Ankle sprains: An investigation into patient perceptions and performance of physical tasks following acute ankle sprains using a mixed methods approach.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signed …….

Dated ……..

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Ethics Approval

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Abstract

Introduction: Ankle injuries are among the most prevalent acute musculoskeletal injuries, and are a significant burden on any health system. The interaction of the physiotherapist with the patient and their mutual understanding of impairments, function and recovery are important to achieving a satisfactory return to work and leisure activities. To date, little attention has focused on this interaction. There is a need for further exploration of differences and associations between outcome questionnaires that investigate similar domains of pain and function, and whether scores from such outcome measures are related to the patient's perception of function and recovery. Of further interest is whether there are relationships between impairment measures and perceived function, and how actual performance of tasks might influence the patients understanding of their capabilities. To provide a more complete picture of these relationships, a 'mixed methods' approach using qualitative research methods within a quantitative study was thought to be most appropriate. The overall aim of this thesis was to utilise this research approach to investigate patients' perceptions of their recovery and elucidate factors important to both therapists and patients that ultimately might enhance their understanding of recovery from an ankle injury.

Literature reviews: Three literature reviews were undertaken. Firstly a review of systematic reviews investigating ankle sprains identified a wide variety of management strategies. There was a lack of strong evidence to support any particular management strategy. Hence clinicians are likely to have difficulty setting appropriate rehabilitation plans. Secondly a critical review identified a number of different outcome questionnaires that were utilised to gauge recovery level; however,

justification for their selection was often lacking. This review also identified that little emphasis was placed on understanding the patients' perception of their injury and the rehabilitation process. A final critical review investigated impairment and performance measures and identified four specific areas that were focused upon by clinicians during the treatment of ankle sprains: joint position sense, postural control, strength and performance during function. However, only weak evidence was found for there being a deficit in joint position sense, postural control and strength in the injured limb following an ankle sprain, and inconclusive evidence of deficits in physical performance of tasks related to function.

Methods: Forty participants with an acute sprained ankle were recruited along with their treating physiotherapist. The participants completed a Global questionnaire, the Lower Limb Task Questionnaire (LLTQ) and the Short Form -36 (SF-36) Questionnaire at the initial visit, at discharge and at a six week follow up visit where they also undertook impairment testing involving, joint position sense, postural control and strength along with a functional performance test and selected functional activities. Ten participants were purposefully selected to undertake semi-structured interviews. The treating physiotherapists completed global questionnaires at the initial visit and at time of discharge. An interpretive hermeneutic approach was undertaken to examine the participants' perceptions.

Results: There were equal numbers of males and female participants and the average age of participants was 30.5 years. The relationship between questionnaires for the domains of pain and function varied between low and high degrees of association. The global limitations scores between the participants and physiotherapists were similar at the initial visit, whereas on discharge the participants had a significantly

lower score ($p<0.05$) compared to the physiotherapists. With respect to impairment testing, there was a significant difference ($p<0.05$) between the uninjured limb compared to the injured limb for the joint position sense and performance agility hop test. All other comparisons of impairments were not significant ($p>0.05$). There was no association between questionnaire scores and impairment measures ($p>0.05$). Additionally there were no significant associations between previous injury and questionnaire scores and impairment measures. Finally in relation to the performance of specific functional tests there was a significant difference ($p<0.05$) between the six week follow up LLTQ score and the score following actual performance of the test. The findings of the participants' interviews identified three key concerns. Firstly, that participants have a limited understanding of questionnaires, and secondly, that there is a difference in understanding of 'recovery' between the therapist and the patient at time of discharge. Thirdly, there was dissociation between outcome measures and the patient's perception of their own recovery.

Conclusions: This study revealed a lack of understanding and effective communication concerning physiotherapy practice in relation to ankle sprains. It was apparent that questionnaires purporting to measure similar constructs are at times dissimilar in scores and are not related strongly. Care needs to be taken in selecting and interpreting outcome measures particularly in relation to questionnaires. It was also apparent that caution should be exercised when considering the influence of impairment measures upon function. Physiotherapists should be aware that patients may perceive a lack of confidence in their level of function at the time of discharge. As a result physiotherapists need to incorporate strategies to improve patient confidence in their management plan.

Chapter 1: Introduction

Ankle sprains are among the most common acute injuries treated in general practitioners' clinics, emergency departments of public hospitals and in physiotherapy clinics (Broad, Robb, Ameratunga, Larmer, & Jackson, 2001; G. A. Jones, 1983; Lynch & Renstrom, 1999; O'Donoghue, 1976). The ankle is the most common injury suffered during physical activity (Aiken, Pelland, Brison, Pickett, & Brouwer, 2008; Hergenroeder, 1990; J. B. Ryan, Hopkinson, Wheeler, Arciero, & Swain, 1989; Rzonca & Lue, 1988). Ankle sprains represent 15-20% of all sporting injuries and about 10% of all presentations to Accident and Emergency departments (Kannus & Renstrom, 1991; Lynch & Renstrom, 1999; Ogilvie-Harris & Gilbart, 1995). Some authors have indicated that 85% of ankle sprains are caused by excessive inversion and involve damage to the lateral ligament (Safran, Benedetti, Bartolozzi, & Mandelbaum, 1999). In the United States the prevalence and severity of ankle injuries has been increasing since the 1950s, and this has been attributed to the increase in recreational activity (Birrer, Fani-Salek, Totten, Herman, & Politi, 1999). With specific reference to New Zealand, ankle injuries are a significant burden on the health system. Figures from the Accident Compensation Corporation (ACC), the major insurance company, place soft tissue injury to the foot and ankle in the top four categories regarding both costs and the number of claims (Accident Compensation Corporation, 2007). In the year 2004–2005, $88 million was spent on ankle claims. Table 1 outlines how both the number of claims and costs have increased over the years 1995 – 2005.

Table 1: ACC ankle claims total for all entitlement claims from 1995-2005.

Year	New Claims		Ongoing Claims		**Total**
	Number of Claims	Cost of Claims	Number of Claims	Cost of Claims	
1995 - 1996	12,160	$28,164,000	3,046	$26,327,000	**$54,491,000**
2000 - 2001	13,850	$37,993,000	2,782	$25,171,000	**$63,164,000**
2004 - 2005	17,039	$54,645,000	3,899	$33,421,000	**$88,066,000**

Source: ACC Statistics (Accident Compensation Corporation, 2006)

Management

At this time the management of acute ankle injuries includes a wide range of interventions used at various stages of recovery to promote healing and to regain usual function. There is a general consensus in the literature to suggest that some form of functional physical rehabilitation should be involved (de Vries, Krips, Sierevelt, & Blankevoort, 2006; Handoll, Rowe, Quinn, & de Bie, 2001; Kerkhoffs, Handoll, de Bie, Rowe, & Struijs, 2007; Kerkhoffs, Rowe et al., 2002). However, a number of systematic reviews have identified that there are varying levels of evidence as to what is the most effective form of rehabilitation for a sprained ankle (Broad et al., 2001; de Vries et al., 2006; Handoll et al., 2001). A survey in the United Kingdom identified considerable variation in aspects of the clinical approach taken in the general management of ankle sprains (Cooke, Lamb, Marsh, & Dale, 2003).

In New Zealand, general practitioners (GPs) and physiotherapists are the health practitioners most often involved in the management of acute ankle injuries (Broad et al., 2001). Physiotherapy treatment is the most common form of physical rehabilitation. An important role of the physiotherapist is to assess and improve where possible, a patient's function (Kay, Myers, & Huijbregts, 2001).

Impairments such as mechanical laxity, proprioceptive deficit, balance and peroneal muscle weakness have all been demonstrated to be involved in ankle instability and therefore are likely to be significant factors in the high recurrence rate of ankle sprain (Freeman, 1965; Garn & Newton, 1988; Hertel, 2002; Tropp, 1986). Despite these impairments being identified, there is conflicting evidence as to their relative importance and the subsequent prioritisation of them within the overall treatment and rehabilitation plan. As a result, there is also conflicting evidence as to what is the most effective rehabilitation management strategy for ankle sprains. Added to this problem is the difficulty for the practitioner to be able to correctly identify when a patient with a sprained ankle has fully recovered. There is sparse evidence within the literature providing practitioners with appropriate discharge criteria for a recovered ankle sprain. Of concern, inadequate or incomplete rehabilitation has been identified as contributing to unsatisfactory results in ankle sprain recovery (Derscheid & Brown, 1985; Grana, 1995). This suggestion is supported by a recent systematic review that identified that a high percentage of patients still experienced pain and subjective instability following discharge from treatment of an ankle sprain (van Rijn et al., 2008). Therefore there is concern that there is significant variation in both rehabilitation interventions and the ability for practitioners to appreciate when a patient is ready for discharge.

Recurrence

It has been estimated that of those who suffer an ankle injury as many as 80% can have recurrent sprains (Hertel, 2000; Leanderson et al., 1999; Yeung, Chan, So, & Yuan, 1994). Most ankle sprains resolve with treatment; however, an estimated 20-72% of patients report residual symptoms or go on to develop chronic ankle

instability and subsequent notable disability (Gerber, Williams, Scoville, Arciero, & Taylor, 1998; Hansen, Damholt, & Termansen, 1979; Hertel, 2000; Hicks, 2000; Karlsson, Eriksson, & Sward, 1996; Lynch & Renstrom, 1999; Ogilvie-Harris & Gilbart, 1995; Robbins & Waked, 1998; Safran, Benedetti et al., 1999). The residual symptoms can present as pain, swelling, stiffness and instability thereby limiting participation in work, sport, recreation and even some daily home activities.

Recurrent injuries and the age of the patient are one of the risk factors for developing chronic disability (Safran, Benedetti et al., 1999). Severe cases of ankle sprain may go on to develop post traumatic arthritis (Martin, Stewart, & Conti, 2007). As a way to emphasis the complexities of ankle sprains, Braun, (1999) recommends that on the initial visit patients are advised that there is no such thing as a minor ankle sprain. Hence there is a need to provide the most effective rehabilitation interventions possible to ensure patients have the optimal recovery from their ankle injury. However, there are a number of problems in deciding the most effective interventions.

Outcomes

One of the difficulties when comparing the effectiveness of ankle rehabilitation studies is the lack of standardised outcome measures (Cross, Worrell, Leslie, & Van Veld, 2002; M. H. Jones, Grimmer, Edwards, Higgs, & Trede, 2006). Physiotherapists have traditionally used impairment measures such as range of movement, strength and gait to evaluate both the treatment effectiveness and patient recovery. However, while these types of impairment measures are easily measured and have been shown to have reasonable reliability, their relevance to function is still debated. With the move to a more evidenced based approach to treatment more

rigorous and appropriate outcome measures are required (M. H. Jones et al., 2006). Stratford (2002) has identified three specific categories of outcome measures that physiotherapists tend to use: (1) Impairment measures, (2) Performance measures and (3) Self-Report Questionnaires. The use of function as an outcome measure has been promoted by the World Health Organisation (WHO). The emphasis on function is a critical component of the International Classification of Functioning, Disability and Health model that the WHO has developed (World Health Organization, 2001). This model is based on a biopsychosocial understanding of disease incorporating bodily, personal and social perspectives of health. Body function encompasses three critical aspects: impairment, activity limitations and participation restrictions. When evaluating effectiveness of interventions these critical aspects of function need to be addressed. Grotle (2005) suggests that in general little attention is paid to which aspects of functioning are measured by outcome questionnaires. Therefore, it is important to carefully consider the type of functional outcome measurement tool that the physiotherapist may use (Duckworth, 1999).

The literature identifies a number of outcome tools that have been used. Toolan (2001) has indicated that the American Orthopaedic Foot and Ankle Society (AOFAS) has encouraged the use of 'consistent' rating systems so that comparisons can be made between different treatments. However, the self-report questionnaire relies on the patient's perception of their functional ability (O'Connor et al., 2003; Stratford et al., 2002). Furthermore self-report questionnaires need to be easily interpreted and have evidence of validity, reliability and responsiveness (Martin, Irrgang, Lalonde, & Conti, 2006). Clinicians generally find the use of questionnaires to be more practical in the clinical environment as they negate the need to have expensive measuring equipment; do not require large space for undertaking physical

tasks, and the patient is able to complete the questionnaire themselves thus saving the clinician's time.

Huijbregts (2002) in a survey, identified that while physiotherapists accepted the importance of outcome measurements they tended to use these on an ad hoc basis or primarily to comply with organisational directives. A number of additional barriers to the use of functional outcome measures have been identified within private physiotherapy practices. A recent survey of Australian private physiotherapy practices following the introduction of mandatory use of functional outcome questionnaires identified among the main barriers to use were:

- The lack of understanding, training and familiarity with the questionnaires by both the patient and the therapists.

- The difficulty in interpreting the scores and in particular the change of scores for the questionnaires.

(Abrams et al., 2006)

Of further interest is the observation that scores from perceived measures of function (eg: questionnaires) may not match actual performance levels attained during physical tasks. McMurray et al (1999) identified discrepancies in perception attained from the Oxford hip scoring system when the rating system was compared with a semi-structured interview on similar content. He further argued that the results of the outcome measurements may have different meanings depending on whether a clinician's or patient's perspective is considered. Parker (2003) also emphasises that the issues and dimensions that matter to the patient need to be addressed in any outcome measurement.

These concerns pose several questions. Firstly, there is a need to identify if this patient's lack of confidence can be determined? Secondly, if patients perceive a lack of confidence then can this be improved by performance of functional tasks? Thirdly, are commonly used outcome measures able to identify those patients who still have impairment in ankle function at time of discharge?

Mixed methods

Tran (2002) highlighted the need to focus on patient's perception of outcomes with less emphasis on the clinician's priorities. It has been suggested that studies that look only at quantitative data in their evaluation of outcome measurements may be inadvertently providing a limited perspective. Further support for this notion comes from Grimmer (2004) who suggested that qualitative research provides essential insights into research and clinical information that the high level randomised control trial is unable to provide.

A combined approach of quantitative and qualitative methodologies, termed 'mixed methods', was first described by Campbell and Fiske (1959). Using a mixed methodology is a relatively new paradigm. As a result there is no gold standard format to follow. There are a number of ways the emphasis can be placed on the approach of this type of research. The particular method that has been followed in this study is termed a 'Concurrent Nested Strategy' (Creswell, 2003). The study consists of a larger quantitative study with a smaller qualitative study nested within the larger study. This approach recognises the complexity of outcome measurements and the depth of understanding necessary to reach an insightful interpretation and evaluation. It is proposed that identifying participant's feelings and perceptions and then comparing these against measurable test results will lead to the possibility of a

better understanding of treatment and discharge rationale based on patient focused outcomes.

Statement of the problem

There were seven key questions pertinent to this study:

1. Are there differences and associations between outcome questionnaires that investigate similar domains of pain and function with regard to the participant's perception at the initial assessment, discharge and six week follow up visits?
2. Do participants and physiotherapists have a similar perception of limitations in function, at initial assessment and discharge?
3. Are there deficits in and associations between measures of proprioception, balance, strength and functional performance across injured and uninjured limbs at six weeks following discharge from treatment for an ankle sprain?
4. Are there associations between questionnaire results related to function and impairment measures (the latter measured by percentage of deficits across limbs at six weeks following discharge from treatment for an ankle sprain)?
5. Do participants' perceptions of ability to perform physical tasks change after performing the tasks?
6. Do participants who have had a previous ankle injury have differences in questionnaire scores and impairment measures from participants with a first occurrence of an ankle injury?
7. How do participants feel about their recovered ankle?

Significance of the problem

Ankles sprains are a costly and complex injury, both in New Zealand and world wide. The number of ankle sprains that become recurrent is significant. Physiotherapists are a primary provider in the management of this condition. The variability of physiotherapy management and in particular, discharge criteria has been identified as an issue. The use of outcome measures has been identified as a means to gain conformity in management of ankle injuries. However, problems in the utilisation and interpretation of outcome measurements have been identified. The problems and complexities of outcome measuring are numerous. Few studies have considered the variability in responses across outcome measures of impairment, performance, self-report questionnaires and patient interviews. Therefore the findings of this thesis will provide a more in-depth assessment of patient perceptions and performance of physical tasks following acute ankle sprains. Such an investigation would be valuable to clinicians involved in rehabilitation and help resolve some of the dilemmas associated with interpreting the responses of patients to questions regarding function, whether they be derived from perceptions or actual performance.

Structure of thesis

To assist the reader the thesis format is outlined in Figure 1. The introduction is followed with a contextual literature review followed by a methods, results and discussion section of the quantitative research. This is followed by the interpretive qualitative chapter involving the rationale, philosophy, methods, findings and discussion of the participant interviews. The final chapter summarises the

combination of the quantitative and qualitative data and makes a number of recommendations. The rationale for separating the methods, results and discussion section is due to the complexity of the quantitative and qualitative methodologies. It was considered inappropriate to attempt to combine the two distinct philosophies. This separation has been made in recognition of the different philosophies of each method and to ensure each method maintains congruence with the philosophical underpinnings.

Additionally to maintain consistency, the order of the results and discussion sections follow the order of the key questions as identified in Chapter One.

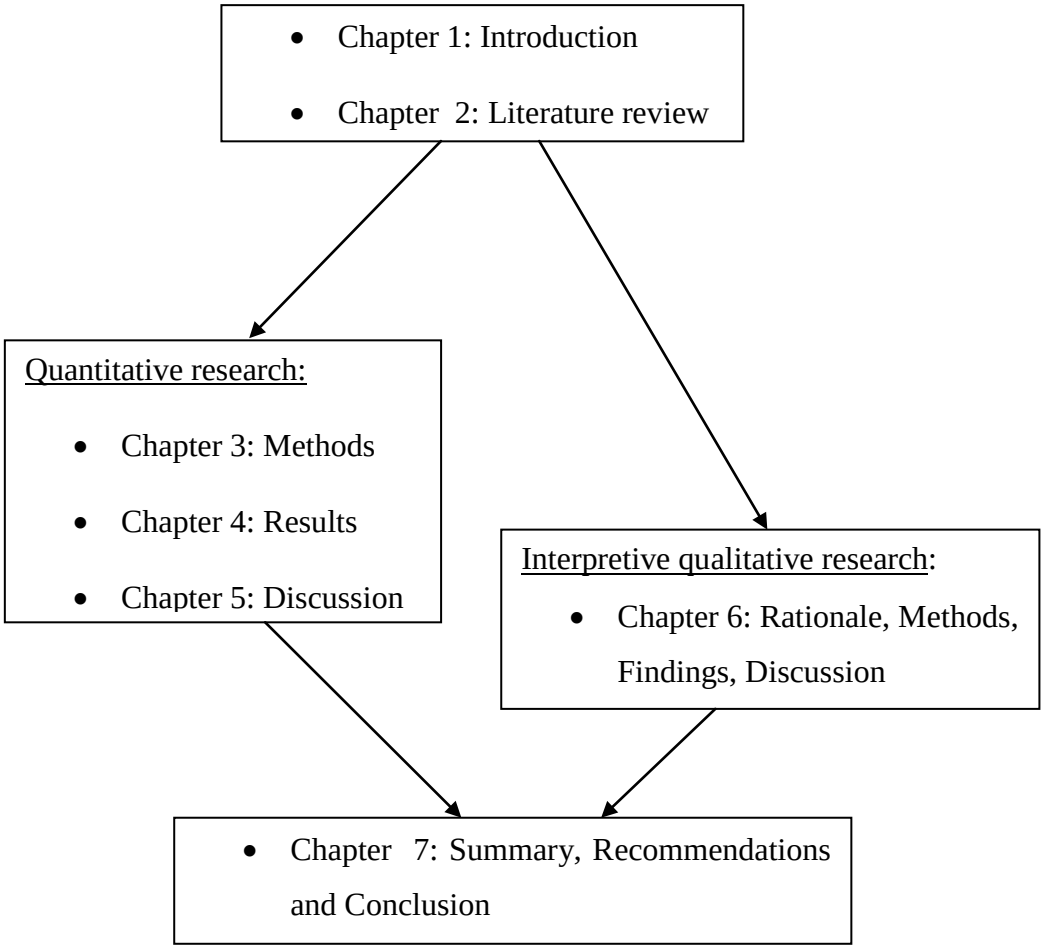

Figure 1: Diagrammatic representation of thesis outline

Chapter 2: Literature Review

This chapter contains three separate sections. Firstly a brief description of aspects related to ankle injury is presented. Thereafter a critical review of systematic reviews of literature pertaining to the treatment of ankle sprains is provided. This is followed by an overview of outcome measurements and a critical review of the literature specifically relating to outcome measurements for the management and treatment of ankle sprains. The final section provides a critical review of the literature specifically related to research investigating ankle impairment measures.

The Injury

Traditionally, ankle sprains have been described in terms of the extent of damage to the lateral ligaments of the joint, which are involved in 85% of soft tissue ankle injuries (Safran, Benedetti et al., 1999; Trevino, Davis, & Hecht, 1994). There is now common consensus within the literature that ankle sprains are classified into three grades of pathology (Lynch & Renstrom, 1999):

Grade 1: Stretch of the ligament without macroscopic tearing; little swelling or tenderness; slight or no functional loss; no laxity.

Grade II: Partial macroscopic tearing of the ligament; moderate pain, swelling and tenderness over the involved structures; some loss of motion; some laxity (mild or moderate).

Grade III: Complete rupture of one or more ligaments; severe swelling, haemorrhage, tenderness; considerable loss of motion, and moderate or severe laxity with instability.

Persistent pain and instability have been estimated at between 10-72% of all ankle sprains (Braun, 1999; Hertel, 2000). The frequency and incidence of

longstanding symptoms following an ankle injury have led some authors to conclude that a simple ankle sprain does not exist (Hertel, 2002). Studies have shown that the grade of sprain at the time of initial injury bears no relationship to the likelihood of residual discomfort or disability (Schaap, de Keizer, & Marti, 1989; Verhagen, de Keizer, & van Dijk, 1995). Management for ankle sprains is generally also described with reference to the grade of ankle sprain. There is general agreement in the literature that Grades I and II sprains are best managed with conservative treatment. This includes initial treatment with rest, ice, compression, elevation (RICE), followed by early mobilisation (Safran, Zachazewski, Benedetti, Bartolozzi, & Mandelbaum, 1999). This might include manual therapy techniques to assist recovery of movement, as well as a graded active exercise programme, which includes proprioceptive re-training and strengthening for the associated muscle groups (Safran, Zachazewski et al., 1999). The treatment for Grade III ankle sprains (complete ruptures) has been somewhat more controversial, with the debate focusing on whether these should be managed conservatively or surgically. Current evidence suggests that conservative management is the treatment of choice in the first instance, with surgical repair being an option at a later stage with no disadvantage resulting from delayed repair (Lynch & Renstrom, 1999; Pijnenburg, van Dijk, Bossuyt, & Marti, 2000; Safran, Zachazewski et al., 1999).

Physiotherapy involvement

Research has shown that GPs refer to physiotherapists more than any other health professional for musculoskeletal conditions (Hadley, 1988; R. J. Marshall et al., 1990). The advent of the Accident Compensation Corporation (ACC) in 1974, gave the public of New Zealand coverage for costs associated with accidental injuries. This included the recovery of treatment costs. Musculoskeletal injuries are a

substantial portion of ACC claims (Accident Compensation Corporation, 2006). As outlined previously ankle injuries are in the top four claims for musculoskeletal injuries (Accident Compensation Corporation, 2006). Physiotherapists are the largest health providers rehabilitating musculoskeletal injuries and are therefore a major health provider of treatment for ankle injuries (Broad et al., 2001).

As a consequence of the physiotherapy profession's link to the biomedical model and the acknowledged expertise of the profession in the musculoskeletal field, there has been a challenge for research to support the interventions with evidence based practice. This challenge has come from within the profession. There has also been a strong call from outside influences to provide evidence of effectiveness from the primary funders (ACC) and the referring medical profession. The provision of research that is both 'valued' and understood has ensured that the quantitative methodology has continued to play an important part of recent physiotherapy research. The drive for physiotherapy evidence has grown rapidly in the latter part of the 20th Century (Moseley, Herbert, Sherrington, & Maher, 2002). As a result, to date the ankle sprain has been studied primarily using a quantitative methodology.

Review of treatment for ankle sprains

Although the overall aim of this study is not to investigate the effectiveness of interventions, it is important to provide a background and an understanding of how physiotherapists treat ankle sprains. An appreciation of the effectiveness of interventions was considered useful as it provides an understanding of what may influence a physiotherapist to decide when a patient is ready for discharge. A preliminary search of the literature was undertaken to investigate the effectiveness of physiotherapy treatment programs for sprained ankles. This preliminary search

identified a number of systematic reviews in this area. Thus a search focused upon systematic reviews of the effectiveness of physiotherapy interventions for sprained ankles was undertaken.

Methodology

The following databases were initially searched: Medline (1966-current), EBSCO Health, (included Biomedical Reference Collection, Clinical Reference Collection, Health Source Consumer/Nursing/Academic Edition, Psychological and Behavioral Sciences Collection and SPORTDiscus), Ovid (included Full text journals, EBM Reviews, AMED, CINAHL, ERIC, Health and Psychosocial Instruments, Ovid MEDLINE, PsycINFO,), CINAHL Current contents; Psyclit; Science Citation Index; sportdiscus, Cochrane controlled trials register, Cochrane Database of Systematic Reviews, Cochrane Complementary Medicine Fields Trial Register, PEDro. The search used the following initial keyword terms: 'ankle$ and injur$ or sprain$ or strain$ and physiotherapy or treatment, and systematic review'.

To be eligible for inclusion in this review, studies had to be systematic reviews, have been published in English, and participants had to have suffered an ankle sprain. The studies also needed to have investigated interventions that could be delivered by a physiotherapist. It should be noted the following is primarily a narrative critical review. It is limited in the following respect; only published reviews have been obtained. A comprehensive search for unpublished reviews, conference proceedings and reports was not undertaken. A further limitation of the current review is that reviews have been analysed and described by a single author, thus there is an acknowledged bias in the conclusions that have been reached. As a result thirty three systematic reviews were identified. The abstracts where possible were obtained and appraised for each of these reviews. Twenty reviews were excluded for

the following reasons; not a systematic review, surgery versus immobilisation, prevalence studies, reviewing only one modality (ice, or ultrasound), previous published systematic reviews that have been updated and journal comments related to a published review. Reference lists of the reviews were checked to identify further reviews. One review found on the Accident Compensation Corporation website was also included (Broad et al., 2001).

A critical appraisal and grading of each systematic review was undertaken involving a modified version of the Effective Practice and Organisation of Care (EPOC) group scoring system (Moe et al., 2007) (Appendix A). The EPOC scoring system comprises nine separate questions graded between 0 and 2 covering aspects of study design. A final overall score (quality rating), out of a possible 18, was awarded to each systematic review (see Table 3). A study was considered of low quality if it scored less than 50% (9/18), moderate quality if it scored greater than or equal to 50% but less than 75% (14/18) and high quality if it scored greater than or equal to 75%.

For clarification in the following section when the term 'review' is used this refers to the systematic reviews that were obtained. When the term 'studies' is used this refers to the individual studies within each of the systematic reviews.

Results

As a result of the search a total of 13 reviews were obtained for full appraisal (See Table 2). The purpose of each review varied considerably and is summarised in Table 2. Ten reviews, (Bleakley, McDonough, & MacAuley, 2008; Broad et al., 2001; de Vries et al., 2006; M. H. Jones & Amendola, 2007b; Kerkhoffs et al., 2001; Kerkhoffs, Struijs et al., 2002; Loudon, Santos, Franks, & Liu, 2008; Pijnenburg et al., 2000; van der Wees et al., 2006; van Os et al., 2005) looked at the most effective

intervention. Two reviews that examined surgery were not excluded as they included studies investigating conservative versus immobilisation management (de Vries et al., 2006; Pijnenburg et al., 2000). Three reviews, (Bleakley et al., 2008; Handoll et al., 2001; van der Wees et al., 2006) investigated the prevention of ankle sprains. One review, (de Noronha, Refshauge, Herbert, & Kilbreath, 2006) that met the inclusion criteria investigated predicting the likelihood of suffering an ankle sprain. This review did not look at interventions, but considered risk factors associated with ankle sprains. Finally, a recent review (van Rijn et al., 2008) considered the clinical course of a conventionally treated ankle sprain.

There were a total of two hundred and fifty studies included across the 13 reviews. However, a number of the individual studies were included in more than one review. Further examination revealed that there were one hundred and fifty seven individual studies. With respect to intention to treat, ten reviews, (Bleakley et al., 2008; Broad et al., 2001; de Noronha et al., 2006; de Vries et al., 2006; Handoll et al., 2001; Kerkhoffs, Struijs et al., 2002; Loudon et al., 2008; van der Wees et al., 2006; van Os et al., 2005; van Rijn et al., 2008) indicated the number of studies that utilised an intention to treat approach (Table 2). Three reviews, (M. H. Jones & Amendola, 2007b; Kerkhoffs et al., 2001; Pijnenburg et al., 2000) failed to mention if the included studies undertook an intention to treat analysis. With respect to time since injury, six reviews, (Bleakley et al., 2008; Kerkhoffs et al., 2001; Kerkhoffs, Struijs et al., 2002; Pijnenburg et al., 2003; van Os et al., 2005; van Rijn et al., 2008) included acute ankle studies. One review, (Broad et al., 2001) included acute and sub acute studies. One review, (van der Wees et al., 2006) included both acute and chronic studies and two reviews, (de Vries et al., 2006; Loudon et al., 2008) included chronic studies only. Three reviews, (de Noronha et al., 2006; Handoll et al., 2001;

M. H. Jones & Amendola, 2007b) did not state the time from injury. The reviews included studies that had a follow up period of up to 11 years (Table 2). Seventy two studies had follow up periods of less than or equal to three months. A further 38 studies did not have follow up periods stated.

The most common intervention identified across the reviews was immobilisation (67). Taping and bandaging (59) were the most common comparative interventions, followed by: bracing (35) physiotherapy (23), rest, ice, compression and elevation (RICE) (23), functional exercises (36), electrotherapy (16), manual therapy (16), medication (8), rehabilitation (6), and other (8). No reviews looked at physiotherapy interventions exclusively. A number of reviews used the generalised term of physiotherapy as the intervention, although many did not provide a detailed description of what this involved.

With respect to outcome measures, performance tests were used in two hundred and sixteen studies (Table 2). Performance tests included postural balance and specific activity tests. Impairment measures were used in one hundred and fifty four studies. Impairment measures included range of movement, strength and swelling. Pain was measured on one hundred and thirteen occasions. A number of variations of pain scales were used; however, the 'visual analogue scale' (VAS) was most commonly indicated. Seven reviews (Bleakley et al., 2008; Broad et al., 2001; de Vries et al., 2006; Handoll et al., 2001; M. H. Jones & Amendola, 2007a; Loudon et al., 2008; van der Wees et al., 2006) specifically mentioned that self-report questionnaires were used on twenty occasions. The remaining six reviews did not indicate if questionnaires were used as an outcome measure. There were sixty two non specific outcome measures used including recurrence rates, incidence and service utilisation. Three reviews, (Kerkhoffs, Struijs et al., 2002; Loudon et al.,

2008; Pijnenburg et al., 2000) used a 'level of evidence' approach throughout the review. Six reviews, (de Vries et al., 2006; Handoll et al., 2001; M. H. Jones & Amendola, 2007b; Kerkhoffs et al., 2001; van der Wees et al., 2006; van Rijn et al., 2008) used a partial 'levels of evidence' approach whereby only selected studies were combined for analysis. The remaining four reviews, (Bleakley et al., 2008; Broad et al., 2001; de Noronha et al., 2006; van Os et al., 2005) did not use a 'level of evidence' approach. With respect to the quality scores of the reviews, these ranged from 3 to 17/18 (Table 3). Eight reviews, (de Noronha et al., 2006; de Vries et al., 2006; Handoll et al., 2001; Kerkhoffs et al., 2001; Kerkhoffs, Struijs et al., 2002; Loudon et al., 2008; van der Wees et al., 2006; van Os et al., 2005) attained a high quality score (greater than 75%). Four reviews, (Bleakley et al., 2008; Broad et al., 2001; Pijnenburg et al., 2000; van Rijn et al., 2008) attained a medium quality score (between 60% and 75%). Only one review (M. H. Jones & Amendola, 2007b) attained a poor quality score (20%).

The findings of the reviews varied considerably. Four reviews (Broad et al., 2001; M. H. Jones & Amendola, 2007b; Kerkhoffs et al., 2001; Pijnenburg et al., 2000) concluded that early mobilisation resulted in better outcomes than immobilisation. With respect to exercise rehabilitation, one review (van der Wees et al., 2006) concluded that a wobble board exercise is useful for prevention of recurrent ankle sprains and one review (van Os et al., 2005) concluded that there was limited evidence that the addition of a supervised exercise programme resulted in greater reduction of swelling and earlier return to work. One review (Loudon et al., 2008) concluded that conservative treatment interventions including balance, proprioceptive and muscle strengthening exercises were effective for patients with functional ankle instability. One review examining factors that might predict

recurrence (de Noronha et al., 2006) concluded that decreased ankle dorsiflexion may increase the risk of ankle sprains. With respect to manual therapy, one review (Bleakley et al., 2008) concluded manual therapy can improve short term symptoms after an ankle sprain, while a further review (van der Wees et al., 2006) concluded manual mobilisation has an initial effect on dorsiflexion range of movement. With respect to taping or bracing one review (Kerkhoffs, Struijs et al., 2002) concluded that no definite conclusions could be drawn as to whether taping, elastic bandage or semi-rigid bracing provided the optimal functional treatment, while a further review (Handoll et al., 2001) concluded that there was good evidence for external supports to prevent ligamentous injuries. One review (van Rijn et al., 2008) concluded that while there is a rapid decrease in pain for the 2 weeks following an acute ankle sprain, after 1 year a high percentage of patients still experienced pain and subjective instability. Finally one review (de Vries et al., 2006) found insufficient evidence to support any specific surgical or conservative intervention.

Discussion

With regard to the overall findings, there were a number of issues that were central to this thesis. These included the difficulty of evaluating the effectiveness of interventions across a number of systematic reviews. This has been highlighted by authors who have identified that care needs to be taken in handling the vast quantity of health information (Clarke, 2007; Hatala, Keitz, Wyer, & Guyatt, 2005; Oxman et al., 1991). While the primary aim of the current review was to investigate the effectiveness of physiotherapy interventions for sprained ankles not all systematic reviews specifically addressed this question. Additionally a number of limitations were identified. Missing data from the individual studies was identified as a common fault by the authors in many of the reviews. The time since injury varied

considerably across the studies with some reviews including acute and chronic studies. It is worth noting that authors of the reviews generally commented that the follow up periods within the studies were often too short to measure effectiveness of interventions. This review classified the studies according to acute, subacute and chronic duration as described by previous authors (Pengel et al., 2007). The acute phase is considered up to six weeks, the subacute phase between six weeks and three months and the chronic stage longer than three months. Further relevance of these timeframes are provided by Hubbard and Hicks-Little (2008) in a recent systematic review where they identified that it took between six weeks and three months for ligament healing to occur following an ankle sprain.

A large number of interventions were applied across the studies. With respect to physiotherapy interventions, while twenty three studies specifically mentioned physiotherapy all the other interventions identified, apart from medication, clearly fell within the general category of modalities that a physiotherapist would be likely to use. The variation in the number and type of interventions and the number of outcome measures made comparisons across individual studies difficult. Authors of the included reviews have identified this as a common weakness in the studies. To be able to identify the most effective intervention a consistency of outcome measures is needed (Bialocerkowski, Grimmer, Milanese, & Kumar, 2004). Outcome measurement using self-report questionnaires has been recommended as an important method of evaluating effectiveness of treatment interventions as well as differentiating severity of injury and patient perception (Mann, Nyska, Hetsroni, & Karlsson, 2006; Ross, Guskiewicz, Gross, & Yu, 2008; Saltzman, 2001; Swiontkowski, Buckwalter, Keller, & Haralson, 1999; Valderas et al., 2008; Vallance-Owen & Cubbin, 2002). The findings from the current review show that

twenty questionnaires were identified across the studies indicating that this method of outcome measurement is perhaps under-utilised. Apart from one review (Loudon et al., 2008) that specifically identified four outcome questionnaires it was not possible to identify what specific functional outcome questionnaires had been used on the other sixteen occasions. Of interest, Loudon and co-reviewers (2008) specifically evaluated if the reliability or validity of outcome measures used in studies had been reported. They found of the sixteen reviewed studies only five reported on reliability measures and no studies reported on validity of outcome measures. No other reviews evaluated this aspect.

The overall poor quality of the individual studies makes any attempt to pool the data from the reviews questionable. While some authors of reviews identified that they excluded some studies from analysis in the pooling of data it was not always possible to ascertain how this had been undertaken. Previous authors (Hatala et al., 2005) have suggested that when there is significant variation in subjects, interventions, outcome measurements and study methods then pooling of data should not be undertaken. Additionally it has been identified that inadequate intention to treat data along with variable follow up periods make pooling of data likely to result in false estimates of effect (D'Amico, Deeks, & Altman, 1998, 1999; Smeeth, Haines, & Ebrahim, 1999). While the scoring system has been previously validated (Oxman & Guyatt, 1991) and utilised for reviews of systematic reviews, (Jamtvedt et al., 2008; Moe et al., 2007), there are limitations with any scoring method. As there is no ‘gold standard’ to benchmark critical appraisal tools against and there is no one generic tool that can be used across all studies then there will always be limitations to their validity (Katrak, Bialocerkowski, Massy-Westropp, Kumar, & Grimmer, 2004).

Despite the identified limitations, this current critical review could make some generalised conclusions based upon a majority consensus appearing across the reviews rather than a strict 'level of evidence' approach. This summary of the reviews lends further support for early mobilisation in the management of ankle sprains. There was a consistent recommendation from two high quality, one medium quality and one poor quality review, that immobilisation should be avoided and early mobilisation was the most effective strategy in ankle sprain recovery. Early mobilisation is in keeping with contemporary treatment management. With regard to active interventions, all listed interventions apart from medication, are incorporated into general physiotherapy treatment. This lends support to the fact that physiotherapists are appropriate health practitioners to be involved in the treatment and management of ankle sprains. However, there is still a lack of evidence as to the most appropriate and effective physiotherapy intervention. The large number and variety of outcome measurements across the studies is cause for concern. While aspects of functional activities were assessed across the studies, in keeping with WHO recommendations (World Health Organization, 2001), the use of any functional outcome questionnaires has not been widely reported. Outcome questionnaires have been highly recommended as assisting in evaluating and improving the effectiveness of interventions (Guyatt, Feeny, & Patrick, 1993). The current review identified that while seven reviews reported the use of self-report questionnaires, these were only used on twenty occasions across all the studies.

The variability in results of both interventions and outcomes across the research, makes it difficult for clinicians to confidently assess when a patient is recovered and ready for discharge based on evidence from research. Clinicians as a result have difficulty determining appropriate long term rehabilitation plans. This is

supported from findings that after one year a high percentage of patients still experienced pain and subjective instability with their ankles (van Rijn et al., 2008), and that patient satisfaction has been demonstrated to be poor at discharge (M. H. Jones & Amendola, 2007a). It has been suggested that these factors may be attributable to the high rate of recurrence of this injury (Refshauge, 2008). Additionally it has been identified that clinicians need to know if their observations reflect the perceived disability of patients (Dowrick, Gabbe, Williamson, Wolfe, & Cameron, 2006). These findings have important clinical implications and are particularly relevant to the current study.

