

Wilson RW and Gansneder BM (2000) Measures of functional limitation as predictors of disablement in athletes with acute ankle sprains. *The Journal Of Orthopaedic And Sports Physical Therapy* 30(9): 528-535

Wojtys EM, Huston LJ and Lindenfeld TN (1998) Association between the menstrual cycle and anterior cruciate ligament injuries in female athletes. *American Journal of Sports Medicine* 26: 614–619

Woo SL-Y, Hollis JM, Adams DJ, Lyon RM and Takai S (1991) Tensile properties of the human femur-anteri-or cruciate ligament-tibia complex. The effects of specimen age and orientation. *The American Journal of Sports Medicine*

19: 217-225

Woods C, Hawkins R, Hulse M and Hodson A (2003) The Football Association Medical Research Programme: an audit of injuries in professional football: an analysis of ankle sprains. *British Journal of Sports Medicine* 37(3): 233-238

World Health Organization WHO (2001) *International Classification of Functioning, Disability and Health (ICF)*. [Accessed 29/01/2019]

World Medical Association Declaration of Helsinki (2013) *Ethical Principles for Medical Research Involving Human Subjects*. JAMA Network. [Accessed 09/02/2019]

Worster A and Haines T (2004) Advanced statistics: understanding medical record review (MRR) studies. *Academic Emergency Medicine* 11(2): 187-92

Wu CL, Naqibuddin M, Rowlingson AJ, Lietman SA, Jermyn RM and Fleisher L (2003) The effect of pain on health-related quality of life in the immediate postoperative period. *Anesthesia and Analgesia* 97(4): 1078-1085

Wynn-Thomas S, Love T, McLeod D, Vernall S, Kljakovic M, Dowell A and Durham J (2002) The Ottawa ankle rules for the use of diagnostic X-ray in after hours medical centres in New Zealand. *The New Zealand Medical Journal* 115(1162): U184-U184

Yilmaz K (2013) Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. *European Journal of Education* 48(2)

Young K and Charlesworth H (2004) Why English female university athletes play with pain: Motivations and rationalizations IN: Young K (ed) *Sporting bodies, damaged selves: Sociological studies of sports-related injury*. London: Elsevier 163-180

Zammit E and Herrington L (2005) Ultrasound therapy in the management of acute lateral ligament sprains of the ankle joint. *Physical Therapy in Sport* 6(3): 116-121

Zuckerman M (1990) The psychophysiology of sensation seeking. *Journal of Personality* 58: 313-345.