It is acknowledged that there is difficulty when investigating effectiveness of treatment. While it is difficult to control for variation in both treatment interventions and therapist interaction with the patient, it is possible to standardise outcome measurements. This review has highlighted the lack of consistency in outcome measurement. An appreciation of the complex nature of outcome measurements is needed before this issue can be resolved. The following section reviews this aspect.

Table 2: Summary of systematic reviews of sprained ankle interventions

Author Date	•Review questions	•No of studies •Intention to treat undertaken within studies •Time since injury •Length of follow up (Number of studies)	•Types of interventions (Number of studies)	Outcome measures (Number of studies) •Pain •Impairment measures •Performance tests •Self-report questionnaires • Others	•Physiotherapy related results as reported by authors •Levels of evidence approach (Yes/No/Partial) •Quality score (/18)
Loudon et al. 2008	•To examine the changes induced by exercise treatments to the various potential functional ankle instability factors.	•16 RCTs and controlled trials •7 studies •Chronic •> 3 months (16)	•Strengthening (5), Balance (3), Exercises (3), Disc training (2), Bi- directional bicycle pedal (1), Joint position sense (1), Co ordination (1)	•Pain (1) •Impairment measures (25) •Performance tests (4) •Self-report questionnaires (4) •Others (0)	•Conservative treatment interventions including balance, proprioceptive and muscle strengthening exercises are effective for patients with functional ankle instability. •Yes •15
van Rijn et al. 2008	•What is the clinical course of conventionally treated acute lateral ankle sprains in adults and its prognostic factors?	•31 observational and controlled trials •10 studies •Acute •≤ 3 months (12) ≤ 1 year (9) > 1 years (10)	•Bandage (12), Bracing (10), RICE (7), Mobilisation (6), Taping (5), Physiotherapy (2), Medication (1)	•Pain (19) •Impairment measures (23) •Performance tests (30) •Self-report questionnaires (0) •Others (0)	•During the first 2 weeks after an acute sprain, there is a rapid decrease in pain; however, after 1 year follow up a high percentage of patients still experienced pain and subjective instability. •Partial •13
Bleakley et al. 2008	•Which intervention(s) best augment early mobilisation and external support after an acute ankle sprain? •What is the most appropriate method of preventing re-injury?	•23 RCTs •14 studies •Acute •< 3 months (17) ≤1 year (4) Not stated (2)	•Electrophysical agents (9), Drugs (7), Manual therapy/rehab (4), Other (3)	•Pain (19) •Impairment measures (15) •Performance tests (16) •Self-report questionnaires (7) •Others (15)	•Manual therapy can improve short term symptoms after ankle sprain and neuromuscular training may prevent re-injury. •No •12

Jones and Amendola 2007	•Does a difference exist between time to return to preinjury level of activity with early functional treatment compared with immobilisation? •Is there a difference between the two groups for patient satisfaction, subjective instability and rate of injury?	•9 RCTs •Not stated •Not stated •< 3 months (2), Not stated (7)	•Immobilisation (9), Tape (4), Brace (4), Early motion (1)	•Pain (0) •Impairment measures (0) •Performance tests (20) •Self-report questionnaires (2) •Others (0)	•Level 2 evidence trend favouring early mobilisation for ankle sprains. •Partial •3
Van der Wees et al. 2006	•To collect evidence to Update Clinical Practice Guideline Ankle Injury of the Royal Dutch Society for Physical Therapy.	•17 RCTs •2 studies •Acute and chronic •≤ 3 months (10), < 1 year (4), ≥ 1 year (3)	•Balance (8), Physiotherapy (7), Proprioception (5), Manual Therapy (4), RICE (3), Tubigrip (3), Plaster (1), Orthosis (1), Directional pedal exercises (1)	•Pain (6) •Impairment measures (5) •Performance tests (21) •Self-report questionnaires (2) •Others (0)	•Level 2 evidence that exercise therapy including a Wobble Board exercise is effective in the prevention of recurrent ankle sprains for patients with functional instability. Level 2 evidence manual mobilisation has an initial effect on dorsiflexion ROM. •Partial •15-16
de Noronha et al. 2006	•Measures of voluntary strength, proprioception, range of motion, or postural sway can predict lateral ankle sprain. •Quantify the risk of lateral ankle sprain.	•3 RCTs, 18 Prospective cohorts •12 studies •Not stated •< 3 months (3), ≤ 1 year (11), > 1 years (7)	• No interventions – predictive study	•Pain (0) •Impairment measures (27) •Performance tests (7) •Self-report questionnaires (0) •Others (17)	•Reduced ankle dorsiflexion range may lead to at increased risk of ankle sprain. •No •14

de Vries et al. 2006	•To compare different treatments, both conservative and surgical, for chronic lateral ankle instability.	•7 RCTs, 6 surgery, 1 conservative treatment •3 studies •Chronic •Not stated	•Exercises (1), Bi-directional bicycle pedal (1)	•Pain (1) •Impairment measures (1) •Performance tests (2) •Self-report questionnaires (3) •Others (0)	•Insufficient evidence to support any specific surgical or conservative intervention for chronic ankle instability. •Partial •16-17
van Os et al. 2005	•To compare the effectiveness of conventional treatment with supervised exercises versus conventional treatment alone.	•7 RCTs •1 study •Acute •≤ 3 months (2), ≤ 1 year (4), > 1 years (1)	•Physical therapy (6), RICE (6), Elastic bandage (4), Rehabilitation (3), Immobilisation (2), Brace (1)	•Pain (3) •Impairment measures (3) •Performance tests (9) •Self-report questionnaires (0) •Others (1)	•Limited evidence that addition of supervised exercise resulted in greater reduction of swelling and return to work. •No •15
Kerkhoffs et al. 2002	•To compare different types and durations of functional treatment for the management or acute lateral ankle injuries.	•9 RCTs •1 study •Acute •< 3 months (2), < 1 year (2), > 1 years (4), Not stated (1)	•Elastic bandage (9), Semi-rigid ankle supports (4), Immobilisation (1), Exercises (1)	•Pain (5) •Impairment measures (7) •Performance tests (11) •Self-report questionnaires (0) •Others (5)	•Elastic bandage seems preferable to tape and semi-rigid ankle support seems preferable to elastic bandage. However, no definite conclusions can be drawn as to which is the optimal functional treatment. •Yes •15
Kerkhoffs et al. 2001	•To assess the effectiveness of the various methods of immobilisation for acute ankle sprain compared with alternative conservative treatments.	•22 RCTs •Not stated •Acute •< 3 months (5), < 1 year (8), > 1 years (9)	•Immobilisation with or without plaster cast (20), Brace (8), Strapping (6), Physiotherapy (2), Wrap (2)	•Pain (11) •Impairment measures (10) •Performance tests (19) •Self-report questionnaires (0) •Others (9)	•Immobilisation for uncomplicated ankle injury should be abandoned. If necessary immobilisation should only be for short periods. Functional treatment should be encouraged. •Partial •17

Broad et al. 2001	•To investigate the evidence for physiotherapy, chiropractic, osteopathy and acupuncture in the management of soft tissue injuries to the ankle joint.	•1 systematic review, 43 RCTs • 19 studies, 24 Not stated •Acute or sub acute •< 3 months (23), ≤ 1 year (12), > 1 years (4), Not stated (5)	•Immobilisation (16), Therapeutic Heat and Cold, Compression and Elevation (7), Functional treatment (7), Electrotherapy (7), Rehabilitation (3), Manual therapy (2), Acupuncture (1)	•Pain (25) •Impairment measures (42) •Performance tests (48) •Self-report questionnaires (1) •Others (7)	•There is some support for use of elevation. No evidence to support the use of immobilisation. No evidence that any type of taping or brace is more effective than any other. Laser therapy should be discontinued as it has been shown to delay recovery and is cost inefficient. The use of electrotherapy is of doubtful value. The use of manual therapy may improve ROM. Rehabilitation programmes with proprioceptive training (balance and coordination) should be recommended. •No •11
Handoll et al. 2001	•To compare the types of intervention for the prevention of ankle ligament injuries in individuals from adolescence to middle age. •Those with no prior ankle ligament injury were analysed separately from those with previous ankle ligament injury. •Those undergoing rehabilitation for ankle sprain were analysed separately.	•14 RCTs •9 studies •Not stated •< 3 months (1), ≤ 1 year (11), > 1 year (2)	•Exercises (7), Bracing (6), Taping (2), Information (2), Physiotherapy (1)	•Pain (0) •Impairment measures (5) •Performance tests (5) •Self-report questionnaires (1) •Others (17)	•Good evidence for the use of external ankle support devices, in the form of a formal semi-rigid ankle orthosis or Aircast brace, to prevent ligamentous injuries, principally of the lateral ligament complex, during high risk sporting activities. Participants with a previous ankle sprain should be advised that future sprains can be reduced with the use of these types of external supports when engaging in high risk activities. There is insufficient evidence from studies of other preventive interventions to provide firm conclusions. •Partial •16-17

Pijnenburg et al. 2000	•To perform a meta-analysis of the effectiveness of existing treatment strategies for acute ruptures of the lateral ankle ligaments.	•27 studies •Not stated •Acute •≤ 1 year (14) > 1 years (8) Not stated (5)	•Operation (18) Immobilisation with or without plaster cast (18) Strapping (8) Physiotherapy (5) Wrap (4) Brace (2)	•Pain (25). •Impairment measures (0) •Performance tests (25) •Self-report questionnaires (0) •Others (0)	•Functional treatment significantly better result with less pain, earlier return to work and less giving way than cast immobilisation. •Yes •12-13

RCT = Randomised Control Trial, NS= Not Stated, ROM = Range of Motion, RTW = Return to Work, RICE = Rest, Ice, Compression and Elevation.

Table 3: Grading scores for systematic reviews of sprained ankle interventions

Author Date	A	B	C	D	E	F	G	H	I	Totals /18
Loudon et al. 2008	2	1	2	1	2	2	2	1	2	15
van Rijn et al. 2008	2	1	2	1	2	2	1	1	1	13
Bleakley et al. 2008	1	1	2	1	2	2	1	1	1	12
Jones and Amendola 2007	1	1	1	0	0	0	0	0	0	3
Van der Wees et al. 2006	2	1	2	1	2	2	2	1	1-2	15-16
de Noronha et al. 2006	2	1	1	1	2	2	2	1	2	14
de Vries et al. 2006	2	2	2	1	2	2	2	2	1-2	16-17
van Os et al. 2005	2	1	2	1	2	2	2	1	2	15
Kerkhoffs et al. 2002	2	2	2	1	2	2	1	1	2	15
Kerkhoffs et al. 2001	2	2	2	1	2	2	2	2	2	17
Broad et al. 2001	2	1	2	1	2	2	0	0	1	11
Handoll et al. 2001	2	2	2	1	2	2	2	2	1-2	16-17
Pijnenburg et al. 2000	1	1	1-2	1	2	1	2	2	1	12-13

Review of outcome measurements

The term 'outcome measurement' is used by a large variety of industries across the world to measure change. The health care industry use outcome measurements in a number of ways, but particularly to evaluate the effectiveness of treatment. A health outcome measure has been described as:

> *'a measure of health change, at a defined point in time, as a result of one or more health care processes'* (Baumberg, Long, & Jefferson, 1995).

The variety of interpretations from outcome measures makes understanding how and when to use them a complex issue. To help clarify some of the confusion and complexities surrounding outcome measurements the following section describes the historical aspects, specifically the development of the health outcome movement, along with the theoretical underpinnings of health outcome measurements and the development of outcome questionnaires.

The positivist paradigm has played the dominant role in Western medical quantitative research. Measurement is a key component of this form of research. Bentz (1998) argues that positivism is not just quantitative research methods where things are measured, but influences what is considered the truth in much of today's world. The positivist philosophy has also permeated physiotherapy (Nicholls & Larmer, 2005).

There are a number of theories as to how outcome measurements have come to play such an important part of health evaluation. Relman (1988) suggested that there have been three distinct revolutions to health care. The first revolution was of the

"Expansion of Hospitals and Specialists" from the 1920's to 1960's. The second revolution was of "Cost Containment" from the 1960's to 1980's. He argued that we are experiencing the third revolution in Medical Care based around the 'Outcome Movement'. This so called revolution centres upon assessment within the health care system and the concern for better accountability. This drive for accountability has been led primarily by funders of health services and the conclusions from the outcome measurements have tended to focus on the funders' perspective (Gerszten, 1998). However, due to a backlash from patient advocates and others against the perceived domination of funders in health care management and perhaps as a move to soften this approach the terms 'patient orientated outcomes' or 'patient focused outcomes' are now more commonly used (Gerszten, 1998). It is further suggested that transparency of health quality and health care is also improved with the use of health outcomes allowing patients and families the ability to make informed choices about their care (Beatty, Neri, Bell, & DeJong, 2004; Fitzpatrick, Davey, Buxton, & Jones, 1998).

Initially the funders of health services required the medical profession, as the lead providers in health care, to justify their treatments and demonstrate change. The increasing scrutiny of the medical profession to be accountable and justify their interventions naturally led to other health providers such as physiotherapists also coming under scrutiny. While funders have been seen to be a major driver, the professions also recognised outcome research as a way to inform 'best practice' (Domholdt, 2005, p. 205). The physiotherapy profession has further defined the meaning of a health outcome as it relates to physiotherapy. Specifically physiotherapy outcome measures have been described as:

> *'a test or scale administered and interpreted by physical therapists that has been shown to measure accurately a particular attribute of interest to patients and therapists and is expected to be influenced by intervention'* (Mayo, 1994).

The growing importance of outcome measures in physiotherapy is highlighted by the Chartered Society of Physiotherapist (CSP) (2000) publishing an update of its standards of professional practice that makes an explicit requirement for members to use published, standardised outcome measures in their routine clinical practice. The updated version states:

> *'Taking account of the patient's problems, a published, standardised, valid, reliable and responsive outcome measure is used to evaluate the change in the patient's health status'* (Chartered Society of Physiotherapy, 2005).

Embodying this requirement within the core standards certainly raises the profile and reflects the increasing pressure for members to have information on the outcomes of their work.

Health outcome measures are not without controversy (Abrams et al., 2006). They can be used as a single point of reference or as the benchmark for an individual's health status in comparison with others. For instance this type of referencing is used to decide rankings on waiting lists for surgery. Outcome measurements may also be used to measure the health status difference from one point in time to another point in time for

one individual. Similarly, particularly in health research, outcomes are commonly used to measure a patient's change prior to and after an intervention.

In this respect, a dilemma for potential users of health outcome measurements, particularly clinicians, is to differentiate which measure will provide meaningful results. Reading the literature does not solve the problem. It is often unclear in research studies if consideration has been given to the contents of a questionnaire or physical tests and which specific aspects are to be measured (Grotle et al., 2005). It is often difficult to understand the rationale for investigators' selecting a specific outcome measure. It has been suggested that historical precedence and expert opinion is often seen as influencing the selection of outcome measurements (Haywood, Hargreaves, White, & Lamb, 2004). There would be justification in often surmising that outcome measurements have been selected at random or for ease of use. An illustration of this lack of clarity is demonstrated in a study by Martin (2005). In this study the authors investigated chronic Achilles tendinosis. Included in the introduction the reader is alerted to the fact that the Short Form-36 is used as an outcome measurement. However, it is not until much later in the methods description that the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale is also identified as being used. Of further interest is that it is only the subjective component of this scale that is utilised in the study. There is no rationale or justification for this outcome measurement being used or for the reason only part of the scale was applied.

Self-report questionnaires rely on the patient's perception of their ability (O'Connor et al., 2003). These have been identified as valid and appropriate tools to measure clinical interventions and treatment (Eechaute, Vaes, Van Aerschot, Asman, &

Duquet, 2007; Mann et al., 2006; Ross et al., 2008; Saltzman, 2001; Swiontkowski et al., 1999; Valderas et al., 2008; Vallance-Owen & Cubbin, 2002). It is commonly accepted that questionnaires allow the standardisation of results across different settings. The critical issue is whose perspective is the outcome designed for? A number of authors have highlighted the complexities of understanding outcome questionnaires and how this may be a barrier to their usage (Beatty et al., 2004; Bialocerkowski et al., 2004; Guyatt, Walter, & Norman, 1987; Martin & Irrgang, 2007; J. Parker et al., 2003; Revicki et al., 2006; Seymour et al., 2001). Questionnaires need to have addressed three key areas of psychometrics: validity, reliability and responsiveness, before confidence can be placed on their usage. Questionnaires need to be easily understood by patients, easily interpreted by clinicians and applied at appropriate timeframes. Furthermore, questionnaires also need to clearly reflect important issues for patients and clinicians.

Generally outcome measurements are a ‘one size fits all’; however, they are rarely sensitive enough to provide a clear understanding of the individual patient’s valuation. A questionnaire that has been developed for a general population is unlikely to be able to clearly differentiate what an individual either thinks, experiences or feels. Moreover inappropriate questions may not accurately reflect the patient’s views thereby compromising the usefulness of the questionnaire findings. Fitzpatrick and co-workers (1998) have described nine dimensions that may be assessed by patient based outcome measures: physical function, symptoms, global judgement of health, psychological well-being, social well-being, cognitive functioning, role activities, personal constructs and satisfaction with care. These dimensions create complexity and dilemma for both the questionnaire developer and the end user of the questionnaire. The questionnaire

developer needs to have a clear philosophical basis for the inclusion of particular dimensions. The chosen dimensions then need to address the concerns and be important to the end user.

As an alternative to patient orientated questionnaires it has been suggested that for measures of impairment, the health practitioner is the best judge of what is a satisfactory outcome (Liang, Lew, Stucki, Fortin, & Daltroy, 2002). As a result outcome measurements with a practitioner focus have a completely different perspective. This perspective reinforces the confusion as to whom the outcome measurements are meaningful for and for what purpose they are intended. Interpreting results from patient focused questionnaires will provide completely different information from the results from practitioner focused questionnaires. Furthermore the posed questions in any rating system are likely to have specific bias to either a patient's perspective or more commonly to a clinician's viewpoint. For instance, McMurray et al (1999) showed that while the Oxford rating system was able to provide valuable quantitative data, a semi-structured qualitative interview allowed subjects to identify gaps and perspectives that the questionnaire alone could not elicit. These included subjects identifying that they could reasonably tick two points on the ordinal scale in a number of questions. Thus the resultant score may provide incorrect information regarding the patient's real status.

Outcome questionnaires are often used at the initial visit and at discharge. The comparison of the two scores is able to demonstrate change and is the basis of statistics such as the standardised response mean (SRM) and effect size which reflects responsiveness. However, these scores are likely to be open to different interpretations. There is no defined score that indicates when patients have reached a discharge status.

Despite the growth in research there is still a lack of good evidence for appropriate discharge criteria that physiotherapists are able to apply confidently in practice. In practice conflict may arise when the patient's perception is different from the clinician's own appreciation of recovery. With respect to ankle sprains there is little information within the literature related to patients' and physiotherapists' perceptions of recovery. Schon (1983) describes this dilemma when he refers to the mismatch between what knowledge successful practitioners are meant to possess and the 'knowing in action' that they in truth require.

The credibility of health outcome questionnaires has been influenced by a scientific perspective. Originally much of the early work in outcome questionnaires was developed by the psychology profession. The term psychometrics was used to describe a branch of psychology concerned with psychological measurements of mental traits, abilities, and processes (S. P. Parker, 2002). Typically, within the scientific literature there are three key areas that evaluate the effectiveness and robustness of a health outcome measurement tool: validity, reliability and responsiveness (Strand, Ljunggren, Bogen, Ask, & Johnsen, 2008). New and developing outcome measurement tools justify their acceptability based on comparability to other established outcome measurement tools. However, it is often taken for granted that these established tools have undergone robust evaluation in the three key areas. As Saltzman (1998) demonstrated, many of the original outcome tools have never been effectively evaluated. There are aspects of using outcome questionnaires as measurement tools that need reviewing. Firstly, most researchers justify their choice of tool based on the fact that it has been validated and found reliable. Saltzman (1998) analysed a number of well established outcome

measurements and traced back the validation process. The common practice for the validation of a new outcome tool is to validate the new tool against another well established tool that has been previously validated. The problem as Saltzman demonstrates is that many of these well established tools have relied heavily on their validation against a previous tool that may not have been validated. This throws into doubt the whole credibility issue of validity. Regardless of this work the outcome movement has continued to grow based on flawed assumptions that the tools have been validated. This notion of validity is a crucial thread in the scientific model that encompasses the outcome movement. One may argue that we have to start somewhere. However, if we continue to blindly follow this path without regard to where we have been then the outcome movement can easily get lost or continue go round in circles. The assumption that there is a 'gold standard' for outcome measurements needs to be continually critiqued.

There is also confusion at times as many terms and definitions may be used for a similar construct eg 'sensitivity to change' and 'responsiveness'. As a further example, Wu (2007) refers to responsiveness as the ability of the measurement to detect change over time, whereas Liang (2000) defines responsiveness as 'the ability of an instrument to measure a meaningful or clinically important change in a clinical state'.

Types of outcome measures

Broadly speaking outcome measures related to physiotherapy fit into three main categories as described by Stratford (2002): (1) impairment measures such as Range of Movement (ROM) measures, strength or swelling; (2) performance measures such as the 6-minute walk test; (3) Self-Report Questionnaires such as the Short Form-36

Questionnaire. Traditionally physiotherapists have used impairment and performance outcome measures in decision making with respect to patient evaluation and discharge decisions following an acute ankle sprain. Less attention has been paid to the use of self-report questionnaires to assist in this evaluation process. Furthermore, of particular interest to this study, there is relatively little information regarding the concordance of impairment or performance measures with questionnaires.

The variety of self-report questionnaires may hinder their usage. With respect to lower limb questionnaires, these have been categorised into eight sub-categories: Generic, Self administered, Condition Specific, Joint Specific, Health Status, Patient Specific, Disease Specific, Global Outcome (Saltzman et al., 1998). With respect to evaluating ankle function, in a review, Mann (2006) identified seven specific scoring systems that have been developed. These seven scoring systems assessed various aspects of impairment, function or subjective appreciation or a combination of these aspects. However, the authors did not provide any critique of the individual scoring systems and provided little information with respect to the validity, reliability or responsiveness. As a result of the variety of outcome measurements available, it was considered relevant to undertake a critical review of the literature to specifically identify what outcome questionnaires were used in relation to ankle sprains and identify aspects of validity, reliability and responsiveness. Furthermore, it was considered important to identify studies that compared questionnaires with other outcome measures.

Methodology

A search of the literature was undertaken using the following electronic databases: Medline (1966-current), EBSCO Health, (included Biomedical Reference Collection,

Clinical Reference Collection, Health Source Consumer/Nursing/Academic Edition, Psychological and Behavioral Sciences Collection and SPORTDiscus), Ovid (included Full text journals, EBM Reviews, AMED, CINAHL, ERIC, Health and Psychosocial Instruments, Ovid MEDLINE, PsycINFO,), CINAHL Current contents; Psyclit; Science Citation Index; SPORTDiscus. Cochrane controlled trials register, Cochrane Database of Systematic Reviews, Cochrane Complementary Medicine Fields Trial Register, PEDro. The search strategy used the following initial keyword terms: 'Ankle*, and Injur*, or Sprain*, or Strain*, and Treatment*, or Intervention*, or Rehabilitation, and Questionnaire*'. The search terms 'Outcome* and Outcome measurement*' were also used, but these terms did not produce any results and so were excluded.

To be eligible for inclusion in this review, studies had to: have investigated ankle sprains, have been published in English and have used some form of questionnaire as an outcome measurement. The initial search revealed 120 references. The abstracts were obtained and reviewed and relevant studies were obtained for full evaluation. A number of studies were identified that were related to ankle fractures and surgery. Where relevant these studies have also been included as the authors have suggested that the measurements may be applicable to any ankle injury. Reference lists of articles were checked for further relevant studies. Identified studies were obtained and a critical appraisal and grading of each study was undertaken involving a modified version of the Cochrane Musculoskeletal Injuries Group (CMIG) scoring system (Thomson, Handoll, Cunningham, & Shaw, 2004) (Appendix B). The CMIG scoring system comprises eight separate questions graded between 0 and 2 covering aspects of study design. A final overall score (quality rating), out of a possible 16, was awarded to each study.

Results

Thirty six studies were identified that met the inclusion criteria and were subsequently reviewed. It was apparent that there were two distinct categories of studies: firstly those studies that investigated psychometric properties of questionnaires with respect to ankle injuries (see Table 4) and secondly ankle intervention studies that utilised questionnaires as an outcome measurement (see Table 5).

Across the thirty six studies there were variations of study design, ranging from double blind randomised controlled trials to a case controlled study. Study populations varied between nineteen participants (V. M. Clark & Burden, 2005) to two hundred and sixty four participants (Kaikkonen, Kannus, & Jarvinen, 1994). Five studies had dropouts greater than an acceptable 20% (Bassett & Prapavessis, 2007; Beynnon, Renstrom, Haugh, Uh, & Barker, 2006; Binkley, Stratford, Lott, & Riddle, 1999; Hiller, Refshauge, Bundy, Herbert, & Kilbreath, 2006; Leanderson & Wredmark, 1995). Thirteen studies (Airaksinen et al., 2003; Borromeo, Ryan, Marchetto, Peterson, & Bove, 1997; V. M. Clark & Burden, 2005; Docherty, Gansneder, Arnold, & Hurwitz, 2006; Evans, Hertel, & Sebastianelli, 2004; Karlsson & Peterson, 1991; McNair et al., 2007; Nyska, Weisel, Halperin, Mann, & Segal, 1999; Olerud & Molander, 1984; Roos, Brandsson, & Karlsson, 2001; Rozzi, Lephart, Sterner, & Kuligowski, 1999; Williams, Molloy, DeBerardino, Arciero, & Taylor, 2003; Zammit & Herrington, 2005) did not state drop out rates within the studies.

With respect to time since injury, one study (Evans et al., 2004) took questionnaire measurements pre-injury and then on day 1, 7, 14, 21 and 28 days following injury. Fifteen studies (Airaksinen et al., 2003; Bassett & Prapavessis, 2007; Beynnon et al.,

2006; Borromeo et al., 1997; Cross et al., 2002; Karlsson et al., 1996; Koll et al., 2004; Leanderson & Wredmark, 1995; Man, Morrissey, & Cywinski, 2007; Nyska et al., 1999; Pugia et al., 2001; Rose, Lee, Williams, Thomson, & Forsyth, 2000; Wilkerson & Horn-Kingery, 1993; Williams et al., 2003; Zammit & Herrington, 2005) took measurements in the acute stage of injury, which was of most interest to the current project. Three studies (Binkley et al., 1999; Pellow & Brantingham, 2001; Perron, Hebert, McFadyen, Belzile, & Regniere, 2007) took measurements at the sub-acute stage. Eleven studies (Brodsky, O'Malley M, Bohne, Deland, & Kennedy, 2005; V. M. Clark & Burden, 2005; Hale & Hertel, 2005; Hoiness, Glott, & Ingjer, 2003; Kaikkonen et al., 1994; Karlsson & Peterson, 1991; Obremskey, Brown, Driver, & Dirschl, 2007; Roos et al., 2001; Rozzi et al., 1999; SooHoo, Samimi, Vyas, & Botzler, 2006; SooHoo, Vyas, & Samimi, 2006) took measurements in the chronic stage of injury (greater than 3 months). The remaining six studies did not state time since injury.

Across the thirty six studies, questionnaires were used on sixty eight occasions. Closer analysis revealed thirty five different outcome questionnaires used. There was difficulty in defining the exact properties of each questionnaire. As such, for the purposes of this review, the questionnaires have been loosely grouped into three sub-categories: condition specific, generic and global outcomes. There were twenty two condition specific questionnaires, nine generic questionnaires and four global questionnaires. The Visual Analogue Scale (VAS) for pain was used on nine occasions and the Short Form-36 (SF-36) was used on eight occasions across the studies. One study (Evans et al., 2004) used the Short Form-12 (SF-12). The SF-12 is a modified version of the SF-36 (Ware, Kosinski, & Keller, 1996). A Global questionnaire was used

on six occasions. Four reviewed studies (Airaksinen et al., 2003; Cross et al., 2002; Karlsson & Peterson, 1991; Olerud & Molander, 1984) used a global functional scale. Hiller and co-workers (2006) used a global VAS to identify perception of ankle stability and Koll and co-workers (2004) used a global VAS to identify efficacy of medication for both the patient and physician along with a patient global tolerance scale. The Lower Extremity Functional Scale (LEFS), the American Orthopaedic Foot and Ankle Society (AOFAS) and the Karlsson's functional scoring scale were used for three studies. The Cumberland Ankle Instability Tool (CAIT), the Lower Limb Task Questionnaire (LLTQ), the Motor Activity Scale (MAS), the Foot Function Index (FFI), the Ankle Joint Functional Assessment Tool questionnaire (AJFAT), the Foot and Ankle Ability Index (FAAI), the Foot and Ankle Ability Index Sport, the Olerud and Molander questionnaire and the Modified Karlsson's functional scoring scale were all used on two occasions. The remaining twenty questionnaires were only used in a single study. One study (McNair et al., 2007) compared seven different questionnaires across different constructs. Another study (Bassett & Prapavessis, 2007) compared four questionnaires. Six studies (Cross et al., 2002; Hiller et al., 2006; Karlsson & Peterson, 1991; Pellow & Brantingham, 2001; Pugia et al., 2001; SooHoo, Vyas et al., 2006) compared three questionnaires. A further eleven studies (Airaksinen et al., 2003; Binkley et al., 1999; Brodsky et al., 2005; Evans et al., 2004; Hale & Hertel, 2005; Hoiness et al., 2003; Koll et al., 2004; Leanderson & Wredmark, 1995; Obremskey et al., 2007; SooHoo, Samimi et al., 2006; SooHoo, Shuler, & Fleming, 2003) compared two questionnaires. The remaining seventeen studies used only one outcome questionnaire.

Fifteen studies (Binkley et al., 1999; Brodsky et al., 2005; Docherty, Gansneder et al., 2006; Hale & Hertel, 2005; Hiller et al., 2006; Kaikkonen et al., 1994; Karlsson & Peterson, 1991; McNair et al., 2007; Obremskey et al., 2007; Olerud & Molander, 1984; Roos et al., 2001; SooHoo, Samimi et al., 2006; SooHoo et al., 2003; SooHoo, Vyas et al., 2006; Williams et al., 2003) investigated the specific psychometric properties of the questionnaires only (see Table 4). With respect to validity, two studies (Brodsky et al., 2005; SooHoo et al., 2003) reported low validity. Both these studies compared the AOFAS and the SF-36. Ten studies (Binkley et al., 1999; Hiller et al., 2006; Kaikkonen et al., 1994; Karlsson & Peterson, 1991; McNair et al., 2007; Obremskey et al., 2007; Olerud & Molander, 1984; Roos et al., 2001; SooHoo, Samimi et al., 2006; Williams et al., 2003) reported moderate to high validity for the respective questionnaires. With respect to reliability, one study (Brodsky et al., 2005) reported low reliability. Seven studies (Binkley et al., 1999; Docherty, Gansneder et al., 2006; Hale & Hertel, 2005; Hiller et al., 2006; McNair et al., 2007; Roos et al., 2001; Williams et al., 2003) reported high reliability for the respective questionnaires. With respect to responsiveness, only five studies (Binkley et al., 1999; Hale & Hertel, 2005; McNair et al., 2007; SooHoo, Vyas et al., 2006; Williams et al., 2003) reported satisfactory levels of responsiveness. The remaining ten studies that considered aspects of psychometrics did not report on responsiveness. Only three studies (Binkley et al., 1999; McNair et al., 2007; Williams et al., 2003) examined all three psychometrics properties within the study.

With respect to the twenty one ankle studies that reported findings involving interventions and used questionnaires as an outcome measurement (see Table 5), seven studies (Bassett & Prapavessis, 2007; Cross et al., 2002; Evans et al., 2004; Karlsson et

al., 1996; Pellow & Brantingham, 2001; Perron et al., 2007; Zammit & Herrington, 2005) gave specific confirmation that the questionnaires had attained previously reported satisfactory psychometric properties. A further seven studies (Airaksinen et al., 2003; Beynnon et al., 2006; V. M. Clark & Burden, 2005; Hiller, Refshauge, Herbert, & Kilbreath, 2007; Hoiness et al., 2003; Leanderson & Wredmark, 1995; Rose et al., 2000) provided a reference for the questionnaire without commenting upon any psychometric information. Pugia and co-workers (2001) commented that validity was likely for one questionnaire based on a referenced study while they specifically stated that no reliability or validity had been undertaken for other two questionnaires used. Man and co-workers (2007) specifically stated that no reliability or validity had been undertaken for the questionnaires. The remaining five studies either gave no reference for the outcome questionnaire or modified a referenced questionnaire without commenting on how this may have affected psychometric properties.

With respect to the results of studies providing an intervention and comparing outcome measures, twelve studies (Bassett & Prapavessis, 2007; Borromeo et al., 1997; V. M. Clark & Burden, 2005; Hoiness et al., 2003; Karlsson et al., 1996; Koll et al., 2004; Leanderson & Wredmark, 1995; Man et al., 2007; Nyska et al., 1999; Rozzi et al., 1999; Wilkerson & Horn-Kingery, 1993; Zammit & Herrington, 2005) reported a change over time, but no significant difference between outcome questionnaires. Four studies (Airaksinen et al., 2003; Hiller et al., 2007; Pellow & Brantingham, 2001; Rose et al., 2000) reported that the outcome questionnaires were able to differentiate between an injured group and controls. Two studies (Evans et al., 2004; Perron et al., 2007) reported that there was no relationship between questionnaire scores and impairment

measures. Both these studies investigated aspects of postural control. In contrast, two studies (Cross et al., 2002; Pugia et al., 2001) reported a significant relationship between questionnaires and impairment measures. Cross and co-workers (2002) found a significant relationship between a global functional question, the SF36 Physical function and days to return to sport. Pugia and co-workers (2001) found a significant relationship between the FAAI, FAAI Sport, AOS questionnaires and weight bearing.

With respect to the quality scores of the studies, these ranged from 1 to 15/16 across the thirty six studies (see Table 6). Seven studies (Binkley et al., 1999; Brodsky et al., 2005; Hale & Hertel, 2005; McNair et al., 2007; Obremskey et al., 2007; SooHoo, Samimi et al., 2006; SooHoo, Vyas et al., 2006) attained a quality score greater than 80% (≥13/16). All seven studies specifically examined psychometric properties only. Seventeen studies (Bassett & Prapavessis, 2007; Cross et al., 2002; Docherty, Gansneder et al., 2006; Evans et al., 2004; Hiller et al., 2006; Hiller et al., 2007; Kaikkonen et al., 1994; Karlsson et al., 1996; Karlsson & Peterson, 1991; Olerud & Molander, 1984; Perron et al., 2007; Pugia et al., 2001; Roos et al., 2001; Rose et al., 2000; SooHoo et al., 2003; Williams et al., 2003; Zammit & Herrington, 2005) attained a score between 50% and 75% (≥8 -12/16). Ten of these studies examined psychometric properties only. The remaining twelve studies scored below 50% (≤7/16).

Discussion

This current review identified fifteen studies that investigated psychometric properties of questionnaires only, as well as twenty one studies investigating intervention effects of ankle treatments where questionnaires were used as an outcome measurement. The time since injury has relevance when considering the outcome

measures that are used (Bialocerkowski et al., 2004; J. Parker et al., 2003). The importance of selecting appropriate questionnaires when considering time since injury has been identified with specific usage of the SF-36 (Keller, Ware, Hatoum, & Kong, 1999; Klevsgard, Froberg, Risberg, & Hallberg, 2002). As an example, a number of questions within the SF-36 focus on the previous 4 weeks, therefore any findings are likely to be less sensitive for the acute injury. Within the reviewed studies, authors were not specific as to the rationale for choosing questionnaires and linking this to injury time frames.

Assessing aspects of pain and function were the predominant domains investigated by questionnaires within the reviewed studies. Within the literature it is commonly reported that both pain and loss of function are important aspects of ankle injuries so it is not surprising that these were the most common characteristics investigated.

The number of questionnaires identified highlights the problems associated in establishing generalisability in outcome measurements and the confusion for potential users of outcome questionnaires. An example which highlights the potential for confusion is that in some instances the same questionnaires have been named differently. The Foot and Ankle Ability Index (FAAI) and the Foot and Ankle Ability Index Sport questionnaires were identified as being used in two studies (Hale & Hertel, 2005; Pugia et al., 2001). However Hale (2005) refers to the questionnaires as the Foot and Ankle Disability Index (FADI) and the Foot and Ankle Disability Index Sport (FADI Sport). Nineteen studies compared two or more outcome questionnaires. The use of more than one outcome questionnaire has the advantage of ensuring that several aspects of patient improvement may be captured. While one questionnaire may have an emphasis on

function another may have an emphasis on quality of life. A questionnaire used in isolation is unlikely to be able to differentiate these qualities. The current review categorised the questionnaires into three groups: condition specific, generic and global. The description of the properties of the questionnaires within some studies was sparse so a subjective judgement has been made in defining these questionnaires. As this review considered ankle injuries it is reassuring to find the greater number of questionnaires were within the condition specific category. Authors who made use of more than one questionnaire did not always select questionnaires from different categories. Some chose to use two condition specific questionnaires while others chose a condition specific and either a generic or global questionnaire. In many instances there was no rationale for comparing the same type of questionnaire or choosing different types of questionnaires.

With respect to the fifteen studies that investigated psychometric properties, variation was found in their reporting. The reporting of the psychometric properties is considered necessary for an outcome questionnaire to be accepted by both researchers and clinicians (Bialocerkowski et al., 2004; J. Parker et al., 2003; Pollard, Johnston, & Dixon, 2007). Only three studies reported on all three aspects of psychometric properties: validity, reliability and responsiveness and all reported good to excellent results. Of studies that investigated only one aspect of psychometric properties, only three studies reported poor results. These findings demonstrated that apart from three studies, the identified questionnaires reached acceptable levels for the specific psychometric properties investigated.

With respect to the twenty one studies involving an intervention and an outcome questionnaire, it is of interest that only seven studies specifically gave information

relating to psychometric properties of the questionnaires. While an additional seven studies referenced previous studies in relation to questionnaires they did not make specific mention of the psychometric properties. It is left to the reader to either assume that these questionnaires have undergone psychometric testing or obtain the referenced article to confirm. The weakness of only providing referencing of previous studies is highlighted by Clark and Burden (2005) that referenced Rozzi et al (1999). The referenced Rozzi study utilised a modified questionnaire and importantly this had not undergone psychometric testing. The remaining seven studies, including the above mentioned study by Rozzi (1999), either stated that psychometric testing had not been undertaken or failed to mention psychometric properties.

The results from the intervention studies demonstrate that outcome questionnaires gave limited support for the effectiveness of the interventions. Only nine studies found significant differences in the outcomes and these were often only within sub-groups. These limited positive results may have had more to do with what the study was investigating rather than failure of the questionnaire. Wilson (1998) suggests that at times the inability to detect treatment effects may be due to the outcome measure being unresponsive to change. Additionally it has been identified that it is critical to ensure that measures assess what they are intended to assess (Pollard et al., 2007). Of particular interest to the present study, only four studies compared questionnaires with other outcome measures. Two studies found no relationship between questionnaires and aspects of postural control, while two studies found a significant relationship between questionnaires and days to return to sport and weight bearing respectively. Additionally no studies were found that compared patients' and therapists' perception of the ankle

injury. When measuring discharge criteria a similar perception of recovery for the patient and therapist would be beneficial to ensure that the patient's confidence and appreciation of their recovery has reached full potential. There were few studies identified in the literature that consider this aspect. One study by Dowrick and colleagues (2006) who investigated disability in an orthopaedic trauma population highlighted that patients and observers differed in their assessment of an individual's level of disability and noted that caution should be taken when relying on an observer's opinion.

With respect to the quality rating of studies, the poor quality rating of a number of studies reflects the emphasis that has been placed on the quality scoring system. As previously identified all seven studies that scored greater than 80% examined psychometrics properties only. The remaining ten studies that examined psychometrics properties scored greater than 50%. The quality grading tool (Appendix B) that was modified from the Cochrane Musculoskeletal Injuries Group (CMIG) scoring system was adapted to address quality issues relating to outcome measurements. Specifically these quality issues related to aspects of validity, reliability and responsiveness as these were considered important for this review. It is acknowledged that this modified scoring system has not been previously used. However, as has been identified there is no consensus on a gold standard in critical appraisal tools and that appraisal tools are often modified to meet specific design quality issues (Katrak et al., 2004). Haywood and colleagues (2004) have developed a detailed data extraction tool for reviewing outcome measures. This tool has merit as a tool to appraise specific outcome measures; however, the current review placed no emphasis on the findings of the identified studies. The

primary aim of the current review was to identify the number of outcome questionnaires used across ankle studies and how well they had been substantiated through studies investigating their psychometric properties.

Several authors have emphasised the importance of questionnaires being able to demonstrate their validity, reliability and responsiveness (Eechaute et al., 2007; Haywood, Hargreaves, & Lamb, 2004). The justification and rationale for choosing a particular outcome measurement should also be clearly identified (Pollard et al., 2007). In many instances this review identified that this was not the case. This is reflected in both the lack of reporting of the psychometrics properties and the poor quality rating scores of a number of studies.

There is no doubt questionnaires are complex in that they require numerous attributes to reach sufficient validity, reliability and responsiveness. To date, research has focused upon providing psychometric measures that establish whether a questionnaire meets the required criteria for effectiveness or usefulness. A fundamental issue which has not received sufficient investigation is how patients interpret questionnaires and whether the scores are a reflection of the patient's perception of the constructs that the questionnaires seek to explore. Furthermore while questionnaires are able to demonstrate change in scores over time, there has been little attention paid to how the questionnaire scores reflect patient perceptions at time of discharge. This is highlighted in the findings of Brodsky and co-workers (2005) who reported that despite patients scoring highly on the AOFAS ankle-hindfoot score, 17% of patients still had functional instability that was not reflected in the AOFAS score. However, in comparison, the SF-36 was able to identify those patients with functional instability.

Hence there is a need to explore if there are associations between outcome questionnaires that assess patient's perceptions of function or quality of life and are able to identify patient concerns following their discharge from treatment for an ankle sprain. Additionally, Pincus and co-workers (1989) commented on the lack of comparisons between questionnaires and traditional outcome measures in relation to rheumatoid arthritis twenty years ago. This review has identified this lack of comparison is still the situation with respect to ankle sprains. Hence there is a further need to explore if there are associations between outcome questionnaires scores and comparisons to the more traditional functional and impairment outcome measures. This review has further identified that there is a lack of information regarding comparison of patient's perception and therapists' perception at time of discharge. This aspect also warrants investigation.

In summary, the current review identified both psychometrics investigative studies and intervention studies involving outcome questionnaires relating to ankle injuries. A total of thirty five different questionnaires were used to investigate ankle sprains. Twenty three of the thirty six studies provided information that supported aspects of validity, reliability or responsiveness related to outcome questionnaire measurements. However, other aspects of justification for the selection of specific outcome questionnaires were lacking. This leaves the reader questioning how appropriate the selected measurements are to apply in a clinical setting. As previously stated there is confusion for the researcher or clinician regarding the most appropriate outcome measurement to select. This review provides evidence as to the variety and lack of rigour in outcome questionnaires used in evaluating ankle sprains.

Table 4: Summary of ankle outcome questionnaire studies investigating psychometric properties

Author and Date	**•Study design • Comparisons/Tasks completed**	**•Number of participants (N=) •Dropouts (N=) •Time since injury**	**•Outcome questionnaire**	**•Results for psychometric properties •Quality Score (/16)**
McNair et al. 2007	•Inception cohort (5 studies included) •Lower Limb Task Questionnaire compared with Short Form -36 (SF-36), Motor Activity Scale, Patient Specific Function Scale, Lysholm Knee Rating Scale, Cincinnati Knee Rating Scale and Ankle-Hindfoot Scale	• Varied between 59 – 174 • Not stated • Not stated	•Lower Limb Task Questionnaire (LLTQ) •Short Form -36 (SF-36) • Motor Activity Scale •Patient Specific Function Scale •Lysholm Knee Rating Scale •Cincinnati Knee Rating Scale •Ankle-Hindfoot Scale	• Validity demonstrated moderate to high correlations with other questionnaires (0.51-0.86). High reliability was also demonstrated (0.96-0.98). The responsiveness and minimal important difference also demonstrated satisfactory results using a number of different statistics. •14
Obremskey et al. 2007	•Cohort •Subjects with unstable ankle fractures compared Short Form -36 and the Short Musculoskeletal Functional Assessment	• N=127 • N=Nil • Greater than 6 months	•Short Form -36 (SF-36) •Short Musculoskeletal Functional Assessment	•The Short Musculoskeletal Functional Assessment had fewer floor or ceiling effects and may be a more effective single instrument to tracks a patient's functional recovery than the SF-36. •13
Docherty et al. 2006	•Cohort •Subjects completed Ankle Instability Instrument	• N=101 Ankle sprain:73, Uninjured:28 • Not stated • Not stated	•Ankle Instability Instrument	•Demonstrated high reliability for the instrument. Test-retest reliability (ICC=0.95), internal consistency using Cronbach alpha coefficient (0.89). •12
Hiller et al. 2006	•Cross sectional study •Subjects completed Cumberland Ankle Instability Tool, Lower Extremity Functional Scale and VAS	• N=236 • N=59 • Not stated	•Cumberland Ankle Instability Tool •Lower Extremity Functional Scale (LEFS) •VAS perception of ankle stability	•Significant correlation between CAIT, LEFS and VAS. Construct validity and internal reliability were acceptable (0.83). Sensitivity was 82.9% and specificity was 74.7%. Test-retest reliability was excellent (ICC=0.96). •12

SooHoo, Vyas et al. 2006	•Cohort •Subjects completed SF-36, Foot Function Index (FFI) and the American Orthopaedic Foot and Ankle Society (AOFAS) Clinical Rating Systems	• N=30 • N=5 • Chronic	•SF-36 •Foot Function Index (FFI) •American Orthopaedic Foot and Ankle Society (AOFAS) Clinical Rating Systems	•Comparisons between FFI and AOFAS to the SF-36 showed increased responsiveness; however, bodily pain and physical component summary were similar. •14
SooHoo Samimi et al. 2006	• Cohort •Subjects completed SF-36 and Foot Function Index (FFI)	• N=73 • N=9 • Chronic	•SF-36 •Foot Function Index (FFI)	•Moderate to high levels of correlation to SF-36 suggests FFI is a valid instrument to measure patient outcome. •14
Brodsky et al. 2005	•Cohort •Subjects who had undergone reconstructive surgery for lateral ankle instability completed SF-36 and American Orthopaedic Foot and Ankle Society (AOFAS) Clinical Rating Systems	• N=73 • N=Nil • Greater than 14 months	•SF-36 •American Orthopaedic Foot and Ankle Society (AOFAS) Clinical Rating Systems	•Internal reliability of AOFAS in relation to the SF-36 was relevant in just three of the seven domains. Content validity of the AOFAS appears less than the SF-36 after lateral ankle instability reconstruction. •13
Hale and Hertel 2005	•Test-retest design •Subjects completed Foot and Ankle Disability Index (FADI) and Foot and Ankle Disability Index Sport (FADI Sport) on three occasions. Subgroup completed 4 week ankle rehabilitation programme	• N=50 Subgroup completed 4 week rehabilitation programme:16 • N=8 • Chronic	•Foot and Ankle Disability Index (FADI) •Foot and Ankle Disability Index Sport (FADI Sport)	•The FADI and FADI Sport demonstrates good to moderate reliability at 1 week and 6 week intervals in detecting functional limitations in subjects with chronic ankle instability (CAI). Also they are sensitive to difference between healthy and CAI subjects and responsive to improvements in function after rehabilitation. •13
SooHoo et al. 2003	•Cohort •Subjects completed SF-36 and the American Orthopaedic Foot and Ankle Society (AOFAS) Clinical Rating Systems	• N=94 • N=3 • Not stated	•SF-36 •American Orthopaedic Foot and Ankle Society (AOFAS) Clinical Rating Systems	•Low levels of correlation between the SF-36 subscales and AOFAS suggest poor construct validity (0.02-0.36). •11

Williams et al. 2003	•Controlled trial •Subjects completed a Quality of Life Measure (QOL), the Clinical Rating Score and the Single Assessment Numeric Evaluation (SANE)	• N=30 Ankle sprain:15, control:15 • Not stated • Less than 2 days	•Sports Ankle Rating System which is made up of - Quality of Life Measure (0-20), the Clinical Rating Score (0-100)and the Single Assessment Numeric Evaluation (0-100)	•Good construct validity with strong correlation between the QOL and SANE ($p<0.001$) across the four measurement points. The Clinical Rating Score correlated strongly with the QOL ($p<0.001$), and moderately with the SANE ($p<0.05$) at the 2 and 4 week evaluations. Very high test-retest reliability was demonstrated as was excellent internal consistency of the QOL with coefficient alphas ranging between 0.87-0.89. Good responsiveness was also demonstrated. •12
Roos et al. 2001	• Cross sectional • Subjects who had previously undergone ankle ligament reconstruction completed the Foot and Ankle Outcome Score and Karlsson Functional Scoring scale (NB: It is not clear that participants completed the latter questionnaire)	•N=213 •Not Stated •Greater than 3 years	•Foot and Ankle Outcome Score •Karlsson Functional Scoring scale (0–100)	• Good content validity was demonstrated. Construct validity showed moderate correlation with the Karlsson scoring (r^s=0.58-0.67). High test-retest reliability (ICC=0.70-0.92) as was high internal consistency of the five subscales with Cronbach's alphas ranging between 0.88-0.97. •12
Binkley et al. 1999	•Cohort study •Subjects with lower extremity musculoskeletal injuries completed Lower Extremity Functional Scale and SF-36 on weekly for 4 weeks	• N=107 Ankle injuries:14 • N=72 • Average of 6 weeks	•Lower Extremity Functional Scale (LEFS) (5-point scale) •SF-36	•Reliability of test-retest was excellent (R=0.94). Correlations between LEFS and SF-36 physical function and physical components scores were (*r*=0.80 and *r*=0.64 respectively). The minimal detectable change is 9 scale points and the minimal clinical important difference is 9 scale points. •15

Karlsson and Peterson 1991	•Cohort •Subjects completed 3 scoring systems and two clinical tests	• N=148 • Not Stated • Greater than 2 years	•Functional Scoring scale (0 – 100) •Overall function, VAS (15cm line) •St Pierre functional score (4 points)	•The functional scoring scale correlates statistically with subjective and objective parameters of ankle joint stability and function ($p<0.001$). •10
Kaikkonen et al. 1994	•Controlled trial •11-test battery	• N=264 Test group:148, Control:100 • N=16 • Average 7 years	•Subjective and Functional Scoring system (100 points) •Subjective-functional assessment	•Significant difference between sub groups of test group for subjective impairment and activity impairment ($p<0.01$). Total test score correlated significantly with isokinetic ankle strength, subjective opinion about recovery and subjective-functional assessment (r=0.40-0.81, $p<0.001$). •8
Olerud and Molander 1984	•Cohort •Subjects completed the scoring scale for symptom evaluation after ankle fracture, subjective ankle function (VAS), one clinical test and radiographic examination	• N=90 • Not stated • Not stated	•Scoring scale for symptom evaluation after ankle fracture. (1-100) •Subjective ankle function- VAS (15cm line)	•The scoring scale correlates with a linear analogue scale, the limitation in range of movement, presence of osteoarthritis and presence of dislocation on X-ray. (NB Lack of statistical analysis to support results). •9

RCT = Randomised Control Trial, VAS = Visual Analogue Scale

Table 5: Summary of ankle intervention studies utilising questionnaires as an outcome measurement

Author and Date	**•Study design •Intervention/Control**	**•Number of participants (N=) •Dropouts (N=) •Time since injury**	**•Outcome questionnaire o Psychometric properties provided**	**•Results comparing outcome measurements •Quality Score (/16)**
Bassett and Prapavessis 2007	•Prospective random design •Home based or clinic based intervention for acute ankle sprains	• N=47 intervention:25, home based:22 • N=11 • Acute	•Lower Limb Task Questionnaire (LLTQ) o Reliability (0.89–0.96) • Motor Activity Scale (MAS) o Reliability (0.90), Sensitive to change (p=0.001) •Sports Injury Rehabilitation Adherence Scale (SIRAS) o Internal consistency (0.82), Test-retest reliability (0.77), Interrater reliability (0.53) •Situational Motivational Scale (SMS) o Reliability (0.80)	•Significant difference over course of intervention for LLTQ recreational scale and MAS; however, there were no significant differences between groups' rate of change for either measure. SIRAS and MAS group scores were high pre and post intervention; however, there were no significant differences between groups. •11
Hiller et al. 2007	•Cross sectional study •Balance measured between unstable and stable ankles	• N=61External control:20, Unilateral Control:19, Unilateral Instability:19, Bilateral Instability:20 • N=Nil • Not stated	•Cumberland Ankle Instability Tool (CAIT) oNot specifically mentioned but reference to Hiller et al, 2006 study (See Table 4)	•CAIT was able to identify difference between external control group (uninjured) compared with the other three groups (injured) but did not detect differences between the injured groups. •11
Man et al. 2007	•RCT •3 groups of subjects : a group that received Neuromuscular Electrical Stimulation (NMES) treatment, a group that received submotor Electrical Stimulation (ES) treatment (designed to act as a control group), and group receiving sham ES treatment	• N=34 NMES:11 ES:11, Sham ES:12 • N=Nil • Less than 5 days	•Modified adapted Hughston Clinic Subjective Rating Scale for Ankle Disorders oReports no validity or reliability testing	•There were no statistically significant differences for self-assessed ankle function. •1

Perron et al. 2007	•Cross sectional study •Subjects were tested on the ability of the Biodex Stability System to distinguish level of function in subjects with a second-degree ankle sprain	• N=70 Grade II ankle sprain:34, controlled subjects:36 • N=Nil • Less than 3 months	•Lower Extremity Functional Scale (LEFS) oReports excellent test-retest reliability and good validity from referenced studies	•No significant relationships found between overall dynamic limit-of-stability scores and the LEFS scores of the subjects with a lateral ankle sprain. •12
Beynnon et al. 2006	•RCT •Functional treatment with different types of external support	• N=212 Grade I ankle sprain:64, grade II:116, grade III:32 • N=82 • Less then 3 days	•Karlsson's functional scoring scale oNot specifically mentioned but reference to Karlsson's thesis	•At 6 month follow up there was no difference between treatments for any grade of ankle injury comparing Karlsson's functional scoring scale, jumping distance and number of toe raises. •5
Clark and Burden 2005	•RCT •Two groups; Exercise and control. The exercise group underwent a monitored 4-week wobble board programme (10 min per session, three times per week)	• N=19 male subjects, Exercise:9, Control:10 • Not stated • Chronic	•Ankle Joint Functional Assessment Tool questionnaire (AJFAT) o Not specifically mentioned but reference to Rozzi et al, 1999 study (See Table 5)	•Significant difference in AJFAT scores occurred between pre and post results for the exercise group only ($p<0.01$). No comparisons between other outcome measures. •3
Zammit and Herrington 2005	•Single blind RCT •Three groups: active ultrasound treatment group; placebo ultrasound treatment group; no ultrasound treatment group	• N=34 U/S Treatment:12, Placebo U/S treatment:10, No U/S treatment:12 • Not stated • Less than 3 days	•Pain VAS (10cm) oReports high reliability, but compromised content validity from referenced studies	•No significant difference for pain across the three groups. No comparisons between other outcome measures. •10

Evans et al. 2004	•Controlled Laboratory Study •Postural control measured and self-reported functional status	•N=28 Control uninjured leg. •Not stated •Pre-injury, then 1,7,14,21 and 28 days post injury	•Modified version of Athletic Training Outcome Assessment (ATOA) oReports reliability and sensitive to changes from referenced studies •SF-12 oNot specifically mentioned but reference to other studies	•Lower scores at day 1, 7 and 14 than at baseline for both ATOA and SF-36. However, there was low correlation between the ATOA and center of pressure excursion velocity and the SF-36 and center of pressure excursion velocity (r<0.49). No comparisons between other outcome measures. •9
Koll et al. 2004	•Double blind RCT •Application of comfrey on acute ankle sprain	• N=143 treatment group:80, control:63. • N=3 • Less than 6 hours.	•Pain VAS oNo reference to psychometric properties •Global evaluation of efficacy (5 point scale) oNo reference to psychometric properties	•The VAS value reduced for subjective pain sensation and movement pain for both groups over time. Group difference did not reach significance. The end result for global efficacy was significantly better for both physician and patient respectively (p<0.0001 and p=0.0009). No comparisons between other outcome measures. •6
Airaksinen et al. 2003	•Prospective double blind RCT •Cold gel vs placebo in soft tissue injury of ankle, knee, hand or leg – 4 times a day for 14 days	• N=74 Gel:37, Placebo:37 • Not stated • Less than 2 days	•VAS (0-100) oNot specifically mentioned but reference to other studies •Global assessment of therapy and patient satisfaction (4 point scale) treatment for both patient and investigator oNo reference to psychometric properties	•Pain, functional disability, patient's satisfaction and investigator's assessment measures were all improved in the treatment group (p<0.001). No comparisons between other outcome measures. •6

Hoiness et al. 2003	•Prospective RCT •6 week high intensity training programme using either bi-directional test pedal or uni-directional bicycle	• N=20 Test group:10, control:9 • N=1 • Greater then 1.5 years	•Modified Karlsson's functional scoring scale oNot specifically mentioned but reference to Karlsson and Peterson 1991 study (Table 4) •VAS (0-100) oNo reference to psychometric properties	•Modified Karlsson's functional score increased significantly from before training to after training for the test group (p=0.005); however, there was no significant difference between groups. No comparisons between other outcome measures. •7
Cross et al. 2002	•Prospective observational study. •Assessed by 3 self-report measures and 4 clinical measures following acute ankle injury and then on return to sport	• N=20 • N=1 • Less than 1 day	•Pain VAS (10cm line) oReported reliability and validity addressed with referenced study •Global function (0-100%) oReported sensitivity to change and validity addressed with referenced studies •SF-36 Physical Function Scale (SF-36-PF) oReported reliability and validity addressed with referenced studies	•Global function question, SF36PF and the subject's ambulatory status had a significant relationship with days to return to sport (r=0.47-0.53) Effect sizes ranged from 0.68-2.73. •11
Pellow and Brantingham 2001	•Single blind controlled study •Intervention group received an ankle adjustment	• N=36 Treatment:15, control:15. • N=6 • Greater than 2 days (sub acute and chronic)	•Short-form McGill Pain Questionnaire o Not specifically mentioned but reference to one study •Numerical Pain Rating Scale 101 oNot specifically mentioned but reference to one study •Functional evaluation scoring scale o Reported excellent reproducibility as referenced to Kaikkonen et al 1994 (See Table 4)	•Significant difference in favour of the adjustment group for reduction of pain (p=0.004) for the Short-form McGill Pain Questionnaire and function (p=0.0001). No comparisons between other outcome measures. •3

Pugia et al. 2001	•Prospective correlational study •Subjects completed the Foot and Ankle Ability Index (FAAI), the FAAI Sport, Ankle Osteoporosis Scale (AOS), ankle girth and weight bearing ability	• N=29 • Nil • Less than 10 days	•Foot and Ankle Ability Index (FAAI) oReports no validity or reliability testing •Foot and Ankle Ability Index Sport oReports no validity or reliability testing • Ankle Osteoporosis Scale oReported likely to be valid for acute ankle sprains as referenced to one study	•Significant correlations found between FAAI and FAAI Sport ($p<0.00$), FAAI and weight bearing ($p<0.00$), FAAI Sport and weight bearing ($p<0.00$), FAAI and AOS ($p<0.00$), FAAI Sport and AOS ($p<0.00$), AOS and weight bearing ($p<0.00$). • 10
Rose et al. 2000	• Controlled Laboratory Study • Injured subjects were given standardised treatment and measured over 3 visits	•N=37 Injured:19, Control:18. •N=Nil •Less than 3 days	•Olerud and Molander questionnaire (0-100%) oNot specifically mentioned but reference to Olerud and Molander, 1984 study (See Table 4)	•Significant change in questionnaire scores between each of the three visits for the injured group ($p<0.0001$). No comparisons between other outcome measures. •8
Nyska et al. 1999	•Non randomised Trial •Comparison of acute grade III ankle sprains treated by immobilisation for three weeks in short leg walking casts to age matched patients treated by controlled mobilization with an Aircast	• N=36 immobilisation:14, aircast:22. • Not stated • Acute	•Pain - VAS (1-10) oNo reference to psychometric properties	•No significant difference between groups for pain. No comparisons between other outcome measures. •6
Rozzi et al. 1999	•Non randomised 2 group pretest -posttest design •4 week, 3 days per week static and dynamic single leg balance training program in those with recurrent ankle sprains. Control group of non-impaired subjects	• N=26 Training:13 Control:13 • Not stated • Chronic	•Ankle Joint Functional Assessment Tool questionnaire (AJFAT) modified from a functional knee evaluation (5 point) oNo reference to psychometric properties as had been modified	•Both groups demonstrated statistically significant improvements in AJFAT scores between pre-test and post-test. No comparisons between other outcome measures. •7
Borromeo et al. 1997	• Double blind RCT •Intervention of hyberbaric oxygen for 3 treatments	• N=32 • Not stated • Less than 3 days	•Pain VAS (10 cm line) oNo reference to psychometric properties	•No significant differences between groups for pain. No comparisons between other outcome measures. •6

Karlsson et al. 1996	•Prospective RCT •Intervention of functional treatment during first week of injury compared to conventional partial weight bearing	• N=86 • N=2 • Less than 24 hours	•Functional Scoring Scale (100 points) o Reported previous validity with reference to Karlsson and Peterson 1991 study (Table 4)	•No significant differences in function scores between groups at follow up. No comparisons between other outcome measures. •8
Leanderson and Wredmark 1995	•RCT •Air-Stirrup or compression bandage followed over 10 weeks	• N=73 Ankle brace:39, Compression bandage:34 • N=15 • Less than 24 hours	•Modified Karlsson's functional scoring scale (85 points) oNot specifically mentioned but reference to Karlsson and Peterson 1991 study (Table 4) •Sickness Impact Profile (SIP) oNot specifically mentioned but reference to other studies	•No significant differences for either the SIP or the Karlsson's functional scoring scale between groups at follow up. No comparisons between other outcome measures. •7
Wilkerson and Horn-Kingery 1993	•Case control study •Subjects received elastic tape, focal compression by U shaped device or focal compression with cryotherapy	• N=42 • N=8 • Less than 24 hours	•Function recovery scale (100 points) o No reference to psychometric properties as had been modified	•No significant differences found between groups using the Functional recovery scale. No comparisons between other outcome measures. •2

RCT = Randomised Control Trial, VAS = Visual Analogue Scale

Table 6: Grading scores for outcome questionnaire studies

Author and Date	A	B	C	D	E	F	G	H	Total /16
Bassett and Prapavessis 2007	2	2	0	2	0	2	1	2	11
Hiller et al. 2007	2	2	1	1	0	2	1	2	11
McNair et al. 2007	2	2	2	2	2	2	0	2	14
Man et al. 2007	1	0	0	0	0	0	0	0	1
Obremskey et al. 2007	2	2	1	1	1	2	2	2	13
Perron et al. 2007	2	2	1	1	0	2	2	2	12
Beynnon et al. 2006	1	2	0	0	0	0	1	1	5
Docherty et al. 2006	2	2	2	2	0	2	0	2	12
Hiller et al. 2006	2	2	2	2	0	2	0	2	12
SooHoo, Vyas et al. 2006	2	2	1	1	2	2	2	2	14
SooHoo Samimi et al. 2006	2	2	2	1	1	2	2	2	14
Brodsky et al. 2005	2	2	2	2	0	2	2	1	13
Clark and Burden 2005	1	0	0	0	0	0	1	1	3
Hale and Hertel 2005	2	2	1	2	2	2	1	1	13
Zammit and Herrington 2005	2	1	1	1	0	1	2	2	10
Evans et al. 2004	1	2	0	1	1	1	2	1	9
Koll et al. 2004	1	0	0	0	0	1	2	2	6
Airaksinen et al. 2003	1	0	0	0	0	1	2	2	6
Hoiness et al. 2003	2	0	0	0	0	2	1	2	7
SooHoo et al. 2003	2	2	1	0	1	2	2	1	11
Williams et al. 2003	2	2	2	2	2	2	0	0	12
Cross et al. 2002	1	2	1	1	1	1	2	2	11
Pellow and Brantingham 2001	1	0	0	0	0	0	1	1	3
Pugia et al. 2001	2	2	0	1	0	2	1	2	10
Roos et al. 2001	2	2	2	2	0	2	0	2	12
Rose et al. 2000	2	1	0	0	0	2	1	2	8
Nyska et al. 1999	1	0	0	0	0	1	2	2	6
Binkley et al. 1999	2	2	2	2	2	2	1	2	15
Rozzi et al. 1999	2	1	0	0	0	2	0	2	7
Borromeo et al. 1997	2	0	0	0	0	2	0	2	6
Karlsson et al. 1996	2	0	1	0	0	2	1	2	8
Leanderson and Wredmark 1995	1	2	0	0	0	2	1	1	7
Kaikkonen et al. 1994	2	0	0	2	0	2	0	2	8
Wilkerson and Horn-Kingery 1993	1	0	0	0	0	1	0	0	2
Karlsson and Peterson 1991	2	2	2	0	0	2	0	2	10
Olerud and Molander 1984	2	2	0	2	0	2	0	1	9

Review of impairment and performance measures

Impairment measures, sometimes referred to as clinical outcomes, have been identified as appropriate outcome measures (Abrams et al., 2006; Swiontkowski et al., 1999). With respect to ankle sprains these types of outcomes typically involve measuring range of motion, strength, swelling, balance and proprioception. Proprioception, balance and strength deficits have been suggested as important impairments that require measurement and attention in the rehabilitation of ankle sprains (Freeman, 1965; Garn & Newton, 1988; Hertel, 2002; Tropp, 1986). Hence one might expect that there would be uniformity in the measurement results concerning levels of impairment for each of these measures following an ankle sprain. A search of the literature failed to identify any reviews that investigated ankle impairment measures. Therefore it was considered relevant to undertake a review of the ankle sprains literature to identify common impairment measures specifically investigating proprioception, balance and strength.

There is good support from the systematic reviews on ankle treatment for the use of outcome measures involving testing procedures with respect to ankle strength, postural control and proprioception. Additionally performance measures have also been identified as appropriate outcome measures (Stratford et al., 2002). Typically performance measures involve aspects of functional ability. As previously reported an emphasis on function is a critical component of the International Classification of Functioning, Disability and Health model (2002). While aspects of ankle strength, postural control and proprioception testing procedures may identify aspects of ankle disability, they do not address functional activities. A number of authors have previously questioned the

relationship between traditional testing procedures and functional movement patterns in relation to postural control (Buchanan, Docherty, & Schrader, 2008; Demeritt, Shultz, Docherty, Gansneder, & Perrin, 2002; Eechaute, Vaes, & Duquet, 2008; Johnson & Stoneman, 2007). Therefore it was considered useful to identify performance tests that involved aspects of function. Given that an aim of this study was to explore the relationship between questionnaires and impairments at the time of discharge there is a need to explore the most appropriate technique or procedure for measuring these impairments.

Methodology

A search of the literature was undertaken using the following electronic databases: Medline (1966-current), EBSCO Health, (included Biomedical Reference Collection, Clinical Reference Collection, Health Source Consumer/Nursing/Academic Edition, Psychological and BehavioralSciences Collection and SPORTDiscus), Ovid (included Full text journals, EBM Reviews, AMED, CINAHL, ERIC, Health and Psychosocial Instruments, Ovid MEDLINE, PsycINFO,), CINAHL Current contents; Psyclit; Science Citation Index; sportdiscus. Cochrane controlled trials register, Cochrane Database of Systematic Reviews, Cochrane Complementary Medicine Fields Trial Register, PEDro.

The search strategy used the following initial keyword terms: ‘Ankle* and Injur*, or Sprain*, or Strain*, and Inversion, or Eversion, or Intervention*, and Propriocepti*, and Joint Position Sense, and Balance, and Postural Control, and Strength’. With respect to performance measures the additional keywords were added ‘functional test*, performance test* and agility’.

To be eligible for inclusion in this review, studies had to: have investigated ankle sprains, have been published in English and have used some form of either an impairment or performance measure as an outcome measurement. The search strategy involved the previous terms and identified studies that had addressed these key issues. The abstracts were obtained and reviewed and relevant studies were obtained for full evaluation. Reference lists of articles were checked for further relevant studies. A critical appraisal of the identified studies was undertaken to consider aspects of internal and external validity issues across the individual studies. Papers were graded according to the quality of the study using a modified version of the Cochrane Musculoskeletal Injuries Group (CMIG) scoring system to provide an overall score for each study (Thomson et al., 2004). The modified CMIG scoring system comprised nine separate questions graded between 0 and 2 covering aspects of study design and outcome measures (APPENDIX C). Three questions (G, H and I) have been specifically adapted by the author to answer specific areas of interest for this study. A final overall score (quality rating), out of a possible 18, was awarded to each impairment paper (See Table 11). There are limitations for this scoring tool as it has not been validated. As previously stated there is no gold standard for scoring study qualities. Of further note two items within the scoring tool relate to controls and interventions. It is acknowledged that a number of the included studies were laboratory studies that did not provide a control or an intervention and this needs to be considered in the overall scoring. A study was considered of low quality if it scored less than 50% (9/18), moderate quality if it scored greater than or equal to 50% but less than 75% (14/18) and high quality if it scored greater than or equal to 75%.

To assess the overall findings a modified 'level of evidence' approach was used (National Research Council & Institute of Medicine, 2001). This considered the quality level of studies and where possible the effect sizes for the individual study findings.

Table 7: Levels of evidence for impairment and performance measure studies

Levels of evidence	Definition
Strong	Consistent findings in greater than three high quality studies (QR≥75%).
Moderate	Consistent findings: in one high quality study (QR≥75%) and two or more moderate quality studies (QR<75% ≥50%) or three or more moderate quality studies (QR<75% ≥50%).
Weak	Consistent findings: in one high quality study (QR≥75%) or one moderate quality studies (QR<75% ≥50%) and three or more low quality studies (QR<50%).
Inconclusive	Inconsistent findings irrespective of study quality
No evidence	No data presented

QR=Quality rating

For the sake of clarity for the following reviews, only the results and discussion for the impairment and performance measures are presented. The above methodology was duplicated for each review.

Proprioception/Joint position sense

Results

The term proprioception is commonly referred to with regard to ankle sprains. However, within the literature its meaning has a number of interpretations (de Jong, Kilbreath, Refshauge, & Adams, 2005). For the purposes of this review the term 'joint position sense' has been adopted as recommended by Refshauge (2003).

Fourteen studies (Bernier & Perrin, 1998; Boyle & Negus, 1998; Docherty, Moore, & Arnold, 1998; Eils & Rosenbaum, 2001; Fu & Hui-Chan, 2005; Glencross &

Thornton, 1981; Holme et al., 1999; Konradsen, Olesen, & Hansen, 1998; Leanderson et al., 1999; Lentell et al., 1995; Refshauge, Kilbreath, & Raymond, 2003; Sekir, Yildiz, Hazneci, Ors, & Aydin, 2007; Waddington & Adams, 1999; Willems, Witvrouw, Verstuyft, Vaes, & De Clercq, 2002) were identified that investigated proprioception or 'joint position sense' in relation to sprained ankles (Table 8). One study (Holme et al., 1999) was a randomised controlled trial and one study (Leanderson et al., 1999) was a randomised trial that did not have a control group. The remaining twelve studies were controlled laboratory studies. Six studies (Bernier & Perrin, 1998; Docherty et al., 1998; Eils & Rosenbaum, 2001; Holme et al., 1999; Leanderson et al., 1999; Sekir et al., 2007) provided an intervention to investigate the effects of training on ankle instability. The remaining eight studies (Boyle & Negus, 1998; Fu & Hui-Chan, 2005; Glencross & Thornton, 1981; Konradsen et al., 1998; Lentell et al., 1995; Refshauge et al., 2003; Waddington & Adams, 1999; Willems et al., 2002) were only concerned with investigating the difference between injured and uninjured ankles.

Six studies (Boyle & Negus, 1998; Docherty et al., 1998; Eils & Rosenbaum, 2001; Fu & Hui-Chan, 2005; Glencross & Thornton, 1981; Konradsen et al., 1998) used a goniometer to measure joint position sense, while four studies (Bernier & Perrin, 1998; Leanderson et al., 1999; Sekir et al., 2007; Willems et al., 2002) used isokinetic dynamometers. One study (Holme et al., 1999) used an Electrical torsimeter, one study (Refshauge et al., 2003) used a linear servomotor, one study (Waddington & Adams, 1999) used an Ankle Movement Extent Discrimination Apparatus and one study (Lentell et al., 1995) used a rotating platform.

Three studies (Holme et al., 1999; Konradsen et al., 1998; Leanderson et al., 1999) tested acute ankles (within one day of injury), one study (Waddington & Adams, 1999) did not state the time since injury, while the remaining ten studies all investigated chronic ankle injuries. Three studies (Bernier & Perrin, 1998; Boyle & Negus, 1998; Willems et al., 2002) used a combination of active and passive joint repositioning testing, four studies (Docherty et al., 1998; Holme et al., 1999; Leanderson et al., 1999; Waddington & Adams, 1999) used active testing only, while the remaining seven studies all used passive testing. One study (Waddington & Adams, 1999) tested joint position sense in weight bearing and one study (Lentell et al., 1995) tested in partial weight bearing. All remaining studies tested in a non-weight bearing position. Two studies (Bernier & Perrin, 1998; Docherty et al., 1998) investigated inversion, eversion, plantarflexion and dorsiflexion joint position sense. Six studies (Boyle & Negus, 1998; Holme et al., 1999; Konradsen et al., 1998; Lentell et al., 1995; Sekir et al., 2007; Willems et al., 2002) tested inversion only while two studies (Leanderson et al., 1999; Refshauge et al., 2003) tested inversion and eversion. One study (Waddington & Adams, 1999) tested plantarflexion and inversion, one study (Eils & Rosenbaum, 2001) investigated plantarflexion and dorsiflexion and one study (Fu & Hui-Chan, 2005) investigated plantarflexion only. One study (Glencross & Thornton, 1981) failed to identify what direction was investigated.

All studies failed to mention any validity of their testing procedure. Seven studies (Bernier & Perrin, 1998; Boyle & Negus, 1998; Fu & Hui-Chan, 2005; Konradsen et al., 1998; Lentell et al., 1995; Refshauge et al., 2003; Sekir et al., 2007) measured Intraclass Correlation Coefficients (ICC) and demonstrated low to high reliability for joint position testing (ICC 0.03 - 0.94).

With respect to the ability to identify joint position sense between injured and uninjured ankles, nine studies (Boyle & Negus, 1998; Fu & Hui-Chan, 2005; Glencross & Thornton, 1981; Konradsen et al., 1998; Lentell et al., 1995; Refshauge et al., 2003; Sekir et al., 2007; Waddington & Adams, 1999; Willems et al., 2002) found a significant difference between the injured and uninjured ankle. Effect sizes were calculated where possible and found to be moderate to large and ranged between 0.40 – 3.93. Only one of the above studies (Sekir et al., 2007) provided an intervention and the results of post intervention testing found no significant difference between the injured and uninjured ankles. Of these nine studies, one study (Waddington & Adams, 1999) measured active joint position sense, two studies measured both active and passive joint position sense, while the remaining six studies all measured passive joint position sense. Also of note with regard to these nine studies, only one study (Konradsen et al., 1998) investigated acute ankle injuries. Three studies (Bernier & Perrin, 1998; Docherty et al., 1998; Eils & Rosenbaum, 2001) investigated the injured ankle only so no comparison could be made across limbs. Two of these studies (Docherty et al., 1998; Eils & Rosenbaum, 2001) found a significant improvement post intervention for the injured ankle. Only two studies (Holme et al., 1999; Leanderson et al., 1999) found no significant difference across the injured and uninjured limbs. Of particular note, Holme (1999) had close to a 50% drop out rate from the study making any conclusions questionable. Only one study (Sekir et al., 2007) made a comparison between joint position sense and other outcome measures and found no correlation.

With respect to the quality scores of the studies, these ranged from 4 to 10/18 (Table 12). Four studies (Eils & Rosenbaum, 2001; Leanderson et al., 1999; Lentell et al.,

1995; Sekir et al., 2007) attained a moderate quality score of 55% (10/18). The remaining ten papers all scored a low quality rating of 50% or less (≤9/18).

Due to the significant variation across studies strong evidence based conclusions can not be made. However, accepting the above mentioned limitations, at a chronic stage of recovery, based on the findings of six studies (four poor quality and two moderate quality) that reported a difference of injured over uninjured ankle joint position sense and that demonstrated a moderate to large effect size (0.40-2.7), there was weak evidence that following a sprained ankle a person is likely to have some deficit in accurate reproduction of joint position. However, at an acute stage of injury the evidence was inconsistent.

Additionally, the findings from three studies (one poor quality and two medium quality) within this current review provided weak evidence that a strengthening intervention may be of benefit in improving joint position sense.

Discussion

The current review identified that many reviewed studies used variations of goniometers to investigate joint position. While a number of studies reported satisfactory reliability for the use of goniometers, no studies reported on aspects of validity. However, the validity and reliability of the electrogoniometer has previously been reported (Edgar, Finlay, Wu, & Wood, 2008; Tesio, Monzani, Gatti, & Franchignoni, 1995).

Before a conclusion can be drawn from the findings of the current review there are a number of factors that need to be considered. There was a general lack of consistency across a number of areas within the studies. These included, study design, intervention, time since injury, variety of testing equipment, variety of direction of movement tested

and variety of impairment outcome measures. It is well established that to use an evidence based approach when comparing studies, requires consistency across study design and study quality. Hatala (2005) further suggests that where interventions and outcome measurements are different then pooling of data across studies is questionable. The variation in study design, study quality, interventions, outcome measurements and findings across the reviewed studies makes any comparison difficult and of questionable value. Therefore no attempt has been made to undertake a meta-analysis in this current review.

The current review found that there was weak evidence that in the chronic stage following a sprained ankle, a person is likely to have some deficit in accurate reproduction of joint position. These findings are similar to a previous review investigating the role of proprioception in ankle sprains (Refshauge, 2003). Despite this conclusion the influence of proprioception to function is debatable. Other authors have identified loss of joint position sense alone does not correlate with a loss of function (de Jong et al., 2005). This finding is also in agreement with Refshauge's (2003) review.

Table 8: Summary of joint position sense studies

Author and Date	• Study Design • Intervention • Equipment	•Subjects characteristics •No of subjects (N=) •Time since injury	•Task •Validity •Reliability	•Results (Effect sizes calculated where possible) •Quality Score (/18)
Sekir et al. 2007	•Controlled Laboratory Trial •Yes- Isokinetic exercise programme 3x week for 6 weeks •Cybex isokinetic dynamometer	•Athletic subjects with injured ankles •N=24 •Greater than 6 months	•Passive inversion joint position sense non-weight bearing •No •Yes ICC=0.90 and 0.94 at 10^0 and 20^0 respectively	•Significantly greater error pre intervention in injured ankles (mean: 2.75 deg) compared to uninjured subjects (mean: 1.64 deg), ($p<0.006$). Effect size=0.81. Error scores in the injured and uninjured ankle joint position senses were not significant post intervention. No correlation between proprioceptive measures with isokinetic data. •10
Fu and Hui-Chan 2005	•Controlled Laboratory Study •No •Cybex Norm dynamometer to provide constant speed and a Penny and Giles electrogoniometer	•Basketball players •N=39 Injured:19 Uninjured:20 •Greater than 3 months	•Passive plantar flexion ankle joint repositioning test non-weight bearing •No •Yes ICC=0.84	•Significantly greater error in limbs of those with repeated ankle sprains (mean: 1.25 deg) compared to control subjects (mean: 0.9 deg), ($p<0.05$). Effect size=0.74. Low to moderate correlation between 3 of the 6 sway angles and joint repositioning (r=0.39-0.54) •7
Refshauge et al. 2003	•Controlled Laboratory Study •No •Linear servomotor	•Subjects with recurrent ankle sprains and controls •N= 69 Control group(no previous injury):30, Recurrent ankle sprains: 39 •Greater than 3 weeks	•Perception of passive inversion and eversion ankle movement non-weight bearing •No •Yes ICC=0.60 at 2.5^0/s and 0.74 at 0.1^0/s.	•Control group were able to detect significantly smaller inversion and eversion movement than recurrent sprain group ($p<0.01$). Effect size=0.80 at 0.1^0/s, 0.74 at 0.5^0/s and 7.5 at 2.5^0/s. •8

Willems et al. 2002	•Controlled Laboratory trial •No •Biodex isokinetic dynamometer	•Physical education students •N= 87 Control group(no previous injury):53, Group 2(3 or more sprains and frequent giving way):10, Group 3(previous sprain but no instability):16, Group 4 (previous sprain but no instability):8 •Group 2 greater than 3 months, Group 3 previous 2 years, Group 4 past 3-5 yrs	•Active and passive joint position sense at 15^0 of inversion and maximal inversion minus 5^0 non-weight bearing •No •No	•No significant differences in absolute error (difference in absolute value in degrees between chosen position and test position) between the four groups in active or passive joint position sense. Significant differences in exact error (provides an indication of difference between chosen position and test position whether subject overshoots or undershoots test angle position) at the maximal inversion minus 5^0 ($p=0.012$). Instability group showed significantly lower value for joint position sense at maximal inversion minus 5^0 compared with control ($p=0.042$). Effect size = 0.74. Instability group showed significantly lower value at maximal inversion minus 5^0 compared with Group 3 ($p=0.012$). Effect size = 1.04. Instability group showed significantly lower value at maximal inversion minus 5^0 compared with Group 4 ($p=0.036$). Effect size = 0.81. •7
Eils and Rosebaum 2001	•Controlled Laboratory trial •Yes- 6 week physiotherapy exercise programme •Custom built footplate with a Penny & Giles goniometer	•Subjects with repeated ankle sprains •N=30: Exercise:20 Control:10 (as many had bilateral instability Exercise :31 and Control:17 = 48 ankles tested) •Chronic	•Passive joint position sense test at 10^0, 20^0 dorsiflexion, 15^0 and 30^0 plantarflexion non-weight bearing •No •No	•Significant improvement (0.5 deg) for exercise group only at all testing angles except for 10^0 dorsiflexion, ($p<0.05$). Effect sizes = 0.73. No analysis of injured versus uninjured ankles. •10

Holme et al. 1999	• Randomised controlled Trial • Training intervention, group physiotherapy rehabilitation. Control only standard advice. • Electrical torsimeter	• Recreational athletes with acute ankle sprains. • N=92 Training:46, Control:46. • Day of injury	• Active joint position sense at 10^0,15^0 and 20^0 of inversion non-weight bearing • No • No	• No significant differences between injured and uninjured limbs for either the training group or the control group. NB: Caution needs to be taken with these results as there was close to 50% drop out rate of participants • 4
Leanderson et al. 1999	• Randomised Trial • 2 interventions: Ankle Brace or Compression bandage • Biodex isokinetic dynamometer	• Subjects with acute ankle sprains • N=73 Air-Stirrup:39 Compression bandage:34 • 1 day	• Active inversion and eversion joint position sense non-weight bearing • No • Yes (ref 2 studies)	• No significant differences across limbs. • 10
Waddington and Adams 1999	• Controlled Laboratory Study • No • Ankle Movement Extent Discrimination Apparatus	• College athletes and academics. • N=20 • Not Stated	• Active joint discrimination test for plantarflexion and inversion weight bearing • No • No	• Uninjured ankles had better overall discrimination then previously injured subjects (p=0.032). Effect size=2.90 and 2.30 for uninjured versus unilateral injured inversion for the right and left ankle respectively. Effect size=1.90 and 2.01 for uninjured versus bilateral injured inversion for the right and left ankle respectively. Effect size=0.13 and 3.93 for uninjured versus unilateral injured plantarflexion for the right and left ankle respectively. Effect size=2.75 and 2.60 for uninjured versus bilateral injured plantarflexion for the right and left ankle respectively. • 4

Boyle and Negus 1998	•Controlled Laboratory Study •No •Pedal Goniometer	•Subjects with recurrent ankle sprains and uninjured •N=92 Uninjured: 67, Injured: 25 •Greater than 3 months	•Active and passive joint position sense at $30^{\%}$, $60^{\%}$ and $90^{\%}$ of ankle inversion non-weight bearing •No •Yes ICC=0.6, 0.75 and 0.65 for active repositioning at $30^{\%}$, $60^{\%}$ and $90^{\%}$ respectively	•Significantly greater error in injured limb (5.1 deg) compared to uninjured limb (3.1 deg) for active joint position sense at $30^{\%}$ ROM, (p=0.004). Effect size=0.6. No other significant differences across limbs. •9
Bernier and Perrin 1998	•Controlled Laboratory Trial •Yes- Sham: electrical stimulation, Experimental: 6 week balance and co-ordination training •KinCom ll isokinetic dynamometer	•Subjects with 'Chronic ankle instability' •N=48 Control:14 Sham:14 Experimental:17 •2 episodes within past 12 months prior to testing	•Active and passive inversion, eversion and plantarflexion joint position sense non-weight bearing •No •Yes Intertester reliability ICC=0.87-0.03. Not tested for Intratester reliability	•No analysis of injured versus uninjured ankles. No significant differences for injured limbs for joint position sense. •8
Docherty et al. 1998	•Controlled Laboratory Trial •6 weeks of strength training using theraband •Custom designed electronic goniometer	•Subjects with functional instability of the ankle. •N=20 •Training group:10, Control:10 •Within past 12 months	•Active inversion, eversion, dorsiflexion and plantarflexion joint position sense non-weight bearing •No •No	•Only tested the injured ankle. Significantly greater mean degrees of error for control vs training group post test for inversion (mean:3.6) (p=0.009) Effect size=1.33. Significantly greater mean degrees of error for control vs training group post test for plantar flexion (mean:4.1) (p=0.027) Effect size=1.56. • 8

Konradsen et al. 1998	•Controlled Laboratory trial •No •Goniometer footplate	•College students with acute ankle sprain of grade 11 or grade 111 •N=50 subjects (44 completed study) Control uninjured ankle •1 day	•Passive inversion joint position sense non-weight bearing •No •Yes in previously unpublished work on healthy subjects	•Significantly greater mean position assessment error score for injured vs uninjured at all times ($p \leq 0.05$). 1 week (mean: 2.5) Effect size=2.7, 3 week (mean: 1.9) Effect size=2.1, 6 week (mean: 1.1) Effect size=1.3, 12 week (mean: 1.1) Effect size=1.1. •9
Lentell et al. 1995	•Controlled Laboratory Trial •No •Rotating platform	•Recreational athletes with chronic unilateral ankle instability. •N=42 Control uninjured ankle (3 dropouts) •Chronic	•Passive inversion joint position sense partial weight bearing •No •Yes ICC for three tests = 0.78 and 0.71 for involved and uninvolved ankles respectively	•Significantly greater amount of motion for injured vs uninjured ($p \leq 0.05$) (mean: 1.1) Effect size=0.4. •10
Glencross and Thornton 1981	•Controlled Laboratory Trial •No •Goniometer	•Subjects with ankle injury at least 8 months prior to study. •N=33 Injured:24 Control (uninjured):9 •Greater than 8 months	•Passive joint position sense non-weight bearing •No •No	•Significantly greater mean error score for injured vs uninjured ($p<0.01$) and joint angle ($p<0.002$). Control group showed no difference in position sense. •8

Balance/Postural control

Results

Balance, postural control or postural sway are often used interchangeably and have been identified as important aspects of normal ankle function. For the purposes of this review the term 'postural control' has been adopted. This interpretation is supported in a recent systematic review (Loudon et al., 2008).

Twenty studies (Akbari, Karimi, Farahini, & Faghihzadeh, 2006; Baier & Hopf, 1998; Bernier & Perrin, 1998; Bernier, Perrin, & Rijke, 1997; de Noronha, Refshauge, Crosbie, & Kilbreath, 2008; Docherty, Valovich McLeod, & Shultz, 2006; Eils et al., 2002; Evans et al., 2004; Fu & Hui-Chan, 2005; Goldie, Evans, & Bach, 1994; Hertel, Buckley, & Denegar, 2001; Hess, Joyce, Arnold, & Gansneder, 2001; Holme et al., 1999; Hubbard, Kramer, Denegar, & Hertel, 2007; Isakov & Mizrahi, 1997; Kidgell, Horvath, Jackson, & Seymour, 2007; Leanderson et al., 1999; Powers, Buckley, Kaminski, Hubbard, & Ortiz, 2004; Rose et al., 2000; Tropp & Odenrick, 1988) were identified that investigated postural control ability using variations of force plates (See Table 9). While force plates have been used as a valid means of measuring postural sway and have been commonly used as an impairment outcome measure, how this outcome is related to balance in 'real world' situations has received less attention.

With respect to study design, two studies (Holme et al., 1999; Powers et al., 2004) were randomised controlled trials and one study (Leanderson et al., 1999) was a randomised trial that did not have a control group. The remaining seventeen studies were controlled laboratory studies. Five studies (Bernier & Perrin, 1998; Eils & Rosenbaum,

2001; Holme et al., 1999; Kidgell et al., 2007; Powers et al., 2004) applied a six week balance training intervention as part of the study. One study (Hess et al., 2001) applied a four week agility training intervention as part of the study, while a further study (Goldie et al., 1994) applied balance training, but did not state for how long. Two studies (Hertel et al., 2001; Rose et al., 2000) tested subjects three times over a 2 week – 4 week period during which the subjects followed a standardised treatment protocol. One study (Baier & Hopf, 1998) investigated the effect of orthoses on postural stability, while one study (Leanderson et al., 1999) investigated an ankle brace compared with compression bandage.

The time between ankle injury and testing varied. Five studies (Evans et al., 2004; Hertel et al., 2001; Holme et al., 1999; Leanderson et al., 1999; Rose et al., 2000) tested acute injuries of less than one week. Thirteen studies (Baier & Hopf, 1998; Bernier & Perrin, 1998; Bernier et al., 1997; de Noronha et al., 2008; Docherty, Valovich McLeod et al., 2006; Eils & Rosenbaum, 2001; Fu & Hui-Chan, 2005; Goldie et al., 1994; Hubbard et al., 2007; Isakov & Mizrahi, 1997; Kidgell et al., 2007; Powers et al., 2004; Tropp & Odenrick, 1988) tested chronic injuries of greater than three months since injury, while the remaining two studies (Akbari et al., 2006; Hess et al., 2001) did not state the length of time since injury.

Eleven studies (Baier & Hopf, 1998; Eils & Rosenbaum, 2001; Evans et al., 2004; Goldie et al., 1994; Hertel et al., 2001; Holme et al., 1999; Hubbard et al., 2007; Isakov & Mizrahi, 1997; Kidgell et al., 2007; Powers et al., 2004; Tropp & Odenrick, 1988) that specifically used a fixed force plate all tested single leg stance. Additionally Hubbard et al (2007) used a Star-Excursion Balance Test to measure dynamic balance. Three studies

(Bernier & Perrin, 1998; Bernier et al., 1997; Docherty, Valovich McLeod et al., 2006) used a Balance system and measured postural sway. One study (Fu & Hui-Chan, 2005) used a Smart Equi Test System and utilised a Sensory Organisation Test. Two studies (Hess et al., 2001; Rose et al., 2000) used a Chattanooga balance machine to measure postural stability. One study (Akbari et al., 2006) used a Biodex Balance System and measured a range of activities: Functional Reach Test, Star-Excursion Balance Test, Body Sway and Limits of Stability, while a further study (Leanderson et al., 1999) used a portable Statometer. One study (de Noronha et al., 2008) used a electromagnetic tracking system along with force plates.

Three studies (Evans et al., 2004; Hertel et al., 2001; Hubbard et al., 2007) specifically mentioned validity of the testing procedures by referencing previous studies. However, Hubbard et al (2007) made reference for the dynamic balance test measure only and not for the force plate. The two other studies both referenced the Goldie (1994) study as providing validity for the force plate equipment. The validity of the other postural measuring equipment could not be confirmed. Three studies (Docherty, Valovich McLeod et al., 2006; Fu & Hui-Chan, 2005; Kidgell et al., 2007) provided reliability data demonstrating moderate to high reliability with an ICC that ranged from 0.73 - 0.97. Six studies (Bernier & Perrin, 1998; Eils & Rosenbaum, 2001; Evans et al., 2004; Hertel et al., 2001; Hubbard et al., 2007; Leanderson et al., 1999) indicated that reliability data had been either previously provided or was comparable to other studies. However, Hubbard et al (2007) made reference to reliability for the dynamic balance test measure only and not for the force plate. Twelve studies (Akbari et al., 2006; Baier & Hopf, 1998; Bernier et al., 1997; de Noronha et al., 2008; Eils & Rosenbaum, 2001; Goldie et al., 1994; Hess et

al., 2001; Holme et al., 1999; Isakov & Mizrahi, 1997; Powers et al., 2004; Rose et al., 2000; Tropp & Odenrick, 1988) did not mention if reliability had been tested. It is worth noting that while the Goldie (1994) study did not specifically mention reliability it is one of the studies that other authors have referenced as providing reliability evidence.

With respect to acute ankle injuries, one study (Leanderson et al., 1999) found significantly greater postural sway between the injured and uninjured ankles at the one, two and four week testing points; however, there was no significant difference at the 10 week testing, while one study (Hertel et al., 2001) found a significant difference in injured over uninjured at day one and during week two, but not at week four. Similarly a further study (Holme et al., 1999) demonstrated a significant difference in postural sway between the injured over the uninjured ankle in both the control and intervention groups at six weeks with a large effect size between 1.67 – 3.66 respectively. However, this difference was not maintained at the 4 month follow up. Two studies (Evans et al., 2004; Rose et al., 2000) investigating acute ankle injuries, found no significant difference in postural control between the injured and uninjured ankles on single leg stance. With respect to chronic injuries five studies (Baier & Hopf, 1998; Bernier & Perrin, 1998; Bernier et al., 1997; Isakov & Mizrahi, 1997; Powers et al., 2004) found no significant difference between the injured and uninjured ankles on postural sway. One study (Docherty, Gansneder et al., 2006) found significantly greater errors in the injured over the uninjured ankle using the Balance Error Scoring System with a large effect size of 1.03, while another study (Fu & Hui-Chan, 2005) demonstrated an increased sway angle of the injured over the uninjured ankle with a moderate to large effect size between 0.63 - 0.88 for the tests performed. A further study (Goldie et al., 1994) investigating chronic

ankle injuries, demonstrated a decreased postural steadiness for the untrained group of the injured over the uninjured ankle with a small effect size of 0.35. Two studies (Hess et al., 2001; Kidgell et al., 2007) tested only the injured ankles and both demonstrated a significant training intervention effect pre and post test with a large effect size (1.49 - 3.65).

A further study (Eils & Rosenbaum, 2001) that tested only chronic injured ankles demonstrated a significant difference in medio-lateral sway after the exercise intervention in both the exercise and control group. One study (Tropp & Odenrick, 1988) demonstrated a significant greater centre of pressure change in the group with the functional ankle instability compared with the control group with a large effect size of 1.09. Finally one study (Akbari et al., 2006) that did not state the date of injury demonstrated significant lower balance ability for unilateral standing with eyes open on involved limb compared to uninvolved limb with a effect size of 0.79 .

In studies that compared outcome measures, Hubbard et al (2007) found a moderate correlation between the FADI, FADI Sport questionnaires and COP velocity and area. In particular they reported that of all functional variables measured, static postural control was most closely related to self-reported functional deficits. Additionally one study (Evans et al., 2004) found only a low correlation between two self-report questionnaires (the modified Athletic Training Outcomes Assessment and the SF-12) and COP velocity. In contrast one study (de Noronha et al., 2008) compared postural balance to the CAIT questionnaire score and found there were no associations between these measures. Bernier (1997) found low correlation between relative instability as measured by stress radiographs and postural sway.

With respect to the quality scores of the reviews, these ranged from 4 to 10/18 (Table 12). Six studies (Docherty, Valovich McLeod et al., 2006; Eils & Rosenbaum, 2001; Evans et al., 2004; Hertel et al., 2001; Kidgell et al., 2007; Leanderson et al., 1999) scored a moderate quality rating of 55% (10/18). The fourteen remaining studies all scored a low quality rating (<50%).

Due to the variation between the studies in study design, time since injury, testing procedures, outcomes and results it is difficult to draw a strong conclusion regarding the effects of postural control on balance. This current review found at the acute stage of recovery, based on the findings of four studies (two moderate and two low studies) and at the chronic stage of recovery, based on the findings of four studies (one moderate and three low studies) there was weak evidence that following a sprained ankle a person is likely to have some deficit in postural control.

Discussion

It is apparent from the findings of the current review that many reviewed studies used variations of force plates to investigate postural control. There was generally poor reporting of reliability and validity testing of the equipment; however, with respect to the use of force plates to measure balance this has previously been reported (Cornwall & McPoil, 2003; Le Clair & Riach, 1996; Middleton, Sinclair, & Patton, 1999).

Some caution needs to be taken with the interpretation of the evidence for both acute and chronic postural control deficits. Of particular note are the relatively low methodological quality scores of the identified studies. This current review found weak evidence for deficits in both acute and chronic ankle injuries. This view differs slightly

from the findings of a recently published systematic review (McKeon & Hertel, 2008) which investigated postural control in acute and chronic ankles sprains. The authors concluded that postural control is impaired in acute ankle sprains, but impairments in chronic ankle sprains have not been consistently reported. The particular 'level of evidence' approach taken in the current study resulted in the conclusion for the chronic injuries; however, it should be noted that while four studies found a difference between injured and uninjured ankles, five low quality studies found no difference. It is also worth noting that three of the four studies investigating acute ankle injuries that involved a rehabilitation programme found a significant difference in balance ability on initial assessments; however, this was not maintained at the end of study follow up.

Of particular interest to this study, two studies (Evans et al., 2004; Hubbard et al., 2007) reported low to moderate correlations between postural control and self-reported functional deficits while a further study (Bernier et al., 1997) found low correlation between relative instability and postural sway. However, in contrast, de Noronha et al (2008) reported that there were no associations between CAIT scores and postural control measures. These were the only four studies identified that compared postural control measurements with other outcome measures.

In summary the current review identified that force plates are an acceptable method to measure postural control. The current review has also identified that there is limited support that a rehabilitation programme may improve balance ability particularly in the acute stage. While the findings of the current review provide weak evidence of a postural control deficit following an ankle sprain, further investigation into this aspect is

warranted. Additionally there may be benefit in investigating the relationship of impairment measures and other outcome measures.

Table 9: Summary of postural control studies

Author and Date	• Study Design • Intervention • Equipment	•Subjects characteristics •No of subjects (N=) •Time after injury	• Task •Validity •Reliability	•Results (effect sizes calculated where possible) •Quality Score (/18)
de Noronha et al. 2008	•Controlled Laboratory Trial •No •Electomagnetic tracking system and Force Plate	•Volunteers with or without functional ankle instability •N=60 Instability group:28 Control:31 •Greater than 1 month	•Jump landing on one leg test to stability •No •No	•Significant difference between controls (mean 1.43 sec) and instability group (mean 2.12 sec) to recover stability for inversion ($p<0.05$). Effect size=0.53. No correlation between CAIT scores and postural measures. •8
Hubbard et al. 2007	•Controlled Laboratory Study •No •Force Plate	•Subjects with unilateral chronic ankle instability •N=30 •Mean of 3 years	•Postural control single leg stance centre of pressure (COP) with eyes open and closed, Star-Excursion Balance Test (SEBT) •Yes for SEBT- referred to previous studies • Yes for SEBT- referred to previous studies	•Only tested the injured limb. Moderate correlation between FADI and COP velocity with eyes open (r=-0.53), COP area with eyes open (r=-0.65), COP velocity with eyes closed (r=-0.53). Moderate correlation between FADI Sport and COP area with eyes open (r=-0.52), COP velocity with eyes closed (r=-0.62). Of all functional variables measured static postural control was most closely related to self-reported functional deficits. •8
Kidgell et al. 2007	•Controlled Laboratory Study •Dura disc training, mini trampoline or control •Force Plate	•University students, local sports population and local police •N=20 Dura disc training:7, mini trampoling:6, Control:7 •Within previous 2 years	•Single leg stance pre program and post program •No •Yes ICC=0.972 for medial and lateral sway.	•Only tested the injured limb. Control group showed no statistical difference between pre and post testing. Significant difference in sway in the two training interventions pre and post test ($p=0.003$). Dura disc pre test and post test effect size=3.65. Mini trampoline pre test and post test effect size=1.49. •10
Akbari et al. 2006	•Controlled Laboratory Study • No • Biodex Balance System	•Male athletes involved in multidirectional sports •N=30 Control uninjured leg •Not stated	•Functional Reach Test, Star-Excursion Balance Test, Body Sway and Limits of Stability •No •No	•Significant lower balance ability for unilateral standing with eyes open on involved limb compared to uninvolved limb ($p<0.001$). Effect size=0.79. •6

Docherty et al. 2006	• Controlled Laboratory Study • No •Balance Error Scoring System	•College athletes with injured and uninjured ankles •N=60 functional ankle instability group:30, Uninjured:30 •Between 6 month and 5 years	•Postural control on variety of surface conditions •No •Yes Inter-tester reliability ICC=0.78-0.96	•Significantly greater errors for injured ankles (mean: 15.7) compared with uninjured ankle (mean: 10.7), ($p<0.001$). Effect size=1.03. •10
Fu and Hui-Chan 2005	• Controlled Laboratory Study • No • Smart EquiTest system	•Basketball players •N=30 Bilateral ankle sprain:19 Uninjured:20 •Greater than 3 months	• Sensory Organisation Test •No •Yes ICC=0.73-0.89 for 6 variable test positions	•Significantly increased sway angles for 3 of the 6 test conditions on the injured ankle (mean range=1.0^0-0.7^0) than uninjured ankles (mean range=1.1^0-0.8^0), ($p<0.05$). Effect size range=0.63 - 0.88. No other significant differences across limbs. •7
Evans et al. 2004	•Controlled Laboratory Study •No •AMTI Accusway force plate	•College athletes with injured ankles •N=28 Control uninjured leg •1 day	•Single leg stance pre-injury and post injury •Yes •Yes	•No significant difference in postural control at baseline and at day 28 between injured and uninjured. Low correlation between ATOA, SF-12 and COP velocity ($r<0.49$). •10
Powers et al. 2004	•RCT • Yes- 6 week strengthening programme •Force plate	•College athletes with functional ankle instability •N=38 Strength training group, proprioception training group, strength and proprioception training group and control (number in each group not stated) •Chronic	•Single leg stance centre of pressure change in medio-lateral and antero-posterior as well as EMG for muscle fatigue •No •No	•No significant difference for test or group effects for postural control. •6

Eils and Rosebaum 2001	•Controlled Laboratory Study • Yes- 6 week physiotherapy exercise programme • Kistler force plate	•Subjects with repeated ankle sprains •N=30 Exercise:20 Control:10 (as many had bilateral instability Exercise :31 and Control:17) •Chronic	• Single leg stance in medio-lateral and antero-posterior as well as sway distance •No •No	•Significantly decreased sway angles in medio-lateral sway measurements after the exercise program in the exercise group (mean difference=1.9mm) than the control group (mean difference=0.9mm), ($p<0.01$). The effect=0.71 No analysis of injured versus uninjured ankles. •10
Hertel et al. 2001	•Controlled Laboratory Study • Functional rehabilitation programme •Force plate	•Subjects with mild to moderate acute ankle sprains •N=17 Control uninjured ankle •Acute	• Postural control • Yes • Yes	•Significant increase of centre of pressure at day 1 and during week 2 ($p<0.05$) but was not maintained by week 4. •10
Hess et al. 2001	•Controlled Laboratory Study •4 weeks agility training •Chattex balance machine	•Subjects with 'Functional ankle instability' •N=20 Group size: Not stated •Not stated	• Postural sway for one legged stance on injured leg only • No • No	•Significant differences between control and experimental groups on injured ankle for gender x group interaction ($p=0.011$). Effect size=2.92. No analysis of injured versus uninjured ankles. • 6
Rose et al. 2000	•Controlled Laboratory Study •Injured subjects were given standardised treatment •Chattanooga balance machine	•Subjects with acute ankle sprains •N=37 Injured:19, Control:18 •3 days	• Postural sway for normal stance and one legged stance • No • No	•No significant differences between ankles in single leg stance for subjects with ankle sprains. No significant differences for two legged or single leg stance between subjects and controls. •6

Holme et al. 1999	•Randomised Controlled Trial •Training intervention, group physiotherapy rehabilitation. Control only standard advice •Force Plate	•Recreational athletes with acute ankle sprains •N=92 Training:46, Control:46 •Day of injury	• Single leg stance measuring postural sway distance • No • No	•Significant increase at 6 weeks post injury in postural sway in the injured over the uninjured in both the training and the control group. Training postural sway (mean difference=16 cm), ($p<0.001$). Effect size=1.67. Control postural sway (mean difference=23 cm), ($p<0.001$). Effect size=3.66. NB: Caution needs to be taken with these results as there was a high drop out rate of participants at 6 weeks. •4
Leanderson et al. 1999	•Randomised Trial •2 interventions: Ankle Brace or Compression bandage •Statometer	•Subjects with acute ankle sprains •N=73 Air-Stirrup:39 Compression bandage:34 •1 day	• Single leg stance measuring postural sway • No • Yes	•The postural sway was significantly greater between the injured over the uninjured ankle at the 1, 2 and 4 week testing; however, at the 10 week testing there was no significant difference between ankles. •10
Baier and Hopf 1998	• Controlled Laboratory Study •Rigid and Flexible Orthoses •Force Plate	•Athletes with 'Functional ankle instability' •N=44 Functional instability:22 Control:22 •Chronic	• Postural sway • No • No	•No significant differences across limbs of either group without orthoses. •7
Bernier and Perrin 1998	• Controlled Laboratory Study •Yes- Sham: electrical stimulation, Experimental: 6 week balance and co-ordination training • The Balance System	•Subjects with 'Chronic ankle instability' •N=48 Control:14 Sham:14 Experimental:17 •Chronic	• Postural sway •No •Yes	•No significant differences across limbs. •8

Bernier et al. 1997	• Controlled Laboratory Study • No •Balance System	•Subjects with 'Functional instability' of the ankle and uninjured ankles •N=18 functional ankle instability group:9, Uninjured group:9 •Between 2 – 15 years	•Static and Dynamic postural stability •No •No	•No other significant differences across limbs. Low correlation between relative instability and postural sway (*r*= 0.02-0.35) •6
Isakov and Mizrahi 1997	• Controlled Laboratory Study • No • Force Plate	•Female gymnasts with at least three inversion injuries to one ankle only •N=8 Control uninjured leg •Greater than 4 months	•Postural sway •No •No	•No significant differences across limbs. •7
Goldie et al. 1994	• Controlled Laboratory Study • Balance training group • Force Plate	•General practice population •N=48 Trained:24 Untrained:24 •Between 8 weeks and 2 years	•Postural steadiness •No •No	•The postural steadiness was significantly worse for the untrained group on the injured leg with eyes open and closed (<0.05) Effect size=0.35. •7
Tropp and Odenrick 1988	• Controlled Laboratory Study • No • Force Plate	•Male subjects with right 'Functional ankle instability' •N=30 Functional instability:15 Control:15 •Chronic	•Change in centre of pressure •No •No	•Significant greater centre of pressure change in functional unstable ankle group than control (p<0.001). Effect size=1.09. • 6

Isokinetic strength

Results

Muscle weakness has long been identified as a residual problem following an ankle sprain (Freeman, 1965). Measuring isokinetic strength of the ankle, particularly the evertors has often been used to test for muscle weakness (Aydog, Aydog, Cakci, & Doral, 2004; Leslie, Zachazewski, & Browne, 1990). Twelve studies (Holme et al., 1999; Hubbard et al., 2007; Kaminski, Perrin, & Gansneder, 1999; Leanderson et al., 1999; Lentell et al., 1995; Lentell, Katzman, & Walters, 1990; McKnight & Armstrong, 1997; Munn, Beard, Refshauge, & Lee, 2003; L. Ryan, 1994; Sekir et al., 2007; Wilkerson, Pinerola, & Caturano, 1997; Willems et al., 2002) were identified that investigated isokinetic strength with respect to inversion/eversion of an injured ankle (see Table 10). One study (Holme et al., 1999) was a randomised controlled trial and one study (Leanderson et al., 1999) was a randomised trial that did not have a control group. The remaining ten studies were controlled laboratory trials. Two studies (Sekir et al., 2007; Wilkerson et al., 1997) incorporated a strengthening intervention, two studies (Holme et al., 1999; McKnight & Armstrong, 1997) had physiotherapy interventions and one study (Leanderson et al., 1999) used two types of bracing as the intervention. The remaining seven studies did not use an intervention. All studies used an isokinetic dynamometer.

Two studies (Holme et al., 1999; Leanderson et al., 1999) tested acute ankles (within one day of injury), one study (Munn et al., 2003) tested sub-acute ankles (within

four weeks), one study (Wilkerson et al., 1997) tested both acute and chronic while the remaining eight studies all investigated chronic ankle injuries.

There was variability in the way studies measured peak torque. Four studies (Kaminski et al., 1999; Munn et al., 2003; Sekir et al., 2007; Willems et al., 2002) measured peak torque for eccentric and concentric contractions. Five studies (Hubbard et al., 2007; Leanderson et al., 1999; McKnight & Armstrong, 1997; L. Ryan, 1994; Wilkerson et al., 1997) measured concentric contractions only, two studies (Holme et al., 1999; Kaminski et al., 1999) measured isometric contractions only, and one study (Lentell et al., 1995) measured eccentric contractions only. One study (Lentell et al., 1990) measured concentric and isometric contractions. Two studies (Kaminski et al., 1999; Lentell et al., 1995) investigated eversion only, one study (Hubbard et al., 2007) measured plantar flexion, dorsi flexion, inversion and eversion, while the remaining nine studies all investigated inversion and eversion contractions. Two studies (Munn et al., 2003; Sekir et al., 2007) measured joint angular velocity at 60^0/s and 120^o/s. Two studies (Wilkerson et al., 1997; Willems et al., 2002) measured joint angular velocity at 30^0/s and 120^o/s. One study (Kaminski et al., 1999) measured joint angular velocity at 30^0/s, 90^0/s, 150^0/s and 210^o/s. Another study (Leanderson et al., 1999) measured joint angular velocity at 30^0/s and 90^o/s, one study (McKnight & Armstrong, 1997) measured joint angular velocity at 30^0/s and 240^o/s while one study (Lentell et al., 1995) measured joint angular velocity at 30^0/s, 60^o/s, 90^0/s, 120^o/s, 150^0/s and 180^o/s. Two studies (Hubbard et al., 2007; L. Ryan, 1994) measured joint angular velocity at 30^0/s. Finally one study (Lentell et al., 1990) measured joint angular velocity at 30^0/s and 0^0/s.

Three studies (Lentell et al., 1995; Munn et al., 2003; Sekir et al., 2007) reported ICC values and demonstrated moderate to high reliability for strength testing (ICC = 0.61-0.90). One study (Leanderson et al., 1999) indicated that reliability had been established in a previous study.

Five studies (Holme et al., 1999; Munn et al., 2003; L. Ryan, 1994; Sekir et al., 2007; Wilkerson et al., 1997) described significant deficits on initial testing in peak torque values for inversion ($p<0.05$) between the involved and uninvolved ankles with moderate to strong effect size ranging from 0.34 - 4.28. These five studies included participants with a range of both acute and chronic ankle injuries. Following a strengthening programme two studies (Holme et al., 1999; Sekir et al., 2007) found that these deficits were no longer significant. One study (Willems et al., 2002) found significant difference between eversion muscles compared with body weight at both 30^0/sec and 120^0/sec. One study (Leanderson et al., 1999) found significant difference between the injured and uninjured ankle for eversion torque after 10 weeks intervention of ankle support. Four studies (Kaminski et al., 1999; Lentell et al., 1995; Lentell et al., 1990; McKnight & Armstrong, 1997) found no significant difference in peak torque between the involved and uninvolved ankle. It should be noted that Lentell (1995) only investigated eversion peak torque. One study (Hubbard et al., 2007) found moderate to strong and significant correlations between between plantar flexion, dorsi flexion, inversion and eversion for both peak torque and average power.

Of interest to the current study, Sekir (2007) found that there was no correlation between the isokinetic data, proprioceptive measures and functional tests, while Ryan (1994) found no correlation between balance scores and strength.

With respect to the quality scores of the reviews, these ranged from 4 to 11/18 (Table 12). Five studies (Kaminski et al., 1999; Leanderson et al., 1999; Lentell et al., 1995; Munn et al., 2003; Sekir et al., 2007) attained a moderate quality score of between 55 -61% (10-11/18). The remaining seven studies had a low quality score of 50% or less (≤9/18).

This current review found that at the acute stage of recovery, based on the findings of four studies (two moderate and two low quality studies) that reported a difference of injured over uninjured ankle strength and that demonstrated a small to moderate effect size (0.12-0.5), there was weak evidence that following a sprained ankle a person is likely to have some deficit in ankle strength. With respect to chronic ankle testing there was inconclusive evidence as to whether there was a strength deficit.

Discussion

As identified in the previous reviews there are limitations that need to be considered when forming a conclusion for this review. There was a general lack of consistency across a number of areas within the studies. Study design, intervention, time since injury, variety of testing procedures, variety of impairment outcome measures used and quality rating of the studies are all factors that need to be considered when reaching an overall conclusion from this review. While only four studies mentioned reliability testing, the validity and reliability of testing using isokinetic dynamometer has previously been widely reported (Aydog et al., 2004; Drouin, Valovich-McLeod, Shultz, Gansneder, & Perrin, 2004; Karnofel, Wilkinson, & Lentell, 1989; Leslie et al., 1990). Two studies were identified that compared ankle strength with other outcome measures and both

found no relationship. Further investigation into the relationship of strength deficit to other measures would be of interest.

This current review found that there was some evidence to suggest that a strengthening intervention programme can improve ankle peak torque. However, further research in this area is needed. Furthermore, this current review found there was weak evidence that there was a strength deficit in the acute stage of an ankle sprain, but inconclusive evidence at the chronic stage.

In summary based upon the current review it is apparent that many reviewed studies used peak torque to investigate isokinetic ankle strength. Hence for the purposes of this study, it was considered useful to measure peak torque in assessing isokinetic ankle strength impairment for inversion/eversion as this would allow a comparison to be made with the reviewed literature.

Table 10: Summary of isokinetic strength testing studies

Author and Date	• Study Design • Intervention • Equipment	•Subjects characteristics •No of subjects (N=) •Time since injury	• Typical contraction • Joint angular velocity range •Reliability	•Results for inversion/eversion measures only (Effect sizes calculated where possible) •Quality Score (/18)
Hubbard et al. 2007	•Controlled Laboratory Study •No •Biodex dynamometer	•Subjects with unilateral chronic ankle instability •N=30 •Mean of 3 years	•Peak torque/body weight and average power/body weight for concentric muscle contractions for plantar flexion, dorsi flexion, inversion and eversion •30^0/s •No	•Only tested the injured limb. Strong to moderate and significant relationships were found between plantar flexion, dorsi flexion, inversion and eversion for both peak torque and average power ($r=0.96$-0.38, $p<0.05$). •8
Sekir et al. 2007	•Controlled Laboratory Study •Yes- Isokinetic exercise programme 3x week for 6 weeks •Cybex dynamometer	•Athletic subjects with injured ankles •N=24 •Greater than 6 months	•Peak torque for eccentric and concentric inversion - eversion contractions • 60^0/s and 120^o/s •Yes ICC=0.89-0.86 at 120^o/s	•Significantly lower concentric invertor peak torque in injured ankle (mean=14.79 Nm) compared with uninjured ankle (mean=17.46 Nm) pre training, ($p=0.000001$). Effect size=1.7. Significantly increased concentric evertor strength post training in injured ankles (mean=17.21 Nm) compared with injured ankles pre training (mean=15.54 Nm), ($p=0.013$). Effect size=0.43. Significantly increased concentric invertor strength after training in injured ankle (mean=16.50 Nm) compared with injured ankle pre training (mean=14.79 Nm), ($p=0.007$). Effect size=0.74. No correlation between isokinetic data with proprioceptive measures and functional parameters. •10
Munn et al. 2003	•Controlled Laboratory Study •No •Biodex dynamometer	•Subjects with 'Unilateral functional ankle instability' •N=16 •Within past 4 weeks	•Peak torque for eccentric and concentric inversion - eversion contractions • 60^0/s and 120^o/s •Yes ICC=0.97-0.71	•Significant decrease in eccentric torque values for inversion at 120^0/s for injured ankle (mean=23.7 Nm) compared with uninjured ankle (mean=26.8 Nm), ($p<0.05$). Effect size=0.34. Significant decrease in eccentric torque values for inversion at 60^0/s for injured ankle (mean=25.9 Nm) compared with uninjured ankle (mean=29.0 Nm), ($p<0.05$). Effect size=0.34. •11

Willems et al. 2002	•Controlled Laboratory trial •No •Biodex Dynamometer	•Physical education students •N=87 Control group(no previous injury):53, Group 2 (3 or more sprains and frequent giving way):10, Group 3 (previous sprain but no instability) :16, Group 4 (previous sprain but no instability) :8 •Group 2 greater than 3 months, Group 3 previous 2 years, Group 4 past 3-5 yrs	•Peak torque and peak torque/body-weight values for eccentric and concentric inversion-eversion contractions •30^0/sec and 120^0/sec •No	•Significant difference across the groups in strength of eversion muscles compared with body weight at both 30^0/sec and 120^0/sec ($p<0.05$). Instability group showed significantly lower value compared with control for eversion strength/body weight at 30^0/sec for both concentric ($p=0.048$), effect size=6.32 and eccentric ($p=0.024$) effect size=5.69. Instability group showed significantly lower value compared with control for eversion strength/body weight at 120^0/sec for eccentric condition ($p=0.024$) effect size=6.32. No significant differences found between inversion for concentric/eccentric peak torque. •7
Holme et al. 1999	•Randomised controlled Trial •Training intervention, group physiotherapy rehabilitation. Control only standard advice •Cybex dynamometer	•Recreational athletes with acute ankle sprains. •N=92 Training:46, Control:46 •Day of injury	•Isometric ankle strength for plantar and dorsi flexion, inversion and eversion •0^o/s •No	•Significant decrease at 6 weeks post injury in strength in the injured over the uninjured in both the training and the control group. Training inversion (mean difference=6 Nm), ($p<0.05$). Effect size=1.98. Training eversion (mean difference=15 Nm), ($p<0.001$). Effect size=2.56. Control inversion (mean difference=19 Nm), ($p<0.001$). Effect size=4.28. Control eversion (mean difference=16 Nm), ($p<0.001$). Effect size=3.23. NB: Caution needs to be taken with these results as there was a high drop out rate of participants at 6 weeks. •4

Kaminski et al. 1999	•Controlled Laboratory Study •No •Kin Com 125 dynamometer	•Male college subjects with unilateral chronic functional ankle instability •N=42 Functional ankle instability: (21) Control (21) •Within past year	•Peak torque for eccentric, concentric and isometric eversion contractions •30^0, 60^0, 90^0, 120^0, 150^0, 180^o/s and 0^o/s •No	•No significant differences found between involved and uninvolved subjects for concentric peak torque. No significant differences found between involved and uninvolved subjects for eccentric peak torque. •10
Leanderson et al. 1999	•Randomised Trial •2 interventions: Ankle Brace or Compression bandage •Biodex isokinetic dynamometer	•Subjects with acute ankle sprains •N=73 Air-Stirrup:39 Compression bandage:34 •1 Day	• Peak torque for concentric inversion -eversion contractions • 30^0/s and 90^o/s •Yes referenced	•Significant decrease in torque values for eversion for injured ankle (mean=20.0Nm) compared with uninjured ankle (mean=22.0 Nm) at the 10 week follow up. Effect size=0.5. No significant difference for invertor torque at the 10 week follow up. •10
McKnight and Armstrong 1997	•Controlled trial •Formal proprioception training •Biodex isokinetic dynamometer	•Subjects with functional ankle instability •N=43 Functional ankle instability (15), Functional ankle instability with training (14) and Control (14) •Chronic	•Peak torque for concentric plantar and dorsi flexion, inversion and eversion •30^0/s and 240^o/s •No	•No significant differences found between groups for inversion or eversion. •7

Wilkerson et al. 1997	•Controlled Laboratory Study •Yes-Strengthening exercise programme 50 reps/day for 4 weeks •Biodex System 2 dynamometer –	•Subjects with acute or chronic ankle symptoms •N=30 Acute group (15) Grade II inversion within 3 weeks, Chronic group (15) multiple sprains and repeated giving way •Acute and Chronic	•Peak torque for concentric and concentric inversion - eversion contractions • 30^0/s and 120^o/s •No	•Significant greater deficits in inversion peak torque at 30^0/s and 120^o/s for the acute group (effect size=0.94 and 1.24), than the chronic group (effect size=0.12 and 0.53 respectively) ($p<0.05$). The evertor/invertor peak torque ratio at 30^0/s and 120^o/s for the acute involved limb versus the uninvolved limb had an effect size=0.76 and 0.94 respectively. The evertor/invertor peak torque ratio at 30^0/s and 120^o/s for the chronic involved limb versus the uninvolved limb had an effect size=0.49 and 0.71 respectively. NB: Caution needs to be taken with these results as there was a high drop out rate of participants at follow up. •7
Lentell et al. 1995	•Controlled Laboratory Trial •No •Cybex 11 dynamometer	•Recreational athletes with chronic unilateral ankle instability. •N=42 Control uninjured ankle •Chronic	•Peak torque for eversion eccentric contractions •30^0, 90^0, 150^0 and 210^o/s •Yes ICC of 0.88, 0.8, 0.65 and 0.61for 30^0, 90^0, 150^0 and 210^o/s respectively	•No significant differences found between involved and uninvolved ankles for eversion. •10
Ryan 1994	•Controlled Laboratory Trial •No •Cybex 11 dynamometer	•Subjects with unilateral ankle instability •N=49 Control uninjured ankle (5 dropouts) •Chronic	•Peak torque for concentric inversion -eversion contractions •30^0/s •Yes ICC of 0.94	•Significant decrease in eccentric torque values for inversion at 30^0/s for injured ankle (mean=22.7 Nm) compared with uninjured ankle (mean=26.6 Nm), ($p<0.001$). Effect size=0.46. No significant difference for evertor strength. No correlation between balance scores and strength. •9
Lentell et al. 1990	•Controlled Laboratory Trial •No •Cybex 11 dynamometer	•Subjects with unilateral ankle instability •N=33 Control uninjured ankle Chronic	•Peak torque for concentric and isometric inversion - eversion contractions •30^0/s and 0^0/s •No	•No significant difference between the involved or uninvolved ankles. •9

Functional performance measures

Results

It has been identified within the previous reviews that there has been significant investigation with respect to ankle strength, postural control and proprioception testing. As previously reported an emphasis on function is a critical component of the International Classification of Functioning, Disability and Health model (World Health Organization, 2001). While the previous testing procedures may identify aspects of ankle disability they do not address functional activities. Riemann (2002) has previously questioned the relationship between traditional testing procedures and functional movement patterns in relation to postural control. Therefore it was considered useful to identify performance tests related to function.

Seven studies (Buchanan et al., 2008; de Noronha, Refshauge, Kilbreath, & Crosbie, 2007; Demeritt et al., 2002; Eechaute et al., 2008; Johnson & Stoneman, 2007; Munn, Beard, Refshauge, & Lee, 2002; Sekir et al., 2007) utilised an agility hop test as a functional performance measure (see Table 11). One study (Buchanan et al., 2008) was a case control study, two studies (de Noronha et al., 2007; Eechaute et al., 2008) were cross sectional studies, three studies (Demeritt et al., 2002; Munn et al., 2002; Sekir et al., 2007) were controlled laboratory studies while the remaining study (Johnson & Stoneman, 2007) was an observational study. Only one study (Sekir et al., 2007) provided an intervention. Johnson & Stoneman (2007) investigated acute ankle injuries whereas the other six studies (Buchanan et al., 2008; de Noronha et al., 2007; Demeritt et al., 2002; Eechaute et al., 2008; Munn et al., 2002; Sekir et al., 2007) investigated

chronic ankle injuries. Only one study (Eechaute et al., 2008) provided validity data for the hop test demonstrating significant difference between the injured and uninjured in time to complete the task ($p<0.05$). Three studies (Buchanan et al., 2008; Eechaute et al., 2008; Sekir et al., 2007) provided reliability data demonstrating high reliability with an ICC of between 0.87-0.98, while Demeritt (2002) provided intratester reliability data demonstrating high reliability with an ICC of 0.98.

With respect to outcomes, one study (Eechaute et al., 2008) found a significant difference between the injured and uninjured ankle with respect to time taken for the test. Sekir (2007) utilised a combination of five different hop tests and found a significant difference between pre and post testing for both distance hopped and time for the test for the injured ankle. The effect size for these two studies was between 0.49-1.06. A further study (Johnson & Stoneman, 2007) stated that the hop tests were statistically significant but did not provide specific results between the injured and uninjured ankles. Two studies (Buchanan et al., 2008; de Noronha et al., 2007) used a timed test but did not report a significant difference, while one study (Munn et al., 2002) evaluated distance jumped and found no significant difference. One study (Demeritt et al., 2002) evaluated the hop test by error score and found no significant difference.

Of interest to this current study, four studies (de Noronha et al., 2007; Eechaute et al., 2008; Johnson & Stoneman, 2007; Munn et al., 2002) compared functional performance deficits to questionnaire scores. Munn and co-workers (2002) found that while subjects reported perceived functional deficits from self-report questionnaire scores this was not matched with results from the functional performance tests. Additionally Eechaute (2008) found that while there was a significant difference between injured

participants and controls for a VAS difficulty score for their dominant ankles, there was no significant difference for the injured participants' VAS perception between their injured and uninjured dominant ankles. Johnson (2007) found that they were not able to make individual predictions based on the results of the lateral hop when compared to the Sports Ankle Rating System (SARS). Additionally de Noronha (2007) found there was no relationship between the hop test and functional instability as measured by the CAIT. Furthermore, Sekir (2007) compared the functional test to an impairment measure and found that there was no correlation between the isokinetic data and the functional performance tests.

Four studies (Buchanan et al., 2008; Demeritt et al., 2002; Eechaute et al., 2008; Sekir et al., 2007) achieved a moderate quality rating between 72-55% (13-10/18), while the other three studies achieved a low quality rating of 50% (9/18) (See Table 12).

This current review found that at the chronic stage of recovery, based on the findings of six studies that reported a difference of the injured over the uninjured ankle, there was inconclusive evidence whether there was a functional deficit with respect to an agility hop test.

Discussion

Only one study reported aspects of validity for this particular hop test in relation to ankle injuries Previous authors have used hop tests as part of testing and training programmes, but have not used the test as an outcome measure in isolation (Bernier & Perrin, 1998; Williams et al., 2003). While few studies have used the hop test in relation to ankle injuries, the use of a hop test has been widely used as a functional assessment in

patients with anterior cruciate knee ligament injuries (Lysholm & Gillquist, 1982; Noyes, Barber, & Mangine, 1991). Furthermore Riemann et al (1999) found that a multiple single-leg hop stabilisation test offered a reliable clinical method of assessing a functional task in a normal population and suggested that this test may be applicable to subjects with a lower limb injury.

Five studies were identified that compared the functional performance tests against other outcome measures. It was of interest that no relationships were found between performance tests and self-report questionnaires and performance tests and impairment measures.

This current review has found inconclusive evidence with respect to the functional performance of hop tests to detect differences between the injured and uninjured ankle. It is suggested that further research is needed in this area.

In summary the hop test is a functional test that is easily reproduced in a clinical setting. The hop test has not been studied widely in relation to ankle sprains. Hence for the purposes of this study, it was considered useful to assess functional performance using an agility hop test to provide further information as to the usefulness of this test in the clinical environment.

Table 11: Summary of agility hop test studies

Author and Date	• Study Design • Intervention • Equipment	•Subjects characteristics •No of subjects (N=) •Time since injury	• Task •Validity •Reliability	•Results •Quality Score (/18)
Buchanan et al. 2008	• Case control • No • Sloped course	•Physically active college aged volunteers •N=40 Chronic unstable ankles:20 Control no previous ankle injury: 20 •Chronic	•Single limb hopping test over flat and sloped course •No •Yes ICC=0.93	•No significant difference between groups in the single limb hopping. •11
Eechaute et al. 2008	• Cross-sectional • No • Laboratory 'runway'	•Participants with chronic ankle instability and active college students •N=58 Chronic unstable ankles:29 Control no previous ankle injury: 29 •Chronic	•Prescribed pattern •Validity for time values between unstable subjects and controls and between injured and uninjured in unstable subjects (P<0.05) •Yes ICC=0.87-0.97 between unstable ankles and between healthy subjects	•Significant difference for the time taken between the injured and uninjured limbs (p<0.05). Effect size =1.01. The multiple hop test is a reliable test for measuring functional performance deficits. •13
de Noronha et al 2007	• Cross-sectional • No • Sloped course	•Volunteer participants with chronic ankle instability and participants without instability •N=40 Chronic unstable ankles:20 External control no previous ankle injury: 20 Internal control: 13 •Chronic	•Single limb hopping test over flat and sloped course •No •No	•No reported difference between the injured and control groups in time to complete test. •9
Johnson and Stoneman 2007	• Observational Study • No • Laboratory 'runway'	•Military cadets who had sustained a lateral ligament sprain and had a pain rating of greater than 3 out of 10 •N=20 •5 days	•3 consecutive lateral hops 3 consecutive forward hops •No •No	•Reported the lateral hop and the forward hop were significant factors but did not provide results. Compared the hop scores to the Sports Ankle Rating System and found neither hop test was able to predict subjective score. • 9

Sekir et al. 2007	•Controlled Laboratory Trial •Yes- Isokinetic exercise programme 3x week for 6 weeks •Cybex isokinetic dynamometer and Laboratory 'runway'	•Athletic subjects with injured ankles •N=24 •Greater than 6 months	•Single limb hopping course, one legged hop for distance, triple legged hop for distance, six meter hop for times and cross six meter hop for time •No •Yes ICC=between 0.89-0.98 for the five tests	•Significantly greater time and distance pre intervention in injured ankles compared to uninjured subjects for all hop tests ($p<0.05$). Effect size was between 0.49-1.06. Significant improvement in injured ankles post exercise. No correlation between isokinetic data and functional parameters. •10
Demeritt et al. 2002	• Controlled Laboratory Study •No •Videotape	•Male college and military volunteers with chronic ankle instability and uninjured ankles. •N=40 Chronic ankle instability: 20, Control no previous ankle injury: 20 •Chronic	•Prescribed pattern •No •Yes Intratester ICC=0.98	•No significant results. • 11
Munn et al. 2002	•Controlled Laboratory Trial • No • Laboratory 'runway'	•Participants with unilateral functional ankle instability •N=16 •Greater than 4 weeks and less than one year	•Triple cross over hop •No •No	•No significant difference in distance between the injured and uninjured. •9

Table 12: Grading scores for impairment measure studies

Author and date	A	B	C	D	E	F	G	H	I	Total
Buchanan et al. 2008	1	2	0	1	2	2	0	2	1	11
de Noronha et al. 2008	1	0	0	2	2	2	0	0	1	8
Eechaute et al. 2008	1	1	0	2	2	2	2	2	1	13
de Noronha et al. 2007	1	0	0	2	2	2	1	0	1	9
Hubbard et al. 2007	1	0	0	0	2	2	1	1	1	8
Johnson and Stoneman 2007	1	0	0	2	2	2	0	0	2	9
Kidgell et al. 2007	1	0	0	2	2	2	0	2	1	10
Sekir et al. 2007	1	1	0	1	2	2	0	2	1	10
Akbari et al. 2006	1	0	0	1	1	2	0	0	1	6
Docherty et al. 2006	1	1	0	1	2	2	0	2	1	10
Fu and Hui-Chan 2005	1	0	0	1	2	0	0	2	1	7
Evans et al. 2004	1	1	0	1	2	2	1	1	1	10
Powers et al. 2004	0	0	0	2	2	2	0	0	0	6
Munn et al. 2003	1	1	0	2	2	2	0	2	1	11
Refshauge et al. 2003	1	0	0	2	2	2	0	1	0	8
Demeritt et al. 2002	1	2	0	2	2	1	0	2	1	11
Munn et al. 2002	0	1	0	2	2	2	0	1	1	9
Willems et al. 2002	1	0	0	1	2	2	0	0	1	7
Eils and Rosebaum 2001	0	2	1	1	2	2	0	1	1	10
Hertel et al. 2001	1	1	0	1	2	2	1	1	1	10
Hess et al. 2001	1	0	0	1	1	2	0	0	1	6
Rose et al. 2000	1	0	0	1	1	2	0	0	1	6
Holme et al. 1999	0	0	0	1	2	0	0	0	1	4
Kaminski et al. 1999	1	2	0	2	2	2	0	0	1	10
Leanderson et al. 1999	0	2	0	2	2	2	0	1	1	10
Waddington and Adams 1999	1	0	0	0	2	1	0	0	0	4
Baier and Hopf 1998	1	1	0	1	1	2	0	0	1	7
Bernier and Perrin 1998	1	0	0	1	2	2	0	1	1	8
Boyle and Negus 1998	1	0	0	2	2	2	0	1	1	9
Docherty et al. 1998	1	0	0	2	2	2	0	0	1	8
Konradsen et al. 1998	0	0	1	2	2	2	0	1	1	9
Bernier et al. 1997	1	0	0	1	1	2	0	0	1	6
Isakov and Mizrahi 1997	1	1	0	1	1	2	0	0	1	7
McKnight and Armstrong 1997	1	1	0	1	1	2	0	0	1	7
Wilkerson et al. 1997	0	0	0	2	2	2	0	0	1	7
Lentell et al. 1995	1	1	0	2	2	2	0	1	1	10
Goldie et al. 1994	1	1	0	1	1	2	0	0	1	7
Ryan 1994	0	0	0	2	2	2	0	2	1	9
Lentell et al. 1990	1	1	0	2	2	2	0	0	1	9
Tropp and Odenrick 1988	1	0	0	1	1	2	0	0	1	6
Glencross and Thornton 1981	1	0	0	2	2	2	0	0	1	8

Limitations of the literature review

As with any literature review there are limitations that should be acknowledged. Limitations of the scored results are that only one reviewer has critiqued each paper and potential bias is possible. As a means of addressing this bias a random selection of ten papers were re-marked after a two week period. The two scores were compared and demonstrated high reliability with an ICC 0.99.

Once the studies were identified and examined it was found that there were significant heterogeneous aspects of the included studies. The varied nature of the studies ranged from randomised controlled trials to selected sampling laboratory testing, studies having interventions to no interventions. Diverse outcome measures were also used and a number of studies had missing data problems. It is acknowledged that attempting to score and compare studies has significant limitations due to the heterogeneous aspects of the included studies and this is reflected in the limited summary conclusions that have been reached in each testing area.

Overall summary of the literature review:

This literature review chapter has provided a critical review of systematic reviews of the treatment and management of ankle sprains along with critical literature reviews into outcome measurements specifically identifying outcome questionnaires and functional and impairment measures associated with ankle sprains.

The critical review of systematic reviews identified that a wide variety of interventions and a large number of outcome measurements were used in the treatment and management of ankle sprains at both the acute and chronic stage of

injury. While in general the systematic reviews had moderate to high quality score ratings, strong evidence based recommendations were not able to be made due to identified problems with the heterogeneity of the systematic reviews. As a result, treatment providers, and in particular physiotherapists, lack evidence as to the most effective treatment and the most appropriate outcome measurements to utilise in the management of ankle sprains.

The critical review of outcome measurements identified that thirty six studies investigating ankle injuries utilised thirty five different questionnaires as outcome measurements. Few studies provided adequate justification for the selection of the respective questionnaires. This section of the literature review provided further evidence of the complexities of outcome questionnaires and the difficulty practitioners are faced with when deciding appropriate discharge measures. The review also identified that little attention is paid to the understanding of the patient's perception.

The critical review section investigating testing procedures looked at four specific areas that have been identified as being involved in ankle sprains: joint position sense, postural control, strength and functional performance. Once more a consistent feature from each review was the variation in study design, testing procedures and outcome measures.

Fourteen studies were identified and reviewed that investigated joint position sense. Based on the finding of this review there was weak evidence that following a sprained ankle, a person is likely in the chronic stage of injury, to have some deficit in accurate reproduction of joint position. However, at an acute stage of injury the evidence was inconsistent. Additionally, there was weak evidence that a strengthening intervention may be of benefit in improving joint position sense.

Twenty studies were identified and reviewed that investigated postural control of the ankle. Based on the findings of this review there was weak evidence for deficits in postural control in both acute and chronic ankle injuries. Additionally there is limited support from this review that a rehabilitation programme may improve balance ability particularly in the acute stage.

Twelve studies were identified and reviewed that investigated isokinetic strength of the ankle. Based on the findings of this current review there was weak evidence that there was a strength deficit in the acute stage of an ankle sprain, but inconclusive evidence at the chronic stage. Additionally there is some support to suggest that a strengthening intervention programme can improve ankle peak torque.

Seven studies were identified and reviewed that investigated aspects of functional performance of the ankle. Based on the findings of this current review there was inconclusive evidence as to whether there was a functional deficit with respect to an agility hop test.

This review has highlighted a number of questions of interest in relation to ankle sprains. The van Rijn's study (2008) identified that a high percentage of patients still experienced pain and subjective instability following discharge from treatment of an ankle sprain. This finding suggests that therapists and patients may not have a similar perception of recovery at time of discharge. The concordance between patient and therapist perception of recovery has received little attention in the literature. It would therefore be of interest to investigate if patients and physiotherapists have a similar perception of when an ankle injury is recovered.

This review has provided evidence of the complexity of and variation in outcome questionnaires with respect to ankle injuries. Further research still needs to be undertaken to improve understanding of appropriate use of questionnaires.

Additionally this review has provided evidence of the variation and lack of consistency in impairment and functional performance measures. As a result this is likely to impact on the clinician's ability in selecting appropriate management strategies to be able to confidently predict the recovery of a patient's ankle sprain. It would therefore be useful to further investigate if there are associations between different impairment and performance measures to assist clinicians in determining ankle sprain recovery.

It was identified that only ten studies compared questionnaire scores to aspects of impairment and performance measures. As a means of providing further information regarding discharge criteria it would be useful to investigate if patients with a measurable impairment or functional weakness are able to be identified from scores of outcome questionnaires.

Additionally Jones's study (2007a) highlighted poor patient satisfaction at time of discharge. It would be of interest to investigate if patient perceptions change following discharge. Furthermore it would also be of interest to investigate if patient perceptions of their ability to perform difficult physical tasks based upon functional questionnaires change as a result of performing the tasks.

Or further interest Refshauge (2008) comments that patient perception at discharge may have an influence on the recurrence rate of ankle sprains. It would therefore be of interest to investigate if those patients with a previous sprain have a different perception of their ankle function than patients who are experiencing their first ankle sprain.

In addition there is a need to explore if questionnaires that assess a patient's perceptions of function or quality of life are able to identify patient concerns following their discharge from treatment for an ankle sprain. It is unlikely that

quantitative methodology alone is able to provide these answers. Therefore incorporating qualitative methodology may be able to provide further useful insights particularly in relation to patient perceptions.

Chapter 3: Methods

This chapter describes the methods for the collection of the quantitative data, specifically the recruitment of participants, the questionnaires, and the biomechanical and performance procedures. The methods relating to the qualitative data are described in Chapter Six.

Subjects

Forty participants were needed for this single group pre-post design, in order to achieve adequate power (80%) with the alpha level set at 0.05, and to detect a small effect size (Cohen's d = 0.2) with relation to the SF-36 physical function section and the LLTQ scores. There were two groups of subjects in this study: the first group were the treating physiotherapists and the second group, the primary focus of the study, were the patients presenting with an acute sprained ankle.

Physiotherapist participants

Physiotherapists were invited to participate if their private practice clinics were situated within a twenty kilometre radius of the Health Rehabilitation Research Centre (HRRC) at Akoranga Campus, Auckland University of Technology (AUT). This criterion was thought necessary to encourage the participation of patients in the performance tests at the HRRC. All of the physiotherapists treated sprained ankles regularly. The physiotherapists then recruited patients presenting for treatment and had a primary diagnosis of an acutely sprained ankle.

To assist in clarity, the term ‘participant’ is from this point used to identify those subjects who presented with a sprained ankle. The participating physiotherapists are referred to as the physiotherapist or therapist. The term ‘Patient’

has been used in the initial and discharge global assessment questionnaires as a means of clearly identifying those subjects with a sprained ankle who were required to complete the respective questionnaires (Appendix D-I).

Participants

The physiotherapists approached patients presenting with the following criteria and invited them to participate.

Inclusion criteria: -A primary diagnosis of an acutely sprained ankle,
-Good understanding of written and spoken English,
-Signed consent form.

Exclusion criteria: -Fractures of the ankle that required Plaster of Paris for longer than two weeks,
-Under 16 years of age,
-Significant neurological problems,
-Other major associated injuries or health problems.

Ethics approval for the project was obtained from the Auckland Ethics Committee on 24th February 2005 (Reference number AKY/04/12/344).

The study consisted of four stages:

Initial recruitment of physiotherapists

Upon agreement, a meeting was arranged at which the researcher presented the outline of the project to all physiotherapy staff within the practice. Eleven private practices were involved in the study. The research information that was left at each physiotherapy practice included: two self addressed postage paid envelopes (one large and one small), a physiotherapist information sheet (Appendix D) and consent

form (Appendix E), a Physiotherapist Initial Global Questionnaire (Appendix F) and a Physiotherapist Discharge Global Questionnaire (Appendix G), a patient information sheet (Appendix H) and consent form (Appendix E), the Patient Initial Global Questionnaire (Appendix I), the Lower Limb Task Questionnaire (LLTQ) (Appendix J) and the New Zealand (English) Short Form-36 Version 2 Questionnaire (SF-36) (Appendix K).

Initial visit of the participant to the physiotherapist

The participants read the information sheet and signed the consent form. Initial questionnaires were then completed. The participants' questionnaires consisted of the Patient Initial Global Questionnaire, the LLTQ, and the SF-36. The physiotherapist completed the Physiotherapist Initial Global Questionnaire. Upon completion, the physiotherapist and participant consent forms, along with the questionnaires were placed in the large postage paid self addressed envelope and posted to the researcher. The physiotherapist then undertook their normal treatment regime with the participant until discharge. As previously stated there is known to be significant variation in physiotherapy treatment regimes of ankle sprains within New Zealand (Larmer, Robb, Hing, Reid, & McNair, 2002). The types of physiotherapy interventions were not a focus of this study and therefore there was no attempt to standardise this aspect. However, all physiotherapists were aware of the ACC treatment profiles and followed the profile recommendations (Accident Compensation Corporation, 2000).

Discharge of the participant from physiotherapy

When the participant was discharged from treatment, the physiotherapist completed the Physiotherapist Global Discharge Questionnaire and posted it to the

researcher. Following receipt of this form, a letter (Appendix L) was mailed to the participant's home along with the following questionnaires: Patient Global Discharge Questionnaire (Appendix M), the LLTQ and SF-36. These were completed and returned to the researcher in a postage paid self addressed envelope. A follow up telephone call was made to the participant if the questionnaires had not been returned within 10 days.

Follow up at six weeks after discharge from physiotherapy

Following receipt of the patient discharge questionnaire by the researcher the participant was contacted via telephone and an appointment arranged for the participant to attend the HRRC at Akoranga Campus of AUT. The appointment was made for a minimum of six weeks following receipt of the physiotherapist's global discharge questionnaire. An information pack containing a confirmation letter (Appendix N), a map, parking sticker and general instructions, was then mailed to the participant's home address. On arrival at AUT, the participants were given an explanation of what the testing would involve. They were then offered the chance to ask any questions. Upon agreeing to continue with the testing, the participants completed the Patient Discharge Global Questionnaire, the LLTQ, the SF36 and a demographic questionnaire. The demographic data collected included the participant's gender, ethnicity, dominant foot, history of previous ankle injuries and number of previous injuries to the ankle. The dominant leg was determined by asking the participant with which leg they would normally kick a ball (Johnson & Stoneman, 2007). The participant's height and weight were also measured and recorded. Thereafter the participant completed a warm up of general calf stretches and five minutes on a stationary bike. Participants were reassured that any

subsequent activity in which they felt pain or discomfort could be discontinued immediately.

The physical tests involved five procedures: a joint position sense test, postural control tests, strength test, performance agility test and specific activity test. In all cases the uninjured ankle was regarded as the control. A detailed explanation of each of these tests follows. Prior to beginning each test a thorough explanation of each test was given to each participant to ensure adequate understanding of each task.

A selected number of participants also undertook a semi-structured interview at this appointment. Purposeful sampling was utilised to select these participants. Each interview was recorded and later transcribed. As previously stated, the findings of this qualitative data are described in Chapter Six.

Questionnaires

Global questionnaire

The Patient Initial Global Assessment Questionnaire asked two specific questions that were scored on a Likert scale. Firstly a general question pertaining to function was presented. The descriptors were:

- I have significant limitations that affect activities of daily living.
- I have moderate limitations that affect activities of daily living, e.g. no sports possible.
- I have some limitations e.g. with sports, but I can participate; I compensate.
- I am able to do whatever I wish with no problems.

These descriptors were anchored to a scale marked from 1–10 with a low score indicating significant limitation and a score of 10 indicating no limitations (See Appendix I). Secondly participants were also asked to rate their pain on a visual analogue scale (VAS). The scale was marked from 0–10 and was anchored at either end of the scale with a score of 0 indicating no pain and a score of 10 indicating

worst possible pain (See Appendix I). The VAS for pain questionnaire has been previously validated (Bijur, Silver, & Gallagher, 2001; Farrar, Young, LaMoreaux, Werth, & Poole, 2001; Hagg, Fritzell, Oden, & Nordwall, 2002; Salaffi, Stancati, Silvestri, Ciapetti, & Grassi, 2004).

The Physiotherapist Initial Global Assessment Questionnaire asks two specific questions that were scored on a Likert scale. The first scale asks the physiotherapist to rate the limitations of the participant's ankle in relation to limitations in function, particularly reflecting upon previous ankle injuries that the physiotherapist had treated. The descriptors were:

- They have significant limitations that affect activities of daily living.
- They have moderate limitations that affect activities of daily living e.g. no sports possible.
- They have some limitations e.g. with sports, but they can participate; they compensate.
- They are able to do whatever they wish with no problems.

These descriptors were anchored to a scale marked from 1–10 with a low score indicating significant limitation and a score of 10 indicating no limitations (See Appendix F). The overall condition questionnaire has been previously validated (Barber-Westin, Noyes, & McCloskey, 1999; Kelleher, Pleil, Reese, Burgess, & Brodish, 2004). The second question asked the physiotherapist to predict how well the participant was likely to recover. The descriptors were:

- Little or no change expected in impairment or function
- Some improvement expected in impairment and function
- Moderate change expected in impairment and function
- Good improvement expected in impairment and function
- Excellent improvement expected in impairment and function

These descriptors were anchored to a scale marked from 0–4 with a zero score indicating little or no improvement expected and a score of 4 indicating excellent improvement expected (See Appendix F). The physiotherapists were specifically

instructed not to discuss the question with the participant, but to reflect from their own experience and judgement.

The Physiotherapist Discharge Global Assessment Questionnaire asked one question relating to the participant limitations at discharge. The scale was the same as the Initial Global Limitations question and was marked from 1–10 with a low score indicating significant limitations and a score of 10 indicating they had no limitations (See Appendix G). As with the initial global question, the physiotherapists were instructed not to discuss the question with the participants, but to reflect on their experience of treating previous ankle sprains.

The Patient Discharge Global Assessment Questionnaire asked three questions: the general overall rating (rated 1-10) and the pain rating (rated 0-10) were repeated from the initial patient global questions (See Appendix M). An additional question asked the participant about their overall improvement since starting treatment. The descriptors were:

- Very much improved
- Much improved
- Minimally improved
- No Change
- Minimally worse
- Much Worse
- Very much worse

These descriptors were anchored to a scale marked from 0–6 with a low score indicating significant improvement and a score of 6 indicating significantly worse.

Lower Limb Task Questionnaire

The Lower Limb Task Questionnaire (LLTQ) is a recently developed lower limb specific questionnaire concerning function, containing twenty questions and takes approximately 5 minutes to complete. It has been shown to have moderate to

high validity, reliability and responsiveness characteristics (McNair et al., 2007). There are two domains: 10 questions related to Activities of Daily Living (ADL) and 10 questions related to Recreational Activities (Rec) (Appendix J). Each question asks the difficulty associated with performing a task in the past 24 hours. The descriptors were:

- no difficulty
- mild difficulty
- moderate difficulty
- severe difficulty
- unable

The scale was marked from 0–4. A zero score indicated inability to do particular activities while a score of 4 indicated little or no difficulty. Additionally each of the twenty functional questions had an importance scale associated with it. The descriptors were:

- not important
- mildly important
- moderately important
- very important

This was marked from 1–4 with a low score indicating not important and a score of 4 indicating very important.

Medical Outcomes Study Short Form 36 Version 2 Questionnaire

The New Zealand (English) Medical Outcomes Study Short Form 36 version 2 Questionnaire (SF-36) is a self administered, multi-purpose, quality of life questionnaire that takes approximately 10 minutes to complete. It is an 11 item questionnaire containing 36 questions and is the most widely used health status questionnaire in the world (Hays, Hahn, & Marshall, 2002; M. H. Jones et al., 2006). The questionnaire provides an 8-scale profile or domains of health. The eight health domains are: Physical Functioning, Role Physical, Bodily Pain, General Health,

Vitality, Social Functioning, Role Emotional and Mental Health (Appendix K). Prior to analysis the SF-36 scores were coded and the eight subscales were transformed to provide scores out of 100 in line with recommended guidelines (Ware, Kosinski, & Dewey, 2000). The SF36 also has an overall Physical and Mental health summary scale. However, these two summaries were not analysed for two reasons. Firstly the re-scoring is based on the American population norms which may not be relevant to the New Zealand population and secondly the SF-36 subscales were considered more useful for comparison to the LLTQ questionnaire. Additionally the developers of the SF-36 have developed an 'Acute' version that has a one week recall rather than the four week recall as in the standard SF-36 (Ware, Kosinski, & Gandek, 2002). However, this 'Acute' version has not been tested on a New Zealand population and was therefore not considered for this study.

The SF-36 is widely recommended for use in outcome research, particularly in clinical research focusing on results for individual participants (Ware et al., 2000). The SF-36 has been used in conjunction with a number of other outcome measurements involving ankle studies and has often been used alongside and in comparison to other questionnaires (Binkley et al., 1999; Brazier et al., 1992; Brodsky et al., 2005; Jenkinson, Coulter, & Wright, 1993; Lee, James, Cohen, Davis, & Anderson, 2005; Ponzer, Nasell, Bergman, & Tornkvist, 1999; SooHoo, Samimi et al., 2006; SooHoo et al., 2003; SooHoo, Vyas et al., 2006). It has been recommended that using both a generic quality of life measure in combination with a specific functional measure is important in outcome evaluation (Guyatt et al., 1993). The SF-36 was therefore considered appropriate to be used alongside the LLTQ.

While the LLTQ and the SF-36 have undergone previous testing related to reliability, it was considered worthwhile to examine the internal consistency of the

questionnaires and their separate domains on this ankle population. Consistency of responses to different questions developed to capture the same concept suggests high internal consistency. Internal consistency reliability was evaluated by Cronbach's alpha statistic (Bland & Altman, 2002; Cronbach & Warrington, 1951).

Protocol for physical testing at the HRRC

In chapter two, the literature review revealed that joint position sense, postural control, strength and functional agility have all been identified as possibly contributing to impairments following an ankle sprain. It was therefore considered useful to undertake specific physical testing to investigate these aspects to enable comparisons of participants of this study with previous research.

All participants performed the physical testing in bare feet. The order of testing, for the joint position test, postural control test and performance test was randomly chosen as was the leg to start in each test. The strength test was performed following the previous three tests to minimise the effects of fatigue as suggested by previous authors (Eils & Rosenbaum, 2001). Participants who were interviewed completed this task following all physical testing.

Prior to this current study, a pilot study was undertaken to establish the reliability of the four testing procedures. Ten healthy volunteers who had no previous ankle injury participated. The results are presented following the description of each test.

Joint position sense

Joint position sense is one method that has been used to assess proprioception and has previously been described in Chapter Two. For the purposes of this study an active non-weight bearing position matching test was chosen. Testing was performed

using a Penny and Giles electro goniometer (Penny and Giles Biometrics, Blackwood, United Kingdom. “M” series twin). The reliability of using goniometry for joint movement has previously been reported (Croxford, Jones, & Barker, 1998; Edgar et al., 2008). The validity of electro goniometers for measuring joint movement has also been examined (Legnani, Zappa, Casolo, Adamini, & Magnani, 2000; Sholukha et al., 2004; Tesio et al., 1995). Moderate reliability was demonstrated for this testing procedure in the pilot study (ICC=0.60). Reliability was increased notably when it was noted that removal of the trial with the greatest error improved the ICC to 0.83 and hence this method was utilised in the main study. T-test showed that there was no significant difference ($p>0.05$) between the left and right ankles.

In the current study, participants lay prone with their ankles hanging over the end of a plinth (See Figure 2).

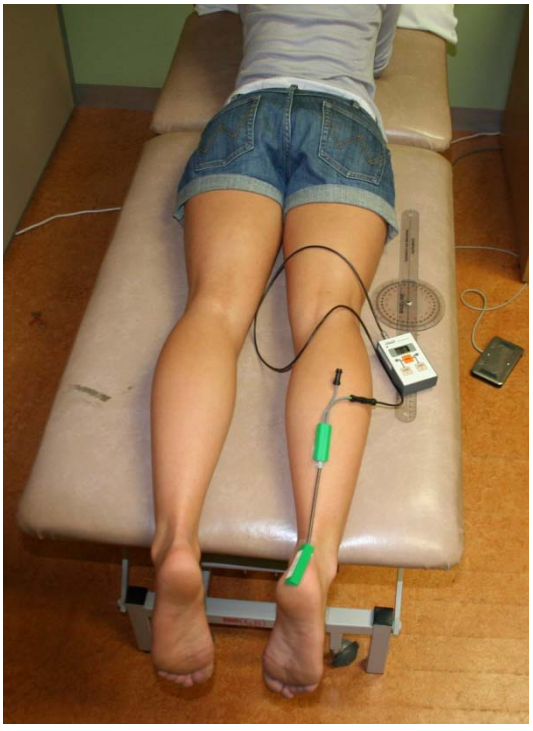

Figure 2: Positioning of the subject for active joint position sense with the Penny and Giles electro goniometer attached.

Participants were positioned for comfort so that the end of the plinth was approximately in line with the lower third of the tibia. They could not see their ankles and were asked not to look at them. Participants were instructed to move their ankle into eversion and inversion. If any participant had difficulty appreciating this movement, the researcher passively moved the joint and then had the participant actively repeat the movement. Participants were then instructed to relax their ankle into what they considered to be a neutral relaxed position. A pen mark was then made at the mid superior aspect of the calcaneum and the mid popliteal crease. A dotted line was drawn transecting these marks with a ruler. The goniometer was then taped to the leg. One end of the goniometer was placed and taped directly over the mark on the calcaneum. The other end was placed and taped on the transecting line drawn on the calf, so that the spring was in a slightly tensioned state. Participants were then instructed to move the ankle into eversion/inversion to ensure that the tape was not pulling and the movement felt comfortable. With the ankle in the relaxed neutral position, the goniometer was calibrated at zero and the participant was then asked to actively move their ankle into full eversion and inversion. This end range of eversion and inversion was recorded. The participants were then asked to repeat this movement three times. Participants were then instructed that the testing would now commence and they were asked to move their ankle to end of range eversion and slowly move into inversion. A verbal instruction to stop was given during the movement and the position recorded. Participants held this position for five seconds, then moved into end range inversion and back to end range eversion and thereafter attempted to relocate the position previously held. Participants confirmed when they thought they had reached the previous position and this position was recorded. Participants then relaxed to the neutral position and rested for 15 seconds prior to

repeating the test. The absolute difference between the held position and the repeated position was calculated and recorded for each movement. In total six position matching tests were recorded. The same procedure was then repeated for the contra-lateral ankle. Of the six final results, the trial with the greatest error was discarded and the mean of the remaining five trials for both the injured and uninjured ankle was used in the analysis.

Postural control

Measuring postural control using force plates has been utilised by previous researchers (Eils & Rosenbaum, 2001; Evans et al., 2004; Jonsson, Seiger, & Hirschfeld, 2004, 2005). The reliability and validity of using force plates to measure balance has previously been reported (Cornwall & McPoil, 2003; Le Clair & Riach, 1996; Middleton et al., 1999). Moderate to high reliability was demonstrated for this testing procedure in the pilot study (ICC=0.62-0.99). Only one variable (the dynamic takeoff phase) resulted in an ICC below 0.80. Reliability was improved to an ICC of 0.81 with the mean of three trials utilised in the analysis, hence this was utilised for the main study. T-test showed that there was no significant difference ($p>0.05$) between the left and right ankles.

Researchers have investigated balance using the one legged standing test as utilised in the current study, whereby participants stand feet side by side and shift laterally to a one legged stance (Evans et al., 2004; Jonsson et al., 2004). In addition to this test, an additional test with the participant taking a tandem stance position and moving forward into a one legged stance position was performed (Jonsson et al., 2005). It was thought that this position may relate more to an activity such as walking.

Participants were given verbal instructions as well as a practical demonstration by the researcher as to how to perform the balance test and then given a practice trial in each position. Three different tests were performed using two force plates. The first test involved the participants' standing with feet side by side and with one foot on each force plate. Participants were instructed to stand in this position with their weight equally balanced on each foot. Participants were instructed to focus on a picture which had been placed at head height on a wall directly in front of them and have their arms relaxed by their side. When the participants indicated that they felt balanced, measurements were recorded for 30 seconds. The 30 second time-frame was based on research that indicated that the optimum test-retest reliability was obtained at between 20-30 seconds (Le Clair & Riach, 1996). The second and third tests involved the participant in tandem standing, that is, one foot in front of the other with one foot on each force plate (See Figure 3). Participants were again asked to focus directly ahead and instructed to indicate when they felt that they had equal weight on each foot. Data were collected for 30 seconds. Participants were then asked to move the front foot to the back and vice-versa and the previous procedure was repeated for the third test.

The remaining two balance tests involved the use of one force plate only. In the first of these tests, participants stood with their feet side by side on one force plate such that they felt equally balanced on each leg and had focused their vision directly ahead. Once they felt balanced they indicated this to the researcher who began data collection. The participant maintained this state for five seconds and then an auditory cue was given, and the participant moved their upper body laterally to stand on one leg fully extended and their body upright. The non-stance leg was held in approximately 30 degrees hip flexion and 45 degrees knee flexion and the participant

was instructed to avoid contact of the legs. Participants were asked to keep their arms relaxed by their side. This one legged stance was maintained for a further 25 seconds. Upon completion, the participant rested and then repeated the same procedure on the contra-lateral foot. This exercise was repeated three times on each foot. The participant was allowed to sit and rest for a minute between each trial.

The second test involved the participant initially in tandem standing on one force plate. The participants were again asked to indicate when they felt balanced with one foot in front of the other. When the participant indicated that they felt balanced, data collection commenced. After five seconds of tandem standing an auditory cue was given for the participant to move forward to balance on the front foot and hold that position for a further 25 seconds. Similar to the previous test, their non-stance leg was held in the previously described position. This exercise was repeated three times on each foot, with rest intervals between each trial.

The balance test utilised AMTI (Advanced Mechanical Technology Inc. USA. Model OR6-5-2000) force platforms (See Figure 3). Prior to each testing session the equipment was calibrated. Three-dimensional ground reaction forces (Fx, Fy, Fz) were collected at a sampling frequency of 100 Hz and relayed to a computerised data acquisition system (Superscope, GW Instruments, Washington, USA.). Two aspects of postural control were of interest. Firstly the vertical (Fz) ground reaction force was analysed to compare weight bearing across legs when both force plates were used. This allowed comparisons to be made between the injured and uninjured limbs to determine if participants favoured one limb over the other in standing. The balance trials on one leg involved two aspects of postural control; a dynamic phase and a static phase.

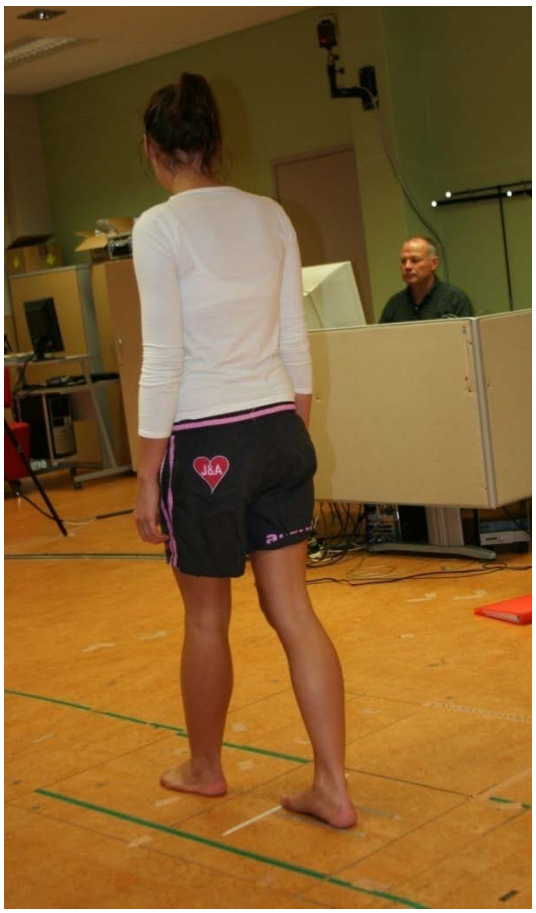

Figure 3: Positioning of the subject for postural control testing in tandem standing on AMTI Force Platform.

Of primary interest the horizontal (Fx) ground reaction forces, which provided measure of sway of the centre of gravity in the medio-lateral direction were analysed. Two five second epochs were selected for analysis. The first five second data epoch, the dynamic phase, occurred from the moment of the auditory cue when the participant lifted one foot until five seconds had elapsed. The second five second epoch, the static phase, was selected visually from the remaining 20 seconds of recording and reflected a period of least force oscillation. The variables calculated were the root mean square (RMS) of force during each five second interval. The mean of the three trials was calculated.

Performance test

The agility hop test is thought to incorporate aspects of balance, strength and co-ordination all of which are necessary for good ankle function (Demeritt et al., 2002; Eechaute et al., 2008). Previous authors utilising this test for an injured ankle population had not indicated any specific distance between points (Bernier & Perrin, 1998; Demeritt et al., 2002) and personal communication with the authors indicated that this had not been considered (personal communication on July 25th 2005). A standardised pattern was marked out on the floor with white tape (See Figure 4) and numbered.

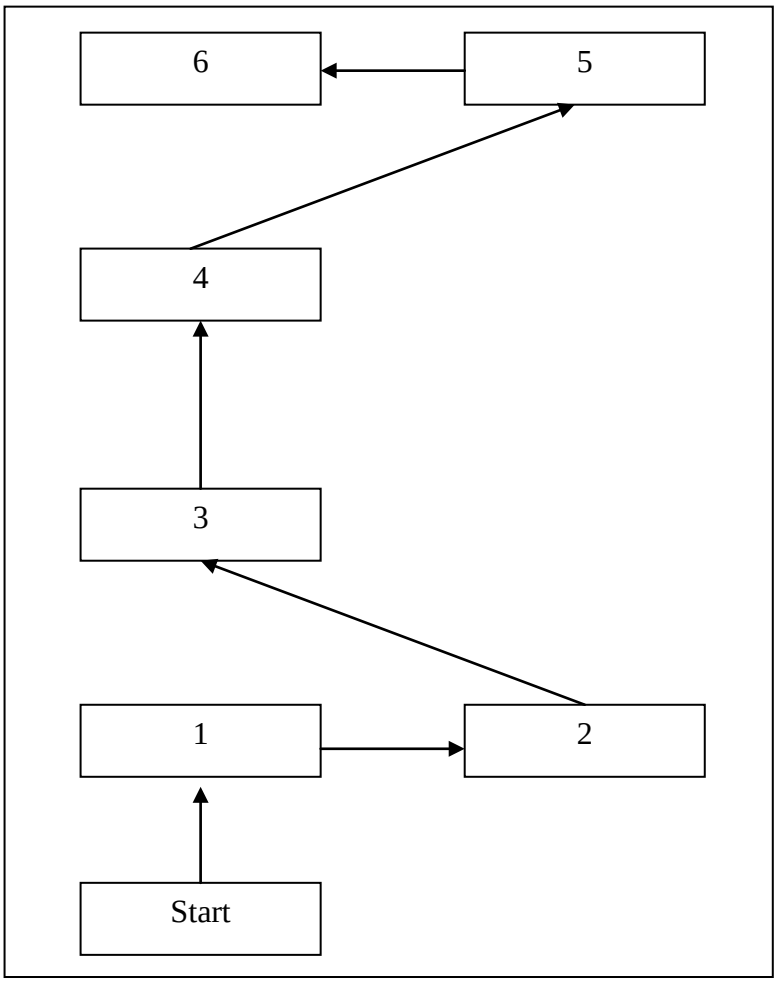

Figure 4: Agility hop test diagram.

Previous authors (Buchanan et al., 2008; Eechaute et al., 2008) have demonstrated high reliability for variations of the hop test. High reliability was demonstrated for this testing procedure in the pilot study (ICC=0.82). T-test showed that there was no significant difference ($p>0.05$) between the left and right ankles.

Prior to commencing the agility hop test each participant completed a single hop from behind a marked line and the distance was recorded. Emphasis was placed on only having the participants hop to a distance with which they were comfortable. This was repeated for three hops on each leg. At the completion of the three hops on each leg, mean distance for each participant hop length was calculated and the distance between each of the six markers was established. Participants were given verbal instructions and a demonstration by the researcher of how the trial should be performed. They were then allowed one practice test on each leg before the trial was recorded.

The agility hop test involved participants starting the hop from behind a start line, hopping to the first numbered marker, regaining their balance as soon as possible and counting aloud for five seconds with arms held at their side and with a fully extended hip and knee joint. They then hopped to marker two and repeated the previous instructions. Participants continued this sequence to finish on marker six. Participants were then given a minute rest before repeating the trial on the contra lateral leg. They repeated the trial three times on each leg.

The trial was scored according to four separate criteria:

1. Participant did not hold landing for 5 secs
2. Moved test foot after landing
3. Touched with other foot or moved other foot excessively
4. Moved arms or body excessively for balance after initial hop

The researcher scored all participants according to these criteria. A participant who met all criteria across each hop scored a maximum of four whereas a participant

who did not meet any criteria at each hop scored a zero. A mean was obtained across the three trials for each ankle.

Isokinetic strength test

As mentioned in Chapter Two, weaknesses of the peroneal muscles have been implicated as a risk factor for the recurrence of ankle sprains. Isokinetic testing is one method that has been described to measure strength (Leanderson et al., 1999; Munn et al., 2003; Schmitt, Kuni, & Sabo, 2005; Sekir et al., 2007; Wilkerson et al., 1997; Wong, Glasheen-Way, & Andrews, 1984).

The validity and reliability of isokinetic dynamometer testing has previously been reported (Drouin et al., 2004) and studies have shown the reliability of ankle inversion and eversion to be adequate (Aydog et al., 2004; Karnofel et al., 1989; Leslie et al., 1990). Moderate to high reliability was demonstrated for this testing procedure in the pilot study (ICC=0.68-0.94). Ankle inversion and eversion at 120º/sec were the only measures that resulted in an ICC less than 0.75. This result was similar to two previous studies (Lentell et al., 1995; Munn et al., 2003). T-test showed that there was no significant difference ($p>0.05$) between the left and right ankles.

In the current study, a Biodex System 3 dynamometer (Biodex Medical Systems, Inc. New York, USA.) was utilised (See Figure 5). The participants were positioned according to that suggested by Munn et al (2003). The angle of the seat back was adjusted to ensure that there was no discomfort from hamstring muscle strain. The leg being tested was supported under the calf muscle and secured with a strap to achieve 30º knee flexion. The calf support was placed approximately a hand distance from the popliteal crease for comfort. The foot was positioned to achieve

20º plantarflexion at the ankle joint. The subtalar joint was positioned in neutral with the angle of dynamometer aligned to transect the sagittal axis of the joint. The heel was firmly fitted into the Biodex heel cup. Straps were secured over the ankle joint and the forefoot. Participants were instructed to concentrate on the specific motion required and minimise any hip or knee motion. The starting position of the foot was in neutral. Isokinetic concentric muscle action of the ankle invertors and evertors was performed at 60º/sec and 120º/sec.

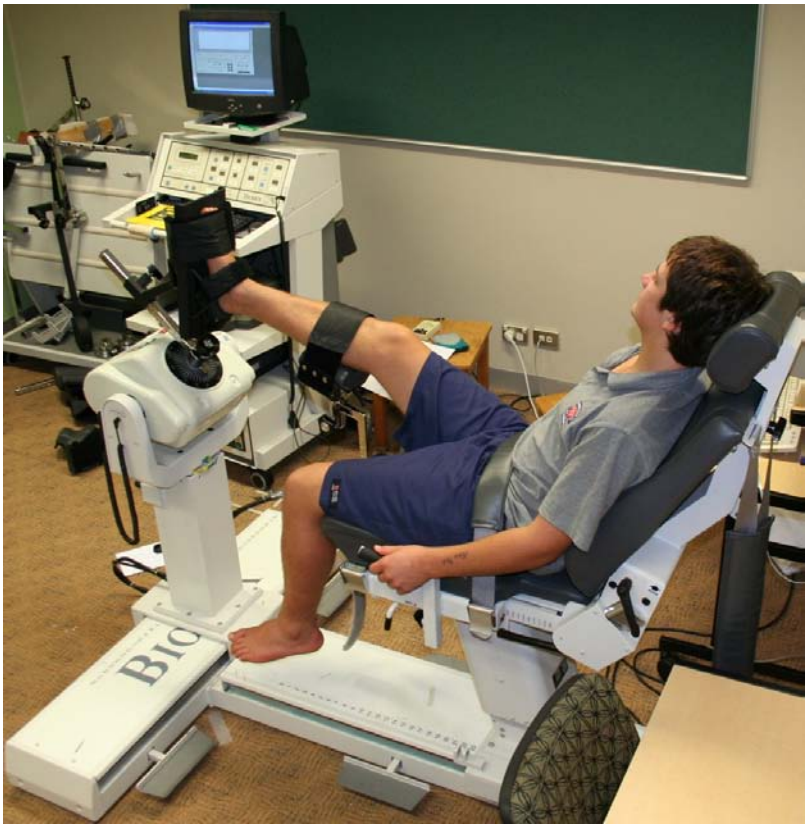

Figure 5: Positioning of the subject for inversion/eversion strength testing on the Biodex System 3 dynamometer.

Participants familiarised themselves with the movement required. The end range of motion for inversion and eversion was then set and the motion was repeated three times to ensure consistency. Participants then completed a warm up protocol of five sub maximal and three maximal contractions at 60º/sec. A two minute rest

period was given between the warm-up and testing. Testing consisted of five maximal repetitions at 60º/sec. A two minute rest was given before repeating the above procedure at 120º/sec. The contralateral leg was then tested in the same manner as above. Participants were given a stop switch to use if they experienced any pain or discomfort. The researcher gave consistent verbal encouragement throughout the testing.

Using the Biodex System 3 software package, peak torque and time to peak torque were recorded from each of the five maximal contractions for both eversion and inversion and for both the injured and uninjured ankles. The absolute peak torque (the highest value) and the associated time to reach this peak torque were used in the analyses. The rationale for selecting the absolute peak torque over the mean peak torque has been previously described by Munn et al (2003). In a five repetition test the first two repetitions generate significantly less torque than subsequent repetitions and as a result significantly reduce the average torque values.

Specific activity test

Following the completion of the four physical tests, the Lower Limb Task Questionnaire, which had been completed by the participant on arrival and prior to physical testing was examined. The researcher searched for the two lowest scoring (most difficult) tasks that the participant had identified and that were also rated as being of greatest importance by the participant. If there were more than two tasks with equal weighting, the participant was given the choice of which two tasks they would prefer to undertake. The researcher did not remind the participant what score they had previously given for the two tasks that were identified. The participant then performed these tasks three times. Equipment was available within the research centre to replicate the described tasks. After completion of the specific tasks,

participants were then given an unmarked LLTQ again and asked to score the tasks they had just performed. Their original rating and then the remark score were recorded.

Data analysis

Statistical analysis was performed using the Statistical Package for Social Sciences, Version 15.0 for Windows Inc (SPSS, SPSS Inc, Chicago, IL, USA) software. In all statistical analyses, a significance level of $p<0.05$ was chosen.

To investigate differences at the initial, discharge and six week follow up visits between outcome questionnaires scores, inferential statistics were performed for the Global, LLTQ and SF-36 scores. Repeated measures analysis of variance ANOVA was performed to determine effects across time points where appropriate. Planned contrasts thereafter were undertaken. Bonferroni corrections were applied. Furthermore to confirm the internal consistency of the LLTQ and SF-36 separate domains and total questionnaire scores for this population of sprained ankle participants, Cronbach's alpha statistics were calculated. A Cronbach's alpha score of greater than 0.7 suggests that the questionnaire domains have good internal consistency (Brodsky et al., 2005).

To specifically answer whether there were associations between outcome questionnaires that investigate similar domains of pain and function with regard to the participant's perception at the initial, discharge and six week follow up visits, scores were assessed using correlation co-efficients. Descriptive analysis was performed and where both variables exhibited normal distributions the Pearson product moment correlation coefficient was performed, otherwise the Spearman rho rank correlation was calculated. Interpretation of correlation scores were: 0-0.25,

little or no correlation: 0.26-0.49, low correlation; 0.50-0.69, moderate correlation; 0.70-0.89, high correlation; 0.90-1.00, very high correlation as recommended by Domholdt (2005).

To investigate if participants and physiotherapists have a similar perception of limitations, the overall condition scores at initial assessment and discharge were examined using inferential statistics. Paired t tests were used and effect sizes and an intraclass correlation model (ICC) were calculated.

To investigate if there were deficits in impairment measures for proprioception, postural balance and agility across injured and uninjured limbs at six weeks following discharge from treatment, paired t tests were used and effect sizes were calculated where appropriate. For strength testing, a 2x2x2 repeated measures analysis of variance ANOVA was performed to determine the effects of injury status, muscle group and contraction velocity on torque measurements. Each factor had two levels: injury status (injured/uninjured), muscle group (invertors/evertors) and velocity (60^{o}/sec /120^{o}/sec). The dependant variables were peak torque and time to peak torque. For measures that demonstrated significance, further analysis was undertaken to determine if there were associations between selected impairment measures. Specifically, percentage differences were calculated between the involved and uninvolved limb ((injured- uninjured/uninjured) x100) for the proprioception, balance and strength data. Mean difference (injured-uninjured) was calculated for the agility hop score. To specifically investigate if there were associations between percentage deficits in proprioception, balance, strength and agility, correlation co-efficients were examined as previously outlined. Bonferroni corrections were applied.

Further investigation into the associations between the scores of domains of function from the questionnaires and impairment and performance measures were undertaken, the impairment and performance were measured by percentage of deficits across limbs at six weeks following discharge from treatment. For the different levels of questionnaire scores and measures of proprioception, balance, strength and agility each variable was dichotomised into two groups, (high or low) based on their distribution. Once dichotomised, logistic regressions were performed to investigate the associations between questionnaire scores and impairment measures. The same statistical analysis was performed to investigate if there were associations between a previous ankle injury and different levels of questionnaire scores and measures of proprioception, balance, strength and agility.

To investigate if patient perceptions of ability to perform difficult physical tasks changed after performing the tasks inferential statistics were performed. Paired t tests, effect sizes, along with non-parametric analysis (Freidman ANOVA) were performed where required. This non-parametric test was chosen because the distribution scores were not normal for some variables.

Chapter 4: Results

This chapter presents the results for the quantitative data. The chapter has been divided into subsections: firstly information concerning the participants is presented. This is followed by the findings related to the first six key questions of this study: the results for the outcome questionnaires and comparisons between questionnaires, the participant and physiotherapist perception of limitations, the results concerning the testing of impairments and comparisons between impairments and thereafter the comparisons of questionnaires and impairment measures. Finally the findings related to the participant's perception to perform physical tasks and the findings of previous ankle injury are presented.

Demographics

Eleven local private practice physiotherapy clinics agreed to participate in the recruitment of patients. Nineteen physiotherapists from these clinics recruited forty seven participants who consented to take part in the research and completed the initial questionnaire. Forty participants completed all stages of data collection. The seven participants for which there were not a full set of data were withdrawn from the statistical analysis for the following reasons: two due to their age (both were over 80 years old and the researcher and participant agreed that the physical testing may have been too demanding for them); three participants left the country prior to discharge and the remaining two participants moved from their initial address and were unable to be contacted despite numerous efforts. Apart from the age characteristics of two of the participants (both over 80 years) comparison of data from the initial questionnaires showed no significant baseline difference between the subjects who withdrew and those subjects who completed the full data collection.

Equal numbers of males and females participated. The average age of participants was 30.5 years (range 16-59) and the average BMI for subjects was 25.7 (range 19.4-45.7). The right ankle was injured in 60% of cases with the dominant leg being injured in 95% of participants. Fourteen participants (35%) had sustained a previous sprain to the ankle with the number of repeated sprains ranging from one to twelve. The average number of days between the initial visit to the physiotherapist and participants presenting for testing at the HRRC was 157 days (range 64-394).

Questionnaires

Descriptive statistics were calculated for the Physiotherapist Initial Global Questionnaire, Patient Initial Global Assessment Questionnaire, Physiotherapist Discharge Global Questionnaire, the two measurement points of the Patient Discharge Global Assessment Questionnaire (at discharge and at the six week follow up) and at the three measurement points of the LLTQ and the SF36 (initial visit, discharge and at the six week follow up). As mentioned in Chapter Three, the Physiotherapist Initial Global Questionnaire, Patient Initial Global Assessment Questionnaire and the Patient Discharge Global Assessment Questionnaire were composed of separate questions and these have been analysed individually. Further analysis of the respective sub-scales of the LLTQ and SF36 were also performed.

Global scores

Figure 6 shows the descriptive data for the initial, discharge and six weeks follow up Global patient limitations scores. There was a significant difference ($p<0.05$) between the mean initial score of 4.1 (SD 1.8) and the mean discharge score of 7.5 (SD 1.7), and between the mean discharge score and mean six week follow up score of 8.6 (SD 1.4) with an effect size of 1.97 and 0.69 respectively.

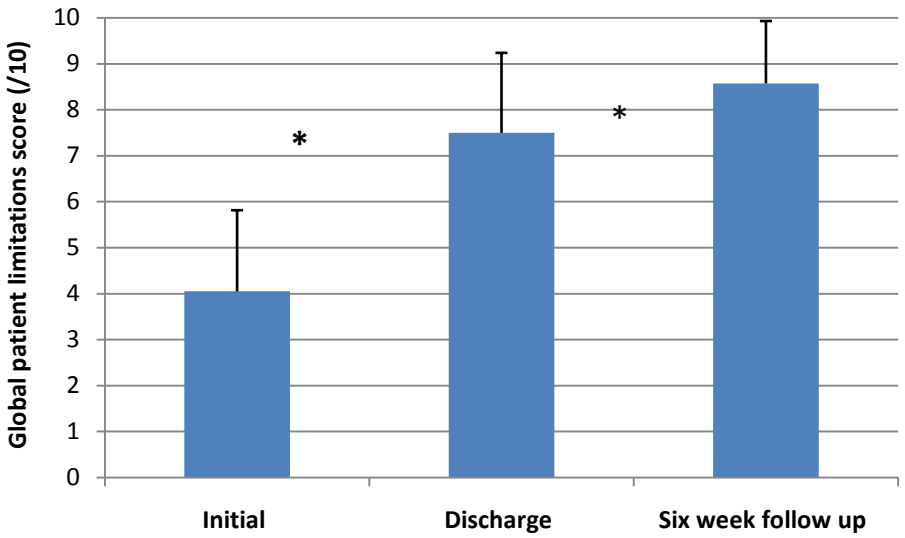

Figure 6: Mean and SD at the initial assessment, discharge and six week follow up for the Global patient limitations scores (* = p<0.05).

Figure 7 shows the descriptive data for the initial, discharge and six week follow up Global pain scores. There was a significant difference ($p<0.05$) between the mean initial score of 5.5 (SD 1.9) and the mean discharge score of 9.0 (SD 1.2) with an effect size of 2.15. There was no significant difference ($p>0.05$) between the mean discharge score and the mean six week follow up score of 9.3 (SD 1.4).

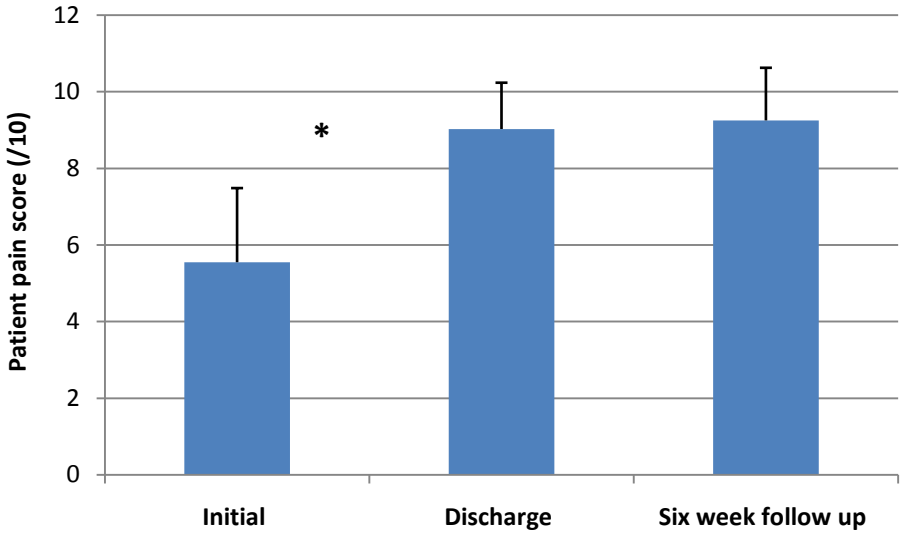

Figure 7: Mean and SD at the initial assessment, discharge and six week follow up for Global pain scores (* = p<0.05).

LLTQ scores

Figure 8 shows the descriptive data for the initial, discharge and six week follow up LLTQ Activities of Daily Living scores. There was a significant difference ($p<0.05$) between the mean initial score of 23.0 (SD 8.6) and the mean discharge score of 37.5 (SD 3.1). There was also a significant difference between the mean discharge score and mean six week follow up score of 38.5 (SD 2.5). The effect sizes were 2.25 and 0.34 respectively.

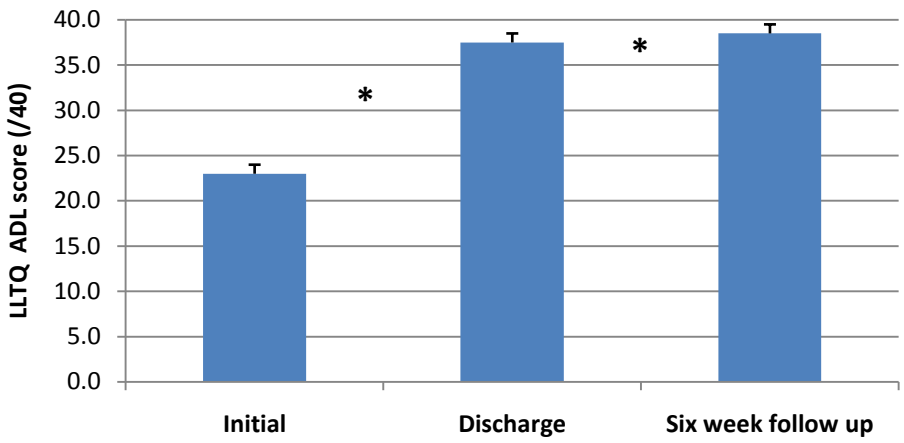

Figure 8: Mean and SD at the initial assessment, discharge and six week follow up for the LLTQ Activities of Daily Living scores (* = p<0.05).

Figure 9 shows the descriptive data for the initial, discharge and six week follow up LLTQ Recreational domain scores. There was a significant difference ($p<0.05$) between the mean initial score of 10.0 (SD 8.8) and the mean discharge score of 30.0 (SD 8.0), and between the mean discharge score and mean six week follow up score of 33.0 (SD 7.0) with effect sizes of 2.37 and 0.42 respectively.

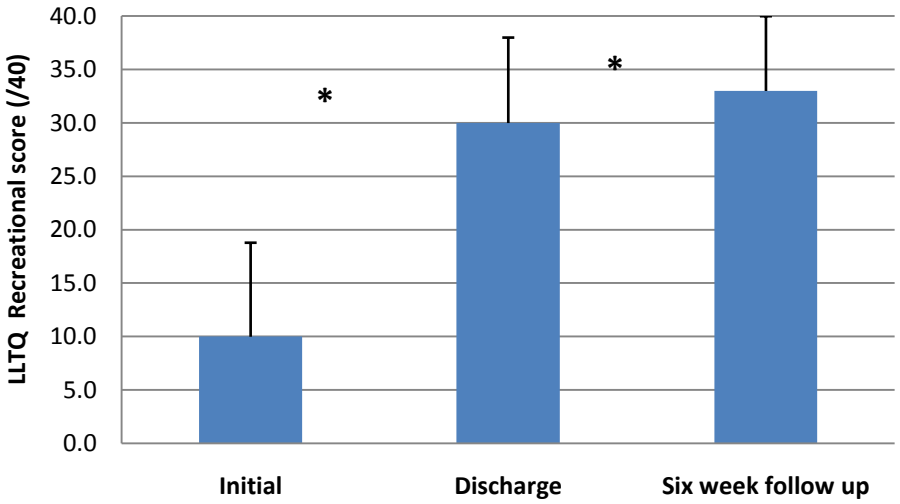

Figure 9: Mean and SD at the initial assessment, discharge and six week follow up for the LLTQ Recreational scores (* = p<0.05).

Table 13 shows the descriptive data for the initial, discharge and six week follow up LLTQ ADL and Rec domain importance scores. There was no significant difference (p>0.05) between the initial score, discharge score and the six week follow up scores.

Table 13: Mean and SD at the initial assessment, discharge and six week follow up for the LLTQ ADL and Rec Importance scores.

LLTQ Importance scores	Mean	SD
LLTQ ADL Initial	29	5
LLTQ ADL Discharge	29	7
LLTQ ADL 6 week follow up	29	7
LLTQ Rec Initial	28	8
LLTQ Rec Discharge	28	8
LLTQ Rec 6 week follow up	28	8

SF-36 scores

Figure 10 shows the descriptive data at the initial assessment, discharge and six week follow up for the SF-36 total percentage scores. There was a significant difference (p<0.05) between the mean initial score of 74.9 (SD 11.3) and the mean

discharge score of 82.7 (SD 7.6), and between the mean discharge score and mean six week follow up score of 85.2 (SD 7.9) with effect sizes of 0.80 and 0.32 respectively.

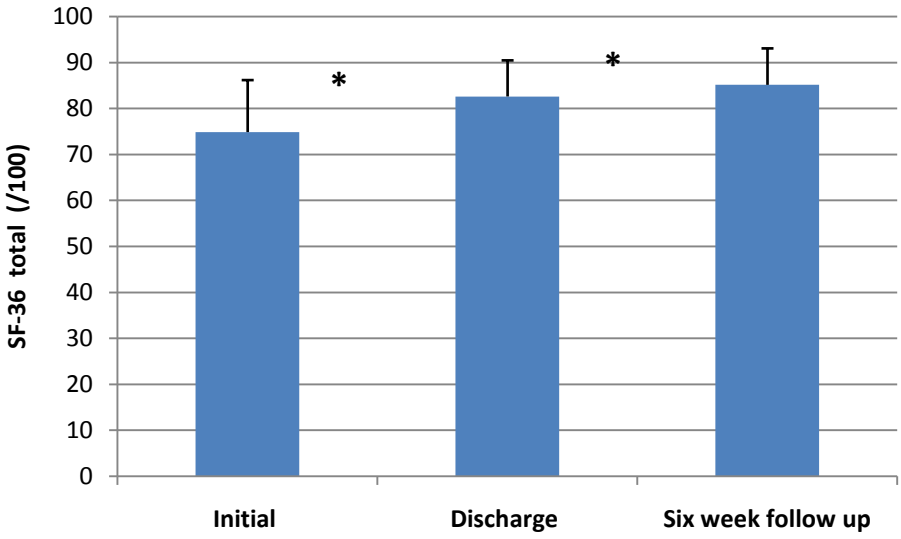

Figure 10: Mean and SD at the initial assessment, discharge and six week follow up for the SF-36 total scores (* = p<0.05).

Figure 11 shows the descriptive data at the initial assessment, discharge and six week follow up for the SF-36 Physical Functioning scores. There was a significant difference ($p<0.05$) between the mean initial score of 59.5 (SD 32.2) and the mean discharge score of 87.5 (SD 14.2) with an effect size of 1.12; however, there was no significance ($p>0.05$) between the mean discharge score and mean six week follow up score of 89.3 (SD 18.7).

Figure 12 shows the descriptive data at the initial assessment, discharge and six week follow up for the SF-36 Role Physical scores. There was a significant difference ($p<0.05$) between the mean initial score of 67.7 (SD 26.6) and the mean discharge score of 83.6 (SD 20.2) and between the mean discharge score and mean six week follow up score of 92.3 (SD 11.7) with effect sizes of 0.67 and 0.53 respectively.

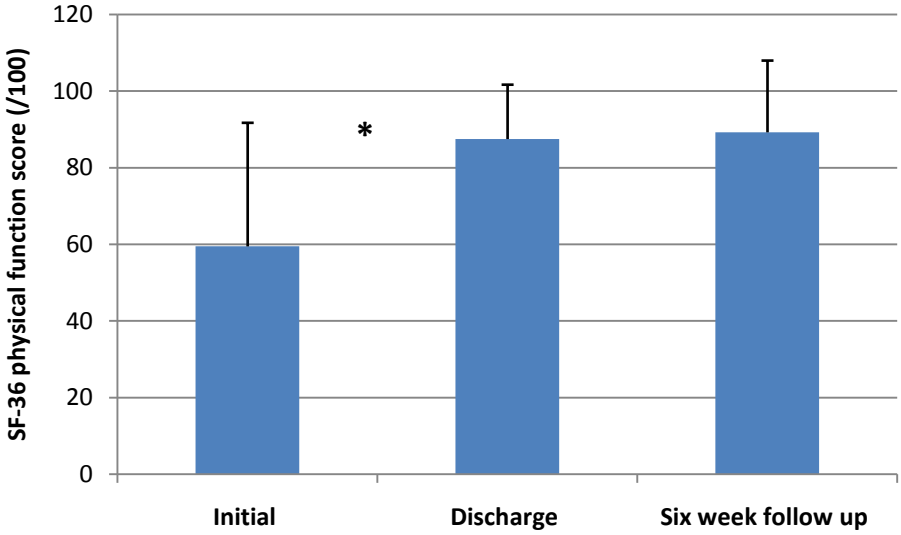

Figure 11: Mean and SD at the initial assessment, discharge and six week follow up for the SF-36 Physical Function scores (* = p<0.05).

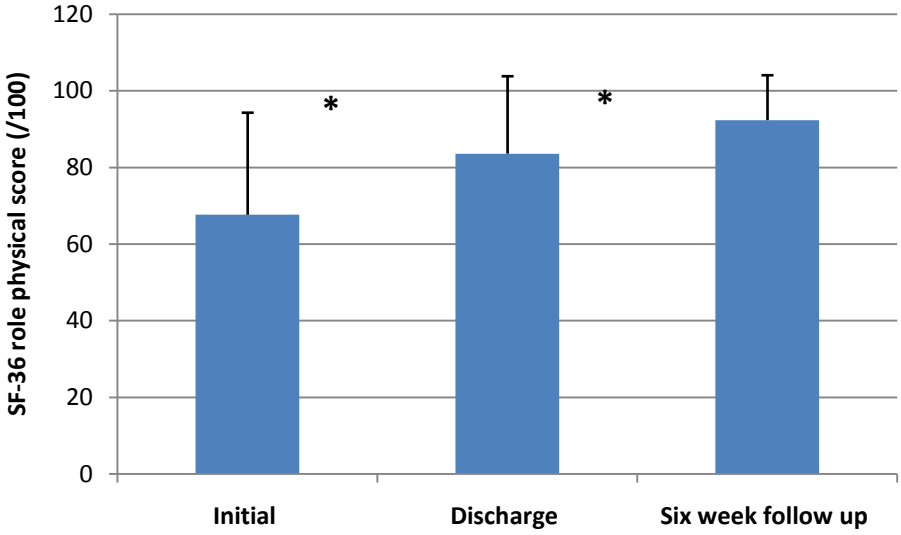

Figure 12: Mean and SD at the initial assessment, discharge and six week follow up for the SF-36 Role Physical scores (* = p<0.05).

Figure 13 shows the descriptive data at the initial assessment, discharge and six week follow up for the SF-36 Pain scores. There was a significant difference ($p<0.05$) between the mean initial score of 52.4 (SD 25.1) and the mean discharge

score of 74.2 (SD 16.5) and between the mean discharge score and six week follow up score of 79.9 (SD 14.6) with effect sizes of 1.02 and 0.36 respectively.

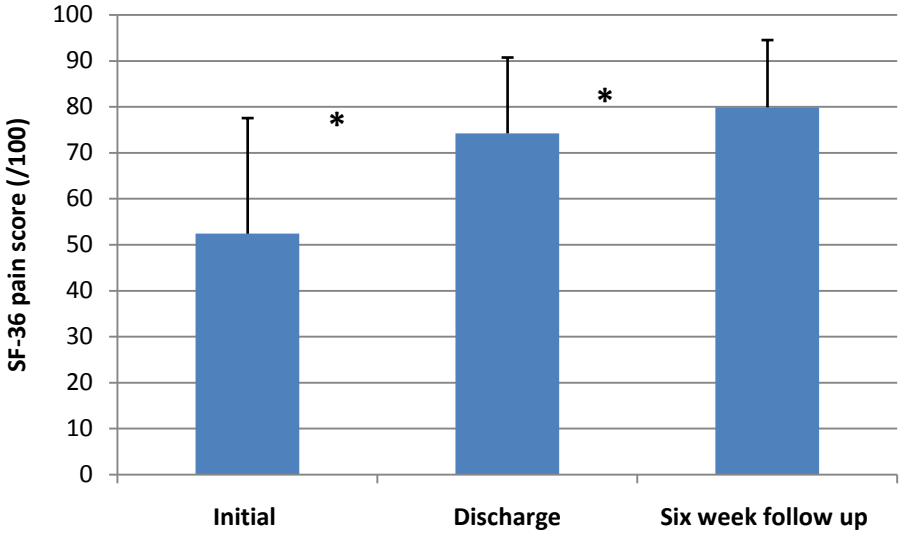

Figure 13: Mean and SD at the initial assessment, discharge and six week follow up for the SF-36 Pain scores (* = p<0.05).

Figure 14 shows the descriptive data at the initial assessment, discharge and six week follow up for the SF-36 Social Function scores. There was a significant difference ($p<0.05$) between the mean initial score of 76.9 (SD 23.8) and the mean discharge score of 85.0 (SD 17.9) and between the mean discharge score and mean six week follow up score of 89.4 (SD 15.9) with effect sizes of 0.38 and 0.26 respectively.

Table 14 shows the descriptive data at the initial assessment, discharge and six week follow up for the SF-36 General Health, Vitality, Role Emotional and Mental Health domains. There was no significant difference ($p>0.05$) between the mean initial score and the mean discharge score, and between the mean discharge score and mean six week follow up score.

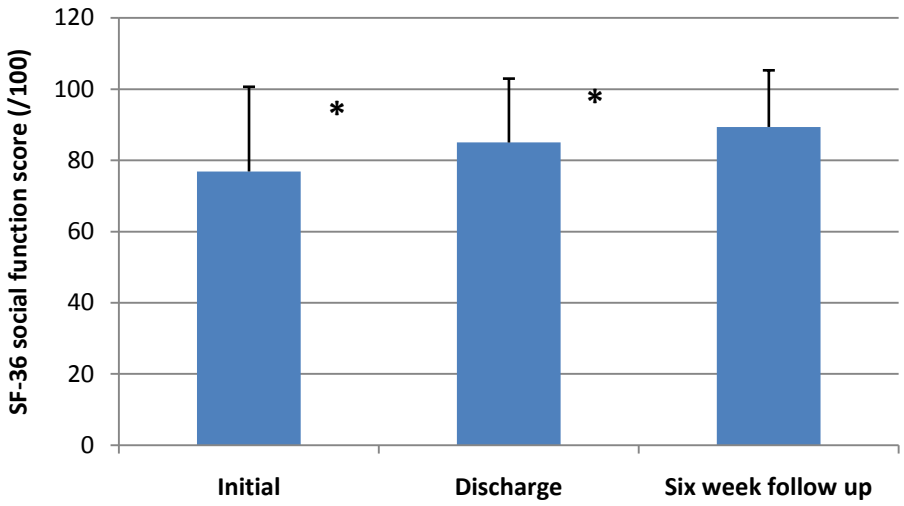

Figure 14: Mean and SD for the initial assessment, discharge and six week follow up SF-36 Social function scores (* = p<0.05).

Table 14: Mean and SD at the initial assessment, discharge and six week follow up for the SF-36 Role Emotional, Mental Health, Vitality and General Health scores.

	Initial		Discharge		Six week follow up	
SF-36 Domain	Mean	SD	Mean	SD	Mean	SD
Role Emotional	83.9	24.4	89.4	16.1	92.1	15.2
Mental Health	75.5	12.0	79.0	12.0	80.7	11.9
Vitality	58.4	17.9	61.6	15.4	64.7	13.1
General Health	75.3	18.2	72.3	16.2	74.6	16.8

Table 15 shows the descriptive data for the internal consistency of the eight SF-36 domains along with the SF-36 total score and the two domains of the LLTQ along with the LLTQ total score. Only the SF-36 Mental Health domain had a score of less than 0.7.

Table 15: Cronbach Alpha scores for SF-36 and LLTQ questionnaire totals and domains.

Question Domain (Number of items)	Cronbach's Alpha Score
SF-36 Physical functioning (10)	0.95
SF-36 Role Physical (4)	0.95
SF-36 Bodily Pain (2)	0.90
SF-36 General Health (5)	0.83
SF-36 Vitality (4)	0.78
SF-36 Social Functioning (2)	0.73
SF-36 Role Emotional (3)	0.95
SF-36 Mental Health (5)	0.60
SF-36 Total (36)	0.93
LLTQ ADL (10)	0.92
LLTQ Recreational (10)	0.93
LLTQ ADL Importance (10)	0.75
LLTQ Recreational Importance (10)	0.89
LLTQ Total (20)	0.97

Comparisons and associations between the Global VAS for pain and the SF-36 Bodily Pain domains

The comparison of Global patient VAS pain question and the SF-36 Bodily Pain subscale are shown in Figure 15. For the purposes of this analysis the Global patient VAS Pain results were recoded and converted to a percentage to be able to make an easier comparison to the SF36 Bodily Pain scale. At the initial visit, the Global patient VAS and the SF-36 had a mean score of 55.5 (SD19.3) and 52.4 (SD 25.1) respectively and were not different statistically. On discharge, the Global patient VAS mean score was 90.0 (SD 12.0) compared to the SF-36 mean score of 74.2 (SD 16.4) and the difference was statistically significant. At the six week follow up the Global patient VAS mean score was 92.5 (SD 13.7) compared to the SF-36 mean score of 79.9 (SD 14.6) and these data were statistically significant. There was no statistically significant association (Spearman rho correlation coefficient) between the Global patient VAS and SF-36 at the initial assessment ($rho=0.21$, $p>0.05$). At discharge and the six week follow up, there were low but significant associations ($rho=0.47$, 0.32, $p<0.05$, respectively).

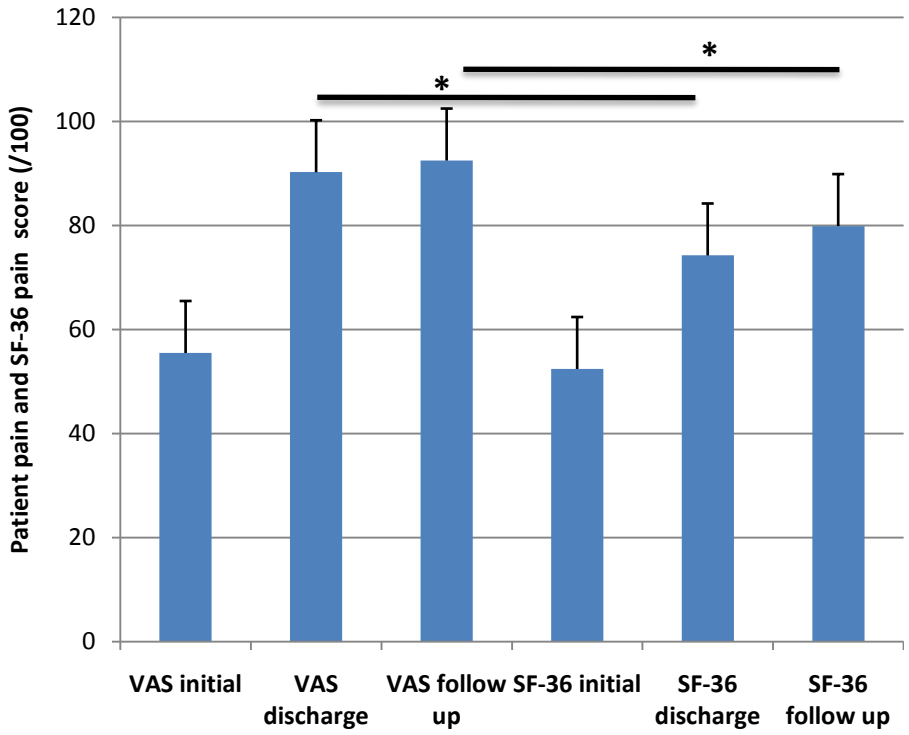

Figure 15: Mean and SD at the initial assessment, discharge and six week follow up for the Global patient VAS and the SF-36 Pain scores (* = p<0.05).

Comparisons and associations between function domains of the questionnaire

The comparisons of patient physical function relating to the Global patient limitations question, the LLTQ ADL subscale, the LLTQ Rec subscale, the SF-36 Physical Function and the SF-36 Role Physical subscale are shown in Table 16. For the purposes of this analysis the Global patient limitations results, the LLTQ ADL and LLTQ Rec subscale were converted to a percentage to be able to make easier comparisons to the SF36 Physical Function and Role Physical results. Initial descriptive analysis revealed that the data set was not normally distributed resulting in Spearman rho correlation coefficients being performed. At the initial visit, the Global patient limitations question gave a mean score of 40.5 (SD 17.7), compared to the LLTQ ADL 57.6 (SD 21.4), the LLTQ Rec 25.0 (SD 22.1), the SF-36 Physical Function 59.5 (SD 32.2) and the SF-36 Role Physical 52.4 (SD 25.1). On discharge

the Global patient limitations question mean score was 75.0 (SD 17.4) compared to the LLTQ ADL 93.9 (SD 7.8), the LLTQ Rec 74.9 (SD 19.9), the SF-36 Physical Function 87.5 (SD 14.2) and the SF-36 Role Physical 74.2 (SD 16.5). At the six week follow up the Global patient limitations question had a mean score of 85.7 (SD 13.6) compared to the LLTQ ADL 96.3 (SD 6.3), the LLTQ Rec 82.9 (SD 18.1), the SF-36 Physical Function 89.3 (SD 18.7) and the SF-36 Role Physical 79.9 (SD 14.6).

The degree of the association (Spearman rho correlation coefficients) between the Global patient limitations question and the LLTQ ADL, the LLTQ Rec and the SF-36 Physical Function varied between moderate to high (0.55-0.74) and was significant across all three time points. The Global patient limitations question and the SF-36 Role Physical were not correlated at the initial visit (0.20, $p>0.05$); however, a low but significant correlation at discharge (0.34) and the six week follow up (0.44) was observed. The degree of the association between the LLTQ ADL and the LLTQ Rec, the SF-36 Physical Function and the SF-36 Role Physical ranged from low to high (0.42-0.82) and was significant across all three time points except for the SF-36 Role Physical at the initial visit (-0.04, $p>0.05$). The degree of the association between the LLTQ Rec and the SF-36 Physical Function and the SF-36 Role Physical ranged from low to moderate (0.38-0.67) and was significant across all three time points except for the SF-36 Role Physical at initial which had little or no correlation (0.05, $p>0.05$). The degree of the association between the SF-36 Physical Function and the SF-36 Role Physical ranged from low to moderate (0.43-0.52) and was significant across all three time points.

Table 16: Spearman rho correlation coefficients scores at the initial assessment, discharge and six week follow up for Global patient limitations question, the LLTQ ADL, LLTQ Rec, the SF-36 Physical Function and the SF-36 Role Physical.

Questionnaire	LLTQ ADL	LLTQ Rec	SF36 Physical Function	SF36 Role Physical
Global patient limitations initial	0.64*	0.67 *	0.57 *	0.20
Global patient limitations discharge	0.55 *	0.64*	0.63 *	0.34 *
Global patient limitations six week follow up	0.58 *	0.74*	0.60 *	0.44 *
LLTQ ADL initial		0.82*	0.44*	-0.04
LLTQ ADL discharge		0.53*	0.58*	0.42*
LLTQ ADL six week follow up		0.62*	0.70*	0.54*
LLTQ Rec initial			0.41*	0.05
LLTQ Rec discharge			0.65*	0.38*
LLTQ Rec six week follow up			0.67*	0.46*
SF36 Physical Function initial				0.45*
SF36 Physical Function discharge				0.43*
SF36 Physical Function six week follow up				0.52*

(* = $p<0.05$)

Participant and physiotherapist perception of limitations

The comparisons of Global limitations scores between the participants and therapists are shown in Figure 16. At the initial visit, both participants and therapists had a mean score of 4.0 (SD 1.8 and 1.7 respectively) whereas on discharge the participant's mean score was 7.5 (SD 1.7) compared to the therapists' mean score of 8.5 (SD 1.3). This difference between the therapist and patient was significant ($p<0.05$) with an effect size of 0.66. At the six week follow up, the participants mean score was 8.5 (SD 1.4). Intraclass correlation coefficients across therapist and patient data at the initial assessment and at discharge were 0.72 and 0.23 respectively.

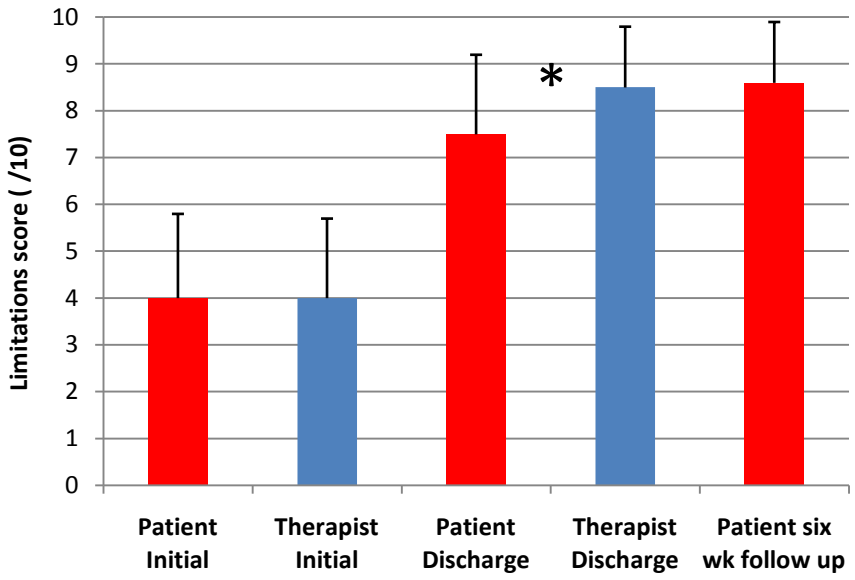

Figure 16: Mean and SD at the patient and therapist initial assessment, patient and therapist discharge and patient six week follow up for the limitations scores (* = p<0.05).

The Patient Global Overall Status showed no significant difference (p>0.05) between discharge and at the six week follow up. At discharge, 40% of participants rated themselves as 'very much improved' and 60% as 'much improved' since the start of treatment. At the six week follow up, 55% of participants rated themselves as 'very much improved' and 45% as 'much improved' since the start of treatment. Interestingly, 5% (two participants) rated themselves 'minimally improved' since the start of treatment at the six week follow up, yet at discharge these subjects had rated themselves as 'much improved'.

The Physiotherapist's Patient prognosis rating at the initial visit showed 97.5% of physiotherapists expected the participants to make a 'good to excellent' improvement in impairment and function. Only one physiotherapist expected a moderate improvement.

Impairment and performance measures

Joint position sense testing

The results for active non-weight bearing inversion/eversion joint position sense are presented in Figure 17. There was significantly less error ($p<0.05$) in the uninjured limb (mean: 1.8^0, SD 1.4) compared to the injured limb (mean: 2.6^0, SD 1.1) with an effect size of 0.63.

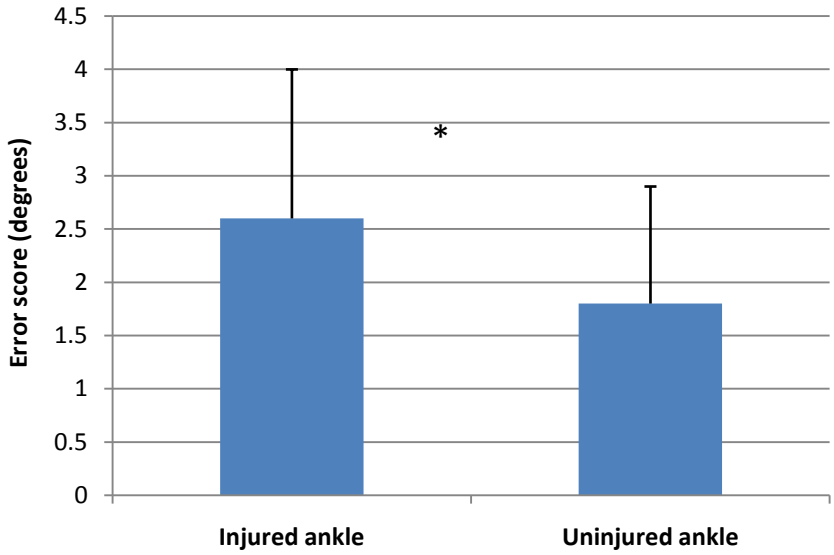

Figure 17: Mean and SD error scores for active non-weight bearing inversion/eversion joint position sense testing between the injured and uninjured ankles (* = p<0.05).

Postural control testing

The balance test investigated the force distribution in parallel stance and the tandem stance between the injured and uninjured ankles. For the parallel stance test, mean forces of 379 N (SD 80) and 382 N (SD 83) were observed for the injured and uninjured ankles respectively ($p>0.05$). For the tandem stance test mean forces of 459 N (SD 119) and 464 N (SD 100) were observed for the injured and uninjured

ankles forwards respectively ($p>0.05$). Similarly the tandem stance test mean forces of 301 N (SD 85) and 302 N (SD 74) were observed for the injured ankle backwards and the uninjured ankle backwards respectively ($p>0.05$).

The one legged stance tests were analysed by calculating the RMS of five second intervals at a dynamic phase and in a static phase (see Table 17). The only significant difference between the injured and uninjured leg was in the parallel dynamic phase ($p<0.05$) with a small effect size of 0.09.

Table 17: RMS values from the Force Plate for injured and uninjured ankles.

Balance Measurement	Mean	SD
Parallel Single Leg Uninjured (dynamic) *	11.93	4.84
Parallel Single Leg Injured (dynamic) *	11.46	5.29
Parallel Single Leg Uninjured (static)	3.09	1.61
Parallel Single Leg Injured (static)	3.07	1.62
Tandem Single Leg Uninjured (dynamic)	11.64	3.97
Tandem Single Leg Injured (dynamic)	11.16	3.89
Tandem Single Leg Uninjured (static)	2.87	1.13
Tandem Single Leg Injured (static)	3.08	1.25

RMS measured in N, * = significance $p<0.05$.

Performance testing

The results for the performance agility hop test are presented in Figure 18. There was a significant difference between the uninjured limb (mean: 10.7, SD 8.1) compared to the injured limb (mean: 14.0, SD 9.4) with an effect size of 0.37. This finding indicated that participants had greater difficulty on the injured limb.

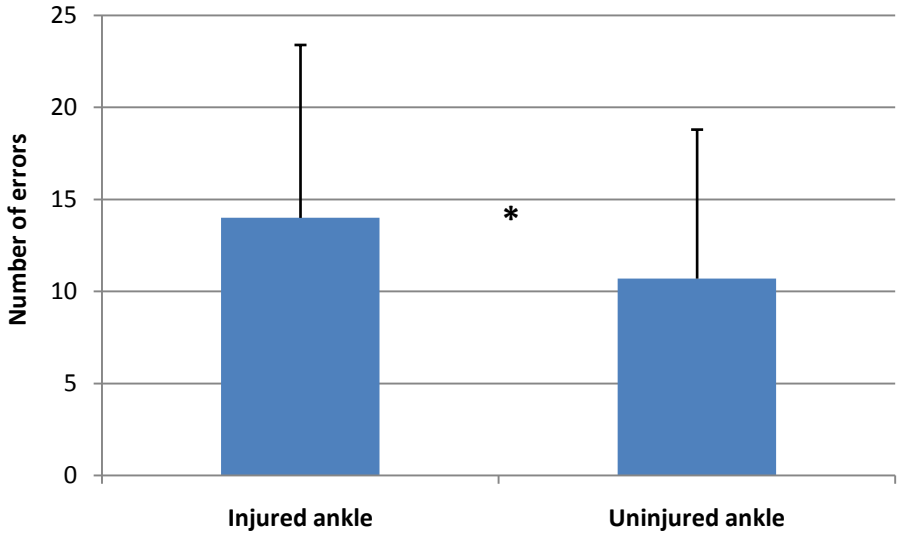

Figure 18: Mean and SD errors for the agility test across the injured and uninjured ankles (* = p<0.05).

Isokinetic strength testing

The results for concentric strength testing are presented in Table 18. There were no significant differences (p>0.05) between the injured and uninjured ankles for peak torque recorded during eversion or inversion at 60º/sec and 120º/sec. Similarly, there were no significant differences (p>0.05) between the injured and uninjured ankles for time to peak torque during eversion or inversion at 60º/sec and 120º/sec. It should be noted that only moderate reliability was shown for the time to peak torque at 120º/sec in the pilot testing.

Table 18: Peak Torque and Time to Peak Torque for eversion and inversion of the injured and uninjured ankles.

Strength Measurement	Mean	SD
Peak Torque 60º/sec eversion injured	22.42	7.19
Peak Torque 60º/sec eversion uninjured	23.62	6.78
Peak Torque 60º/sec inversion injured	27.68	9.98
Peak Torque 60º/sec inversion uninjured	26.84	9.98
Time to Peak Torque 60º/sec eversion injured	0.28	0.09
Time to Peak Torque 60º/sec eversion uninjured	0.29	0.10
Time to Peak Torque 60º/sec inversion injured	0.28	0.08
Time to Peak Torque 60º/sec inversion uninjured	0.29	0.13
Peak Torque 120º/sec eversion injured	19.41	5.82
Peak Torque 120º/sec eversion uninjured	20.49	5.63
Peak Torque 120º/sec inversion injured	24.95	8.61
Peak Torque 120º/sec inversion uninjured	23.68	8.69
Time to Peak Torque 120º/sec eversion injured	0.17	0.08
Time to Peak Torque 120º/sec eversion uninjured	0.18	0.07
Time to Peak Torque 120º/sec inversion injured	0.16	0.07
Time to Peak Torque 120º/sec inversion uninjured	0.17	0.07

NB: Peak Torque was measured in Nm and Time to Peak Torque measured in seconds.

Associations between and impairment and performance measures

Correlation coefficients were performed to investigate associations between the percentage differences of the joint position sense scores, and the mean difference of the agility scores. There were no associations of significance found between these two impairment measures. Note, while the difference in the parallel dynamic phase of the postural balance test was significant, there was such a small effect size that it was not considered sufficient to include in the analysis.

Associations between questionnaire scores and impairment and performance measures

With respect to associations between the questionnaire scores and the four measures of proprioception, balance, strength and agility performance there were no

statistically significant findings ($p>0.05$) across any of these analyses. Furthermore there was no systematic direction in the difference between whether participants scored high or low on the questionnaire scores and whether they scored high or low in relation to impairment scores ($p>0.05$).

Performance of specific activities that participants perceived as most difficult at six weeks following discharge

Figure 19 shows the results for the discharge, six week follow up and the remark scores following the performance of the two specific tasks that the participants had highlighted from the LLTQ. The total score (/8) was calculated from the two tasks that the participant identified as potentially the most difficult and the most important to them at the six week follow up. There was no significant difference ($p>0.05$) between mean discharge of 5.7 (SD 1.5) and the mean six week follow up score of 5.6 (SD 1.1). However, there was a significant difference ($p<0.05$) between the mean six week follow up score of 5.6 (SD 1.1) and the mean remark score following actual performance of the task of 7.25 (SD 1.0) with an effect size of 1.58.

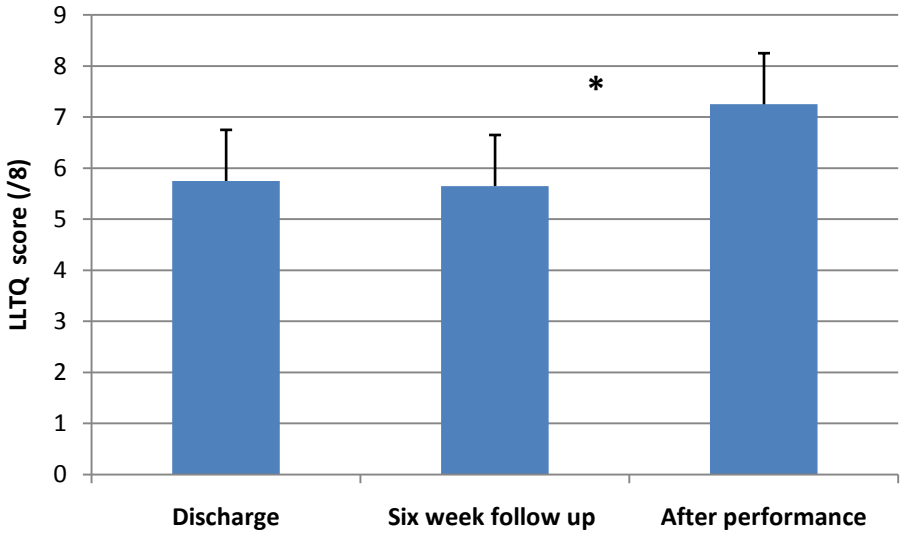

Figure 19: Mean and SD scores for the two LLTQ questions identified as most difficult at discharge, six week follow up and after performance of the tasks (* = p<0.05).

Previous injury

Comparisons were made regarding the participant's previous injury status compared to the questionnaire scores and the four measures of proprioception, balance, strength and agility. No results attained statistical significance across any of these analyses. Specifically, there was no difference between participants who had sustained a previous injury or not and whether they scored high or low on the questionnaire scores. Additionally there was also no difference between participants who had sustained a previous injury or not and whether they had an impairment or not.

Chapter 5: Quantitative Discussion

This chapter contains the discussion related to the quantitative findings from the study. Firstly the demographics of the participants are discussed followed by the discussion related to the results of the six questions posed in Chapter one of this study.

Demographics

The literature concerning the treatment of sprained ankles and in particular the interaction of the physiotherapist and the patient focuses largely on a limited number of populations. In particular students and athletes are the common source of participants in studies examining ankle sprains and physiotherapy interventions. Thus, the opportunity to generalise the findings to a sample of patients from a general clinical practice was somewhat limited. Of the forty one studies reviewed with respect to ankle impairment and performance measures, eighteen studies selected subjects from athletic teams or college and universities. Only five studies specifically identified subjects from the general practice population. Thus a strength of the current study is that results are likely to be more generalisable and relevant to the general practice population. When comparing studies that have undertaken similar testing, it was found that the mean age of the participants for the current study (30.5 years) was older than most of the reviewed studies. With respect to the BMI, the mean (27.5) was at the upper end compared to other studies indicating that these participants were bordering upon being overweight (Utter, Scragg, Denny, & Schaaf, 2009). The right ankle was injured in 24 (60%) participants which compares

to Evans (2004) study (60%). The recurrence rate of ankle sprains was high with 35% of participants having a previous sprain and a number of participants reporting repeated sprains. Van Rijn (2008) reported similar recurrence rates in a systematic review. The participant's dominant leg was also more frequently injured (95%). This finding has not been widely reported. While this study investigated acute ankle sprains, the mean time between the initial visit and the six week follow up was 157 days. This places the participants in the latter stages of tissue repair, (ie. greater than three months since injury), at the time of testing.

Questionnaires

Are there differences and associations between outcome questionnaires that investigate similar domains of pain and function with regard to the participant's perception at the initial assessment, discharge and six week follow up visits?

Global questionnaires are often used to compare psychometric properties of questionnaires. They have been used to assess responsiveness against other outcome questionnaires where they are used as an anchor (Cross et al., 2002; Kelleher et al., 2004) and to test concurrent validity (Hiller et al., 2006). The rationale for using the global questionnaire was to compare the results against the LLTQ and the SF36. While the SF-36 has been used extensively with respect to musculoskeletal conditions, the LLTQ questionnaire is less well known and it was therefore considered useful to use a Global questionnaire alongside these questionnaires.

The results of the Global patient limitations question that related to functional activities showed a significant improvement from the initial to discharge scores and a further significant difference between discharge and the six week follow up scores. The implications for this finding are that patients' activities of function continue to

improve after discharge. This finding has not been widely reported. Only two reviewed studies (Airaksinen et al., 2003; Cross et al., 2002) used a global scale of function to measure over time. Airaksinen and co-workers (2003) found a significant difference between groups for both treatment interventions and over time. Cross and co-workers (2002) found a significant difference over time for the score related to function. Karlsson (1991) used a global VAS to identify patients' ankle joint function. However, this study did not use any specific criteria other than 'normal ankle joint function' to 'total ankle joint dysfunction'. Additionally, Olerud and Molander (1984) used a global functional scale to compare against a newly developed scoring tool; however, this scale was not measured over time.

The results of the Global pain question showed a significant improvement from the initial to discharge scores, but no significant difference between discharge and at the six week follow up. This finding is in keeping with previous reviewed research (Airaksinen et al., 2003; Borromeo et al., 1997; Cross et al., 2002; Koll et al., 2004; Zammit & Herrington, 2005). The result is perhaps not surprising and one that could be the expected result for an acute soft tissue injury due to the effect of time for natural healing to occur. Additionally, if therapists are using pain scores as discharge criteria then this finding would indicate that this may be appropriate.

Of note, while there was no significant difference found for pain between discharge and the six week follow up scores, there was a significant difference found for the limitations in function between these two times. This finding suggested that a combination of outcome measures need to be considered when assessing patients at discharge and that using only one measure may be inappropriate.

With respect to the LLTQ results, there was a significant difference between the initial score and the discharge score, and between the discharge score and six

week follow up score for both the Activities of Daily Living and the Recreational components of the questionnaire. As this is a relatively new questionnaire, this finding has not been previously reported with respect to ankle sprains. It is of note that participants still recorded a significant improvement between discharge and the six week follow up in both Activities of Daily Living and the Recreational components of the questionnaire. While the more difficult Recreational activities were expected to continue improving following discharge, it is perhaps surprising that the more general Activities of Daily Living remained difficult to perform at discharge.

An additional component of the LLTQ questionnaire is the importance section of the questionnaire. This component allows the participant to self rate the importance of particular functional activities. This has the advantage of identifying activities that the participant may value more than others. While the participant may rate the functional question of 'kicking a ball' as impossible to do, they also have the ability to identify that this activity may not be important to them. This allows the therapist to focus the rehabilitation process on activities that are both difficult and important to the participant. The results from this study found that there was not a significant difference in the overall importance rating between the initial, discharge and six week follow up for both the ADL and recreational activities. The relevance of the importance section has not previously been reported in relation to ankle injuries. Of note, the overall scores for the importance section (28-29/40) are a reflection that the specific items were relevant to the individual. This finding suggests that questionnaires that include assessment of importance allow therapists to appreciate whether a specific questionnaire is appropriate for a particular patient. A

low importance score would suggest that the questionnaire contains tasks that are not relevant to the patient.

With respect to the total SF-36 questionnaire scores, there was a significant difference between the initial score and the discharge score, and between the discharge score and six week follow up score for the total percentage scores. The nine reviewed studies that used the SF-36 questionnaire did not compare the total SF-36 score, preferring to compare the subscales of the SF-36.

With respect to musculoskeletal injuries the most utilised subscale of the SF-36 is the Physical Function subscale (Ware et al., 2002). The SF-36 Physical Functioning subscale found a significant difference between the initial and discharge score but no significant difference between discharge and six week follow up. The difference between the initial and discharge scores compares favourably with one study that investigated acute ankle sprains (Cross et al., 2002). Comparisons of the other studies that reported on the SF-36 Physical Functioning subscale were not relevant as they investigated chronic ankles, ankles following surgery or ankle fracture. There were no studies that reviewed a similar timeframe between discharge and a six week follow up for acute ankle sprains. With respect to this study, the SF-36 Physical Function subscale did not show a difference between discharge and the six week follow up. The questions that comprise the SF-36 Physical Functioning subscale would be classified as a combination of activities of daily living and recreational functional activities; however, the questions relate to the participant's 'health' rather than specifically related to the ankle. Furthermore, some of the questions have little relevance to ankle function. This lack of clarity may be one reason why the findings of the SF-36 Physical Functioning subscale are in contrast to

the LLTQ and the Global limitations question results for the time between discharge and the six week follow up.

The SF-36 Role Physical subscale showed a significant difference between the initial and discharge score and between discharge and six week follow up. The SF-36 Role Physical subscale asks questions specifically relating to the impact of daily activities on 'physical health' rather than the more general 'health' as the SF-36 Physical Functioning subscale does. As a result, participants may have been able to better relate these questions to their ankle injury as opposed to the SF-36 Physical Functioning questions. Comparisons to other reviewed ankle studies were not possible as no other studies presented results for similar timeframe or outcomes. This finding again adds further evidence that the participant's perception continues to improve following discharge with respect to functional activities.

The SF-36 Pain subscale scores found a significant difference between the initial score, the discharge score and the six week follow up score. Once more no comparisons could be made to other reviewed ankle studies as no studies presented results for similar timeframe or outcomes. The SF-36 Social Function subscale showed a significant difference between the initial score, discharge score and six week follow up score. No comparisons could be made to other reviewed ankle studies as no identified studies presented results for similar timeframe or outcomes. The findings of a significant improvement for social function across the three time points lends further support that participants continue to improve after discharge. The three remaining SF-36 General Health subscales, Vitality, Role Emotional and Mental Health did not find a significant result across the three time points. It is possible that these three domains are not affected in an ankle sprain. Cross and co-workers (2002) used the SF-36 when investigating acute ankle sprains; however,

only reported on the SF-36 Physical Functioning subscale. Previous authors have only used the SF-12 to measure ankle sprain (Evans et al., 2004). The SF-12 is a modified version of the SF-36 with an emphasis on general health related functioning and does not investigate mental health issues (Ware et al., 1996). It would be reasonable to suggest that aspects of vitality, emotional and mental health may not be compromised in participants suffering an acute ankle injury. The results from this study provide support that it may be unnecessary to use the full version of the SF-36 when investigating acute ankle sprains.

The moderate to high Cronbach Alpha scores for the SF-36 and LLTQ Questionnaires suggests that the questionnaire domains have satisfactory internal consistency in relation to this ankle population. Only the SF-36 Mental Health domain had a score of less than 0.7 which may indicate that questions relating to mental health may not have relevance to patients suffering from an ankle sprain.

Comparisons and associations between questionnaire domains

Comparison of the Global patient pain VAS and the SF-36 Pain subscale provided useful information. The Global patient pain VAS showed a significant difference between initial and discharge scores but a stable score between discharge and six week follow up whereas the SF-36 Pain subscale found a significant difference across all three time points. The degree of association between the Global patient pain VAS and the SF-36 Pain at initial visit was small (rho=0.21) and was not significant suggesting that the SF-36 pain subscale may not be as useful for acute injuries. This difference is likely to be due to the Global patient pain VAS measuring pain over the preceding 24 hours whereas the SF-36 Pain subscale measures pain over the past four weeks. Previous authors have identified the ‘four week’ questions as problematic when using the SF-36 for acute injuries (Keller et al., 1999;

Klevsgard et al., 2002). Additionally there was low but significant association between the Global patient pain and the SF-36 Pain scores at the discharge and the six week follow up. There were no studies identified that compared the SF-36 and a Global patient pain questionnaire. The findings from this study suggest that a Global patient pain VAS may be more sensitive to changes in pain for acute conditions.

With respect to the comparisons of questionnaire functional domains the findings demonstrated that the Global patient limitations question, the LLTQ ADL, LLTQ Rec and the SF36 Physical Function had moderate and significant correlations across all three time points, except for the LLTQ ADL and the SF36 Physical Function and the LLTQ Rec and the SF36 Physical Function at the initial visit, which had low but significant correlations. Only one study (Cross et al., 2002) was identified in the literature review that compared functional questionnaires. The authors compared a global functional question and the SF-36 Physical Function scale and found there was a significant relationship between these two questionnaires and days to return to sport between initial and discharge.

It is also worth noting the SF-36 Role Physical had little or no correlation to the Global Patient Overall condition question, the LLTQ ADL and the LLTQ Rec at the initial visit. This poor correlation is likely be due to the fact that the SF-36 Role Physical asks questions related to the previous four weeks and therefore is unlikely to be as relevant in an acute injury state.

Clinicians and researchers need to take care in assuming that similar domains across questionnaires will provide similar information. Examination of the LLTQ ADL and LLTQ Rec domains reveal questions that ask about distinctly separate tasks and activities whereas within the SF-36 Physical Function scale, five of the ten questions relate to walking a distance and climbing stairs which could be considered

similar tasks. Different items are given the same weighting, but are likely to have considerably different values for the patient. While questionnaire scores are likely to demonstrate change between the initial treatment and discharge, how meaningful and relevant this is to the patient needs to be addressed. The outcome score may never be a fair reflection of what the patient is actually experiencing particularly in relation to activities concerning function. There is a risk that interpreting a significant change in scores indicates that there has been an equivalent improvement in the patient's perception of their injury. The results from this study have demonstrated that while there was a significant change with regard to improvement across the three measurement points and participants scored highly at discharge, this did not always have a strong correlation across scores of similar domains. Also of interest is that participants continued to demonstrate improvement in scores related to function after discharge. Furthermore, care needs to be taken when choosing specific outcome questionnaires related to measuring function and considering the time since injury

There are vast arrays of outcome measurements available in relation to ankle sprains interventions as has been demonstrated in the literature review. The dilemma the practitioner or the researcher has is which outcome measure or tool to use. Numerous studies have concluded that to improve future research around the area of outcome measurement standardised measures need to be used to allow for comparisons. However, understanding the limitations of particular questionnaires needs to be considered when deciding what particular questionnaire to use. With respect to the SF-36, one of the most widely used outcome questionnaires in musculoskeletal research and a questionnaire that is often used to validate new questionnaires, this study has identified that caution should be exercised in accepting the SF-36 as the benchmark particularly in relation to acute ankle sprains.

The results from this study of the comparison of the LLTQ to the Global patient limitations question and the SF-36 provides support that the LLTQ may be a useful questionnaire to measure functional perception for an acute ankle population. This finding has not previously been reported for an acute ankle population.

Participant and physiotherapist perception of limitations

Do participants and physiotherapists have a similar perception of limitations in function, at initial assessment and discharge?

Studies comparing therapists and patients perceptions of the functional limitations of a musculoskeletal injury at discharge have not been widely reported. In particular a search of the literature failed to identify any studies that compared physiotherapists' and patients' perceptions of their functional ability with respect to ankle sprains. This study found that on a global questionnaire score, participants and physiotherapists have a similar appreciation of the limitations of the participants' ankle sprain on initial examination. However, at time of discharge there was a significant difference between the physiotherapist and participant scores. The fact that the physiotherapist rated the overall condition of the ankle as a greater improvement than the participant is noteworthy. Of particular note there was moderate to strong correlation between the participant and physiotherapist scores at the initial visit but weak correlation for the discharge scores. This would indicate that there is a far greater disparity at discharge between the physiotherapists' and participants' perceptions of recovery. Clearly physiotherapists have a different perception of the recovery of the injured ankle from the participant. Factors that contribute to physiotherapists making discharge decisions in relation to ankle sprains have not been reported. The physiotherapist is likely to make the discharge decision

based upon a number of factors. They may have considered measures such as pain, swelling and gait and have asked the participant how they felt. The physiotherapist may have decided, based upon their past experience, that they had no further ability to influence the recovery of the ankle with the available treatment techniques. Additionally, it is unknown if the physiotherapists in the current study made use of other questionnaires to influence their discharge decision. They did not have access to the participants' discharge questionnaires as these were sent and completed at the participants' homes after they had been discharged. It is unknown if the physiotherapists were aware that a less that optimal score had been attained at discharge. Previous authors (Abrams et al., 2006; Huijbregts et al., 2002) have identified the reluctance of physiotherapists to use outcome questionnaires. This study did not investigate what factors influenced the discharge decision, but this is an area that is worthy of further research. What is of note is that whatever criteria the physiotherapists used did not match the participant's perception at discharge. It was not until at least six weeks following discharge that the participant's limitations score matched the physiotherapist's discharge score. This finding has important clinical implications and is further evidence that therapists may be discharging patients with a less than optimal functional perception of their recovery.

The third participant global question in this study related to the overall improvement status of the participant's condition since the start of treatment. The results indicate that participants rated their status as 'much improved' to 'very much improved'. This improvement in status could be expected with the normal recovery time of a soft tissue injury. This question was only asked at discharge and the six week follow up. There was no significant difference found between these two times. Of interest is that the overall status score was stable across these two time points in

contrast to the participant's rating of their limitations which continued to improve. This would suggest that a functional limitations question is likely to be more sensitive to measure continued improvement following discharge and may be more useful in assessing patients' perception of their abilities.

The physiotherapist's patient initial prognosis rating indicated that the physiotherapist expected the participant to make a good to excellent recovery. This score indicates that the therapist has a high expectation of a near full recovery for this particular injury. This may indicate that therapists have an expectation that most ankle sprains will make an uneventful recovery. This expectation may be based upon the physiotherapist's experience or knowledge of the normal recovery time for this injury. However, how this may have an influence on the therapist's discharge understanding is unknown.

Using outcome scores to help decide discharge criteria should be treated with caution. As this study has demonstrated participant's scores continued to improve following discharge. As previous authors have highlighted, patients discharged from hospital settings with musculoskeletal conditions had the lowest satisfaction of any condition (P. A. Clark et al., 2005). While participants' satisfaction levels were not investigated in this study the fact that the participants' discharge scores continued to improve in a number of areas would suggest that care needs to be taken in interpreting appropriate discharge criteria. What has still not been answered is, what is an appropriate attained questionnaire score for a patient to be discharged with the knowledge that they have recovered sufficiently to undertake their normal functional activities?

Impairment and performance measures

Are there deficits in and associations between measures of proprioception, balance, agility and strength across injured and uninjured limbs at six weeks following discharge from treatment for an ankle sprain?

Measuring impairments in the rehabilitation of ankle sprains has been considered an important aspect of outcome measurement as they are thought to influence function (Freeman, 1965; Garn & Newton, 1988; Hertel, 2002; Tropp, 1986). The literature review highlighted that changes in impairments have not been consistently reported. The current study's results for the four selected physical impairment and performance tests are discussed below.

Joint position sense testing

A loss of proprioception has been identified as one of the residual disabling factors following ankle sprain (Refshauge, 2003). Joint position sense is one method used to measure impairment in proprioception. This study investigated active non-weight bearing inversion/eversion joint position sense. The results found significantly less error in the uninjured limb compared to the injured ankle. These results are similar to nine reviewed studies (Boyle & Negus, 1998; Fu & Hui-Chan, 2005; Glencross & Thornton, 1981; Konradsen et al., 1998; Lentell et al., 1995; Refshauge et al., 2003; Sekir et al., 2007; Waddington & Adams, 1999; Willems et al., 2002) that found a significant difference between the injured over the uninjured ankle for joint position sense. The effect size (0.63) found in this study compares with the effect sizes found in the above studies (0.40 – 3.93). The mean difference found in the present study of 0.8^0 between the uninjured and injured ankles also compares with the mean differences of the previous studies (0.3^0 – 4.0^0). The current

study results have provided further evidence that joint position sense is affected following an ankle sprain. What remains unclear is how clinically relevant is this degree of loss.

Of note, only one of the above studies (Waddington & Adams, 1999) investigated active joint position sense; however, this study tested participants in a weight bearing position. Additionally only one of the above studies (Refshauge et al., 2003) tested inversion and eversion. The present study investigated participants at a minimum of six weeks following discharge from physiotherapy. This placed the majority of participants in the latter stages of repair (Hubbard & Hicks-Little, 2008). Apart from one study (Konradsen et al., 1998) that investigated subjects at day one of injury and one study (Waddington & Adams, 1999) that did not state the time since injury, the remaining seven studies all investigated chronic ankle injuries. The present study included subjects with a mean age of 30.5 years of age. Two of the above studies (Konradsen et al., 1998; Waddington & Adams, 1999) had participants with a mean age of 28 years, while the remaining studies had participants with a mean age of 25 year or under. A number of previous studies have specifically excluded subjects over 25 years of age due to evidence showing that balance and proprioception naturally decline after this age (Glencross & Thornton, 1981; Rose et al., 2000). However, this restriction makes any findings limited when attempting to generalise to the wider population. The present study provides evidence that joint position sense is affected across a wider age range and these findings are more likely to be applicable to a general practice population.

Some caution needs to be considered with regard to the present findings and the reviewed studies as no studies have been consistent in design, with variations in direction of movement and variation in active and passive movement tested.

However, this study provides further evidence that at the latter stage of repair, joint position sense is affected following an ankle sprain. Despite this growing body of evidence that there is a deficit in joint position sense, how this relates to ankle function and residual or continuing ankle dysfunction is unknown. What remains unclear is if there would be benefit in focusing more attention upon improving the loss of joint position sense. Additionally, although the literature provides some evidence that a rehabilitation programme may reduce this joint position sense deficit how this affects recurrence of ankle sprains also remains unknown.

Postural control testing

A decrease in postural control or balance has been identified as a possible complication following an ankle sprain (Hertel, 2002). This study investigated two aspects of postural control: force distribution in two legged parallel and tandem stance between the injured and uninjured ankles and one legged stance in both parallel and tandem starting positions. The one legged stance recorded a dynamic phase or 'takeoff' component and a static phase or 'stable' component in both parallel and tandem stance.

The results showed no significant difference in force distribution between the injured or uninjured leg in either parallel or tandem two legged stance. This finding has not been previously reported. The finding provides evidence that participants were able to distribute weight evenly in a relatively passive resting state. With respect to two legged postural control following ankle sprain, only three studies were identified that investigated this parameter (Bernier et al., 1997; Fu & Hui-Chan, 2005; Rose et al., 2000). Both Rose (2000) and Bernier (1997) found no significant difference between postural sway index while the remaining study (Fu & Hui-Chan, 2005) measured sway angle in a sensory organisation effect and found a significant

difference between the injured and uninjured ankles. The rationale for investigating force distribution between the injured and uninjured ankles in two legged stance was to identify if participants favoured one leg over the other in normal stance. The findings of this study suggest that subjects recovering from ankle injuries do not favour one leg over the other in either parallel or tandem two legged stance.

With respect to single leg static balance, there was no significant difference between the injured and uninjured limb in either parallel or tandem stance. These results differ from the findings of the literature review, which found weak evidence for deficits in both acute and chronic ankle injuries. However, the current findings lend support to a recently published systematic review (McKeon & Hertel, 2008) that investigated postural control in acute and chronic ankles sprains. The authors concluded that impairments in chronic ankle sprains have not been consistently reported. The inconsistency in reporting of postural control in the chronic stage may be due to the variation of testing procedures and the different outcome measures utilised.

While static testing is used as an assessment of balance, how this relates to everyday function is less clear. It has been suggested that dynamic movement testing may yield more useful information relating to everyday functional tasks such as walking (Jonsson et al., 2004). It has been further suggested that the first 5 sec of weight transference is the most crucial for one legged balance (Jonsson et al., 2004). However, this aspect has received little attention in the literature, with a number of studies specifically ignoring the first 5 -10 secs of balance testing. This study also investigated both parallel stance and tandem stance. While parallel stance is accepted as an assessment for balance and has been used in many studies it has been suggested that tandem stance may be a more useful functional stance (Jonsson et al., 2005). In

tandem stance the subject has a narrower base for support and has to move forward to gain balance similar to a normal walking pattern.

The only finding of significance for either the parallel or tandem one legged stance results was between the injured and uninjured leg at a parallel dynamic phase. The clinical significance of the difference found between the injured and uninjured leg at a parallel dynamic phase is unclear. From the results it would appear that in fact the uninjured leg was worse than the injured leg. It is worth noting; however, that this result had only a small effect size (0.09). This result was surprising. Consideration was given to the fact that the uninjured leg was predominantly the non-dominant leg in participants and hence may not have as good postural control. However, the pilot testing showed that leg dominance is not a factor with respect to postural control. Thus this result is likely to be a Type I error due to the number of statistical tests undertaken.

Jonsson and colleagues (2004) have previously investigated a dynamic takeoff phase in relation to postural control; however, the participants in this study were from a healthy young and elderly population that did not have an ankle injury. Only three of the reviewed studies (Bernier & Perrin, 1998; Bernier et al., 1997; Fu & Hui-Chan, 2005) investigated dynamic activity in subjects with an ankle injury. Both studies by Bernier and colleagues (1998; 1997) tested subjects with a moving force plate and found no significant difference between limbs, while Fu and colleagues (2005) used a moving sway referenced visual surrounding and found a significant difference in one of the four sway test positions. The rationale for investigating a dynamic takeoff phase was to identify if subjects with an ankle injury were more unstable during this phase of movement.

The literature review did provide some evidence that a rehabilitation programme may be of some benefit in improving postural control in the acute stage. Three of the five reviewed studies that investigated acute ankle sprains initially found a significant difference between the injured and uninjured ankle (Hertel et al., 2001; Holme et al., 1999; Leanderson et al., 1999). However, at follow up this difference was not maintained. As the participants in this study had all undergone a physiotherapy rehabilitation programme it is possible that any postural deficits may have been resolved with the rehabilitation that participants had received. However, the type of rehabilitation that participants received was not considered in this study. The findings from the current study suggest that postural control is not a problem at this stage of the rehabilitation process.

Isokinetic strength

Muscle weakness particularly of the evertors has long been identified as an impairment following an ankle injury (Bosien, Staples, & Russell, 1955; Freeman, 1965). The results of the study showed there was no significant difference between the injured and uninjured ankle for concentric peak torque at either joint angular velocity. Similarly, there was no significant difference between the injured and uninjured ankle for time to peak torque.

Seven other studies investigated the strength of subjects within the subacute to chronic stage of rehabilitation. Five reviewed studies (Leanderson et al., 1999; Munn et al., 2003; L. Ryan, 1994; Sekir et al., 2007; Wilkerson et al., 1997) reported a significant difference between the injured and uninjured ankle. In contrast, four reviewed studies (Kaminski et al., 1999; Lentell et al., 1995; Lentell et al., 1990; McKnight & Armstrong, 1997) found no significant difference in peak torque between the involved and uninvolved ankle.

The literature provides some evidence that a strengthening intervention programme may be of some benefit in improving peak torque. As the participants in this study had all undergone a physiotherapy rehabilitation programme it is possible that strength deficits may have been improved with the rehabilitation that participants had received. This may have resulted in the non significant findings.

While this study did not identify weakness involving the ankle invertors or evertors, participants commented that following discharge they still perceived and felt as though their ankle was weak. This 'feeling' of weakness is a complex problem and is likely to involve more than just problems in muscle strength.

Performance testing

Agility exercises have been identified as one method to test functional performance activities in relation to ankle injuries. Testing activities of function has been identified as the recommendations of the WHO (World Health Organization, 2001). The results of the current study showed that there was a significant difference in the number of errors between the injured and uninjured ankle with a small effect size (0.37). Within the literature, three studies (Eechaute et al., 2008; Johnson & Stoneman, 2007; Sekir et al., 2007) found a significant difference between the injured and uninjured ankle for the hop test. These findings were in contrast to four studies (Buchanan et al., 2008; de Noronha et al., 2007; Demeritt et al., 2002; Munn et al., 2002) reviewed that did not find a difference between the injured and uninjured ankle. Only one study (Demeritt et al., 2002) measured errors in the hop test. An advantage of the hop test utilised in the current study is that it can be applied in a clinical setting without the need for expensive equipment or time consuming analysis. Demeritt and co-workers (2002) identified errors via a videotape analysis,

whereas this study relied on the researcher's observations. A video analysis is likely to be more accurate; however, this may not be practical in the clinical environment.

Associations between and impairment and performance measures

While a performance hop test incorporates a number of impairments which might hamper performance, the relationship has not been formerly tested in many studies. Although it is a task that does include a number of constructs such as balance, proprioception and strength it is still just a single task and does not necessarily reflect activities in which the patient might normally engage.

In the current study investigations of associations between the joint position sense scores and the performance scores revealed no significant association. This finding is supported by the only study that was identified that compared a performance measure against impairment measures (Sekir et al., 2007). The authors reached a similar conclusion that there was no correlation between proprioceptive measures and functional hop tests. These two findings suggest that having an impairment deficit bears no relationship to having a performance deficit. The lack of associations may be that patients develop other means such as increased hip or knee proprioception or strength to compensate for impairments around the ankle. As this has not been widely reported further investigation into this aspect would be useful.

Associations between questionnaire scores related to function and impairment measures

Are there associations between questionnaire results related to function and impairment measures (the latter measured by percentage of deficits across limbs at six weeks following discharge from treatment for an ankle sprain)?

Few studies have considered the relationship between self-reported questionnaires and impairment measures. With respect to the questionnaires scores concerning function and the deficit levels observed in the four measures of joint position sense, postural control, isokinetic strength and performance agility testing, the current study found there were no significant associations. Of the ten studies identified in the literature review that investigated associations between questionnaires and impairment or performance measures, four studies (Cross et al., 2002; Evans et al., 2004; Hubbard et al., 2007; Pugia et al., 2001) reported little to moderate correlations (0.40-0.73). The remaining six studies reported similar findings to the current study.

Performance of specific activities that participants perceived as most difficult at six weeks following discharge

Do participant's perceptions of ability to perform physical tasks change after performing the tasks?

The effect of performance on the participants' perception of function was notable. There was a statistical significant improvement in perception of difficulty after completing the task. No participants scored themselves lower after performing the functional tasks. Munn and co-workers (2002) have reported perceived functional deficits from self-report questionnaire scores did not match results from functional performance tests. Thus the current findings lend further support to the notion that patients have a difference between perceived function and actual function in relation to tasks. This finding has clinical relevance with respect to discharge criteria. There may be value in identifying activities that patients deem to be difficult and then have

them undergo these tasks in a controlled situation prior to discharge. Of interest, balancing on one leg for 10 secs was one question within the LLTQ and was an identified task that a number of participants rated as still being difficult at testing. However, after undergoing the postural control tests and performing the task participants all indicated an improved score. The implication of this finding is that there may be value in ensuring patients perform balance activities prior to discharge and that they have an appreciation of their level of ability for this task. While this study confirmed that participants' perception improved immediately upon undertaking the activity it is unknown if this perception is maintained after leaving the testing environment, and perhaps is transferred to that of other tasks overall. This finding is worthy of further research.

Previous injury

Do participants who have had a previous ankle injury have differences in questionnaire scores and impairment measures from participants with a first occurrence of an ankle injury?

An investigation of participants who had sustained previous ankle sprains to those who were first time ankle sprains found that there was no association between whether participants had impairment or not. This finding would suggest that having a previous injury does not indicate that the patient is likely to have any greater impairment at discharge than someone who has a first episode of ankle sprain. No studies were identified that commented on differences between patients with a first time sprain compared with patients with multiple sprains.

Limitations

As with any study there a number of limitations that have been identified. The first is the physiotherapist level of clinical experience. No attempt was made to identify the range of experience. This may have resulted in more experienced physiotherapists discharging patients at a different recovery level. However, as participants were treated in large clinics many participants were treated by several physiotherapists during their treatment. Consideration was given to requesting that only one physiotherapist be the treatment provider. However, in preliminary discussions with clinic principals, this was considered an impediment to the study being undertaken in the clinics. Additionally, it was not an aim to compare individual physiotherapist's treatment effectiveness. Other potential variations relate to the number of treatments that each participant received and the type of interventions that participants underwent. These factors have the potential to have impacted on the participants' discharge status. However, as the literature has demonstrated, despite the variety of interventions, there is not a rehabilitation intervention that has shown a clear benefit. Furthermore this study's aim was not to investigate treatment effectiveness, but rather the participant's perception at different times in the rehabilitation process.

Chapter 6: Qualitative methodology and findings

*"Understanding is the most perfect knowledge that is attainable for us humans."*Johann Gustav Droysen

This chapter contains the qualitative section of this mixed methods study. Firstly a brief historical overview of how the quantitative methodology became so predominant in physiotherapy research is outlined and as a consequence the resultant lack of qualitative research. This is followed by the rationale for adopting an interpretive methodology within this mixed method study. The findings of the interpretive aspects of the study are then presented using a hermeneutic analysis of the participants' semi-structured interviews. While this chapter predominantly focuses upon the seventh question of this study relating to the participants' feelings about their recovered ankle, aspects of the previous six questions are also addressed.

History

An appreciation of the historical development of quantitative research allows an understanding of why this type of research has traditionally played such an important role in the biomedical Western sciences and by default physiotherapy research. The emphasis of the quantitative research paradigm is illustrated. As evidence of this a search of the common databases using the keyword string, 'ankle$ or sprain$ or strain$ and physiotherapy and qualitative research', did not produce any results of published qualitative studies. Researchers of Western scientific research and in particular physiotherapy research by default generally select quantitative

methodology. A rationale for the selection of the quantitative research paradigm is rarely defended or explained. The selection of quantitative methodology takes on an almost assumed position. The following section provides a brief explanation as to how this has occurred identifying some of the key historical influences that have led to this position. This is not the definitive explanation of the quantitative history merely an overview, as a detailed analysis is worthy of a thesis in its own right.

Historically the quantitative paradigm has had prominence in the Western medical sciences since Descartes in the 17th Century questioned the Aristotelian view of the world (Leder, 1984, p. 257). It has been suggested that the emphasis on quantitative methodology took its strengths from these 17th Century philosophers who promoted the notion of the 'science world' (Polkinghorne, 1983). A number of philosophers supported this notion of science as the 'only' truth. Bacon (1561 – 1626AD) delineated the principles of the inductive thinking- experimental method, which, while as a method goes back to the times of Aristotle, was an advancement or replacement of Aristotle's method (Polkinghorne, 1983). Bacon considered the only knowledge of importance to man was empirically rooted in the natural world, and that a clear system of scientific inquiry would assure man's mastery over the world. He further believed that all science starts from observation and then slowly and cautiously proceeds to theories. Descartes (1596 –1650AD) further developed this thinking and resolved to trust only that which is clearly and distinctly seen to be beyond any doubt (Descartes, 1911). He demanded certainty and truth. This belief in the sciences as paramount took stronger hold with the development of the Positivist paradigm. This is described as:

> *'Positivism: A scientific and philosophical position for which knowledge is based solely on concrete facts, sensory*

perception and experience and metaphysics is entirely rejected' (Crotty, 1998).

Auguste Comte set out the principles of positivism. Comte used the term positivism in the 19th Century describing the developing 'scientific method' (Sarantakos, 1994). Human thought and knowledge naturally developed from religion to metaphysics to positive science. Comte propagated that all fictitious or 'negative' philosophical speculation about the human realm should be given up and instead the 'positive' or scientific study of human beings should be undertaken (Polkinghorne, 1983). Inherent in Comte's thinking are several general principles, but one in particular stands out:

'that the scientist has an elite position in relation to knowledge and society in general' (J. D. Marshall, 1987).

One of the dominant proponents of the positivist paradigm has been the Western biomedical model. The biomedical professions have taken ownership of the 'science as truth' philosophy. This philosophy has widened in the later part of the 20th Century to develop the 'science as effectiveness' notion (Kuhn, 1996). This later term is more commonly known as 'evidence based practice' (EBP). The evidence based philosophy has defined levels of evidence where research is ranked in a hierarchical fashion (Higgins & Green). The randomised controlled trial is commonly regarded as the highest form of evidence and the gold standard of quantitative research (Sackett, Stauss, Richardson, Rosenburg, & Haynes, 2000). A descending level of evidence is outlined for other forms of research such as case control studies and expert opinion (Forsyth et al., Jan 2008). It should be noted that the levels of evidence and the weightings that are attached to these levels do not

attract universal agreement and that there is significant variation as to how various research is valued (Atkins et al., 2004).

Historically, physiotherapy has grown from a branch of the orthodox Western medical profession (Nicholls & Larmer, 2005). As such it has been argued that physiotherapy as a profession has always followed the biomedical model as the major discourse in its underlying philosophy (Ekdahl & Nilstun, 1998; Pratt, 1989). Although always sitting somewhere within the allied health field, physiotherapy has tended to follow the orthodox medical model of health and illness. In physiotherapy's formative years, at the beginning of the 20th Century, delivery of care was performed in an almost technician like fashion under the direct guidance of a medical practitioner. The profession has now evolved to being led by its own active researchers and evidence based independent practitioners with full autonomy who have developed a far wider range of skills than their predecessors. Bassett (1995) outlines a possible theoretical framework that gives some rationale to the development of the present physiotherapy emphasis on the positivist paradigm. There has been particular attention on the clinical reasoning process as a major contributor to this path to autonomy (Bassett, 1995). From this historical perspective it could be argued that initially physiotherapy did not have its own specific discourse.

The early 'physiotherapy profession' did not have a defined body of knowledge as such and merely followed and adapted the medical body of knowledge. There were very few specific terms that only the physiotherapist used or specialised techniques that only a physiotherapist could safely perform. Explanations of how physiotherapy worked were based on other disciplines' knowledge and particularly others' research. Physiotherapists were not always autonomous practitioners and

often worked under the direct guidance of a doctor. This was easily achieved as most early physiotherapy practice was based within the hospital setting.

The growth of the physiotherapy profession within the Western world commenced following the First World War when returning wounded soldiers needed to be rehabilitated back to society. These soldiers were often the bread winners of their families and as there was no social security system to support those unable to work every effort was needed to facilitate their independence (Cleather, 1995). Physiotherapists worldwide have developed the position as the movement rehabilitators as a consequence of this role.

It has been argued that the physiotherapy profession claimed ownership of the rehabilitation techniques of massage and remedial exercise by process of a power base that was closely aligned to and had the support of the powerful medical profession (Anderson, 1977). The introduction of electrical modalities, at around the time of the Second World War, brought about the 'technique development phase' (Polkinghorne, 1983). Physiotherapists were now able to administer a procedure to the patients that only they were trained to deliver. This was a further significant change in the evolving role of the physiotherapist which could be seen in light of the technological growth within the Western world where things had to have 'bells and whistles' to be effective and powerful. This was true within the medical model where there were more and more interventions performed on patients with improved types of technology as a result of growing research. This 'technique' development further enhanced the physiotherapist standing. With the development of this new 'technique' phase came the questioning as to effectiveness. Effectiveness was to be demonstrated by research. Inherent in gauging effectiveness is the ability to measure. Quantitative research places an emphasis on measuring (M. H. Jones et al., 2006). However, for

the physiotherapy profession being able to demonstrate this effectiveness was a problem as the profession still lacked a research base. It is argued that the physiotherapy profession has grown on the coat tails of the developing medical profession. It is only reasonable to expect therefore, that as the medical profession was put under the spotlight regarding treatment effectiveness, physiotherapists also came under scrutiny. It is not surprising then, that when questions arose as to the effectiveness of any particular physiotherapy intervention, physiotherapists used similar research tools to the medical model. The maturing profession needed to be the owner of its own research to be fully accepted as truly professional. This research had to be understood within the context of the predominant medical model. Therefore the emphasis on the dominant research paradigm, that of the quantitative theory has been maintained (M. H. Jones et al., 2006).

This growth in the quantitative research has led to the evolving evidence based practice doctrine within physiotherapy and the importance for clinicians to incorporate this into their daily practice (Iles & Davidson, 2006). However, attempting to incorporate evidence based knowledge into practice presents significant difficulties. In practice clinicians are confronted daily with patients who do not resemble any research participant. Therefore attempting to link the evidence to the clinical situation presents dilemmas. Clinicians may apply the best evidence available in providing an intervention and find that it does not work for a particular patient. Alternatively an intervention that has little supporting evidence may be the 'wonder cure' for the next patient. Anecdotally some of the most revealing evidence one can receive is from individual patient feedback. The insight and personal experience the patient brings with them has a richness that is unlikely to be found in

a randomised clinical trial. However, this form of evidence, 'individual patient feedback', is not generally valued in the medical literature.

It has been argued that the quantitative methodology is less able to provide information on patients' feelings and perceptions (Patton, 1999). It has further been identified that the medical model has failed to acknowledge the role of qualitative research (Grimmer et al., 2004). Evidence regarding the lack of qualitative research has been shown by McKibbon and Gadd (2004) who conducted a literature review and found that only 0.6% of all articles across 170 core clinical journals were of qualitative studies. They also concluded that qualitative studies tended to be published in journals with a low Science Citation Index (SCI). While Parry (2003) in an editorial, acknowledged that qualitative research in the area of rehabilitation is increasing, she identified a number of issues associated with the acceptance of this methodology in health research in comparison to the quantitative methodology. Some of these concerns focus on the methodological approaches and that the methods are less standardised. Specifically within physiotherapy it has been suggested that the contribution of qualitative research has been under-valued (McPherson & Lord, 2000).

It has been suggested that qualitative research is able to provide unexpected insights into research findings (Borkan, 2004). Furthermore it has been suggested that the scientific approach tends to ignore the uniqueness of the individual and instead focuses on the management of the condition (MacLeod & McPherson, 2007). Interpretive research is one method of qualitative methodology that can examine an individual patient's perceptions. The value of interpretive research has often been down-played by those who believe it lacks objectivity (Koch & Harrington, 1998). However, qualitative research is able to give insights that are not exposed in

quantitative analysis. A combination of both types of research, termed 'mixed methods', has the potential to provide greater understanding.

Combining both quantitative and qualitative methodologies does present problems. There are a number of ways the emphasis can be placed on the approach of this type of research. The research can have equal weightings of each of the quantitative and qualitative methodologies or a predominance of one over the other (Creswell, 2003). As with any developing concept there are initial problems and these have been identified particularly when analysing both types of data together (Patton, 1999). It is possible that the data gathered in a mixed methods approach may give rise to conflicting interpretations. The result may mean that discussion from the combined analysis may not provide an integrated conclusion.

A further concern with a mixed methods approach is that either the quantitative or qualitative findings are added as an afterthought and are not incorporated into the original study design (Tashakkori, 2003). To reduce this form of bias it is recommended that data be collected simultaneously. These possibilities have been considered from the beginning of this particular study. The 'Concurrent Nested Strategy' method that has been followed in this study consists of a larger quantitative study with a smaller qualitative study with both sets of data collected simultaneously (Creswell, 2003).

Qualitative Methodology

An interpretive methodology was undertaken for this study with a specific emphasis on a hermeneutic analysis as a means to uncover understanding and interpretations into perceptions of the 'lived experience' for the participant with a sprained ankle.

The origins of the word hermeneutics is linked to Hermes, the messenger God of the Greeks (Mueller-Vollmer, 2002). Hermes was the go-between the gods and man. He therefore had to be able to understand and interpret what the gods communicated and then translate the message to man so they would appreciate correctly the message the gods were wishing to convey. Hermeneutics is both an art and a science. It is the ability to understand and interpret that is at the heart of hermeneutics. Polkinghorne (1983) quotes Wilhelm Dilthey as saying:

> *'Understanding and interpretation constitutes the method used throughout the human sciences. It unites all of their functions and contains all of their truths'* (p. 29).

This statement by Dilthey could be applied to any analysis we undertake whether it be a qualitative or quantitative approach; however, for the purposes of this chapter it relates specifically to the hermeneutic approach of the semi-structured interviews that I conducted. The interpretation is related specifically to the experiences I bring to this study in an attempt to improve the understanding of the patient's perception of their ankle injury.

Chladenius (Chladenius, 2002) suggests that speech or writings assume that the person will use their knowledge in order to bring an understanding to the work. Any interpretation of the work must be with the insight that the reader or listener has a particular world view of life. Every interpretation will have a unique awareness. All too frequently assumptions are made that the listener or reader has the same understanding that the speaker or writer had when they conveyed the message.

Our interpretation of any communication is both an appreciation of the context of the message and the addition of our personal influences and life experiences. While the message may seem straightforward, our interpretation will influence the

understanding. Our understanding has been developed through a multiplicity of life's perceptions and experiences. As Heidegger suggests:

> *'All interpretation is grounded on understanding' (Heidegger, 2002, p. 228).*

The appreciation and awareness of our own perceptions and experiences are critical in allowing the understanding we bring to any interpretation. While it is acknowledged that we will have prejudices, Gadamer encourages us to:

> *'have the courage to make use of your own understanding' (Hans-Georg Gadamer, 2002).*

While we can take confidence in Gadamer's encouragement, Dunne (1997), suggests that a primary misunderstanding of interpretations is the failure of the interpreter to appreciate the discrepancy between their own context and what the original author or speaker was attempting to convey. He further exposes the flaw that one can:

> *'…systematically divest oneself of one's prejudices, and thereby establishing 'contemporaneity' with one's author'* (Dunne, 1997, p. 108).

As a novice researcher in this style of interpretive hermeneutic analysis, I acknowledge my limitations. Interpretation is an integral part of daily clinical physiotherapy practice. Interpretation comprises analysis of experience based upon what information is available and how this is perceived. The trustworthiness and validity of such research is dependent on the interpreters' capacity to integrate experiential knowledge and apply it to the matter in hand. Being a physiotherapist requires that one is able to interpret signs, symptoms and language in order to implement appropriate treatment.

My interpretations of the transcribed participants' interviews are a reflection of more than the written text. The interviews were completed following a one to two hour testing procedure where I had engaged in a relaxed interaction with the participant. The participants gave many casual insights during the course of the testing that were outside the interview and were therefore neither recorded nor transcribed. These insights; however, were able to add to the understanding I brought to the questioning and the resulting interpretations. The participants' body language and non verbal cues also added to my understanding of the meaning of the written conversations. It would be extremely difficult to capture these additional cues and this has not been attempted.

Our interpretations and understandings of conversations or writings are always grounded in our past experiences and what we bring to that moment of understanding. Heidegger describes this as our 'fore-having', our 'fore-sight' and our 'fore-conceptions' (Heidegger, 1996). The 'fore-having' is the understanding in advance that allows us to prepare and make sense of what we are about to interact with. From my experiences I appreciate that the participant will have experienced a swollen, painful ankle and have had difficulty walking. I have the experience of the educational knowledge I have gained in reading about this condition along with the experience of previous injuries that I have treated. The 'fore-sight' is looking ahead to see what is likely to happen. This is based on the understanding of my experiences that the patient will recover from this injury over a period of weeks. I appreciate that at the time of testing the participant has already been discharged from treatment and will have largely recovered and be walking normally. The 'fore-conception' is the ideas that we have already developed in advance. I may bring an expectation that the participant may still be favouring the ankle.

As the participants relate their stories about their ankle I immediately relate this to my own experience. This may challenge my understanding. It may be that I have experienced a similar injury to that described. Was it the same? Was my experience better, similar or worse? Did I have the same thoughts? These are the prejudices that we bring. Gadamer defines prejudice as:

> *'..a judgement that is given before all the elements that determine a situation have been finally examined'* (Hans-Georg. Gadamer, 1995, p. 240).

We all have prejudices about everything. What we are asked to do to achieve hermeneutical understanding is to examine those prejudices, to understand what we already understand, so we may be open to newness. Gadamer (1995) refers to this as 'historical consciousness'. This historical consciousness is something that we must firstly acknowledge and secondly have an understanding of prior to interpreting others' thoughts. While the physiotherapist may have this 'historical consciousness' in relation to the ankle injury, what of the patient? Have they experienced this injury before? Are they aware of the 'healing' time? What expectations do they have during the treatment process?

In regard to my own prejudices, the dominant preconceptions that I acknowledge I carried into the interviews were the bias that participants had a perception of a 'weak ankle'. This had been developed and flavoured through many years working in the clinical setting. Numerous patients had reinforced this notion and had in fact stimulated my interest in this research area. Over the years I have also developed an understanding of the difficulties and complexities of measuring using questionnaires and outcome measurements. In particular the results of these measures did not always match how the patient felt.

My interest and fascination in ankles began during my physiotherapy training. However, the actual awareness that I had an ankle became apparent some years earlier when I sprained my ankle playing rugby. Until that stage my ankle was not something that I had concentrated much thought upon. The ankle was merely a continuum of my body. We generally do not consider the ankle in isolation or even consider it when undertaking activities. We have the intuitive assumption that the ankle will 'just do' what we want it to do.

For example there is no conscious thought that we need to plantar flex and evert our ankle to initiate movement to get up from a chair. Through science we are taught to understand that there are a multitude of muscles and tendons that interact to allow the movement to occur. The muscles and tendon receive information from nerves that have been stimulated from chemicals released in our brain for this unconscious movement to take place. It is not until a trigger occurs that causes us to focus on our ankle, that we really become aware of it and lose the 'taken for granted' aspect of the ankle. It is not until this trigger happens that we become conscious that we even feel we have a specific need for an ankle. Until then the ankle has just 'been'.

In examining the transcribed conversations, I have identified and interpreted exerts of the conversations that support this underlying prejudice. I have also attempted to identify contradicting interpretations where appropriate.

This chapter highlights my selection from the full transcripts and further illustrates my bias towards certain understandings and interpretations of the conversations. The captured texts are a snapshot of the interviews and the quotes that I have considered of relevance to this study. The questions that guided this part of the study aimed to uncover participants' perceptions of their sprained ankle following

discharge from physiotherapy. Additionally the understanding of outcome questionnaires was also sought from participants.

Method and Analysis

Interviews were conducted at the HRRC immediately following the physical testing. Selected participants were identified during the physical testing procedure and asked to undertake the interview. Ten participants were selected for the semi-structured interview on the basis of obtaining a representative sample of the study population. The participants were purposefully selected to ensure that a mix of age, gender, limitations and activity was represented in the sample. Each participant was given a unique name and number identification to protect their real identity. The semi-structured interview began with specific questions that were asked of all participants (Appendix O). Following these specific questions the opportunity for the participant to expand on any areas regarding the questioning was also encouraged.

Each interview was taped and later transcribed. The transcripts were read and reread by myself to promote thinking (Smythe, Ironside, Sims, Swenson, & Spence, 2007). Selected data have been presented in the findings to present insight into the participant's experience.

Trustworthiness was maintained by articulating the decision trail within the findings keeping within a specific methodological framework and maintaining reflective notes throughout the research process (Koch, 1996, 2006). The context of this study has been described to enable the reader to discern similarities and differences with their own context.

The primary aims in the semi-structured interview were to uncover the understanding and experience of the participant's completing the questionnaires and

in particular where difficulties were encountered along with their understanding of their perception of their ankle.

Participants

There were six males and four females. Their ages ranged from 52 years (the oldest participant) to 18 years old. Seven participants had never experienced a sprain previously while one participant had identified as having suffered the most previous sprains (at least 12). Six participants had injured their right ankle. Nine participants identified as being New Zealand European and one identified as being Asian. One participant approached declined to partake in the interview due to time constraints. The participant who declined to be interview identified as being Maori. The general profile of the selected participants reflected a cross section of those involved in the study.

Findings

With respect to the understanding of questionnaires that are routinely given to all ankle patients, participants expressed their insights in a variety of ways:

> *"Yeah, easy to follow, but I'm stupid so I stuffed them up the first time." (Owen 42)*

and

> *"They were basically very easy to understand, except you could take in your own opinions on the well-being, such as how you interpret the word 'well-being' can be quite vague." (Bill 112)*

and

> *"Yeah, the questions, you don't really know how long it's for or when it says squatting does it mean squatting for a long time or just going up and down and how you answer this." (Jenny 19)*

The difficulty of understanding and answering the questionnaires is acknowledged by the participants when they blame themselves for making any mistakes. Owen readily accepts the responsibility for any lack of clarity in the questionnaire. He identifies that he answered some questions with a different appreciation from when he answered the questionnaire the second time. The impersonal nature of the questionnaires does not provide evidence of how they have been interpreted. Participants make their decision based upon a multitude of factors which have been developed and influenced by their life experiences. The questionnaires do not offer guidance as to the 'meaning' of the question. It is left to the participant to make their own judgement call to interpret. Owen has illustrated what other participants reported feeling when they were completing questionnaires. He would rather acknowledge that he has made the mistake in interpretation of the questionnaire than to attribute any confusion to questions that could easily be interpreted in different ways. Bill shows a different level of understanding of the questionnaires when he identifies the multiple meanings that can be attributed to particular words. He suggests that there are words such as 'well being' that appear 'quite vague' at times. Jenny further illustrates this confusion regarding the lack of clarity of some of the questions and that perhaps her answer may be affected by this lack of clarity.

This difficulty in understanding the questionnaires is further illustrated by Paul:

> *"I think I filled the second one out with my back in mind, I felt depressed and upset but I think that was more with my back. I had hurt my back badly just before having the questionnaires and I have now had an operation you know so it is better now, but back then it was sore so it was hard not to think about my back and only my ankle you know." (Paul, 113)*

Paul shows how his perception of his ankle was coloured by the depression caused by his back condition. In other words, when asked how he was feeling, he was not able to separate out his 'ankle' condition from his 'back' condition. While he is now able to rationalise that at the time his sore back was more likely to have caused his depression than his ankle, at the moment of filling out the questionnaire he simply felt 'depressed' and hence his response reflected his more pressing problem and not the problem being investigated in the questionnaire. He was seeing himself as a whole person, responding to overall feelings, not able to be like a machine that can highlight or isolate one part for inspection and comment accordingly. The questionnaire was not able to identify this aspect of Paul's thinking. Interpretations of the questionnaires were further highlighted by Beth:

> *"There was one thing in one of the questionnaires and it was talking about our health and the impact our health has had and I was wondering if that was health in general or our health in regards to the injury which is sustained from the ankle." (Beth 21)*

Beth reinforces this notion of lack of clarity in the meaning of the written questionnaires. This is particularly so when questionnaires incorporate both general

and specific questions. While some questions are related to the whole person other questions are specific to the injured body part. Participants would appear at times to have difficulty being able to easily differentiate between general and specific notions. Indeed Beth exposes the divide between health and injury. Gadamer (1996, p. 73) suggests that it is only in illness or injury that we become aware of our body in the recognition of a disturbance. In health we are unaware of any disturbance and it is this lack of disturbance that completely escapes our attention. We do not dwell on being in good health, it is just 'there' and taken for granted.

The injury has caused a disturbance to Beth, but only in relation to her ankle. Beth demonstrates the dilemma of attempting to separate her ankle from the rest of her body. She is able to relate to the ankle due to the disturbance, but the rest of her body is free from the disturbance. Perhaps a concern for Beth is that she is only conscious of her 'health' when she has to use her ankle. When she is at rest and not using her ankle her health is undisturbed. Even though Beth has 'health' all the time, it is only when she needs her ankle that her health changes. Beth exposes the difficulty of being able to differentiate and grade this on the questionnaire.

This acceptance of 'health' is further described by Paul:

> *"I did have to think how my ankle was and …" (Paul 113)*

Paul in his recovery is now able to forget about his ankle. There is no disturbance now so the ankle has assumed normality. When asked in the questionnaire about the ankle Paul has to consciously think and separate the ankle from the normality that it has assumed.

A further complexity in the understanding of questionnaires, is the difficulty in relating perception to function. The questionnaires ask explicit questions that rely on the participant's recall of performing specific tasks:

> *"Yes it did because I remember from the second questionnaire I had still remembered thinking no that's definitely difficult. I've still got a little bit of hesitation or damage and by doing those tests it just showed me that I haven't (laughs) that it's probably in my mind."* (Di 06)

and

> "*… maybe a little bit subjective as to how much I thought I needed, or could apply – you know jumping, or something like that, how relevant was it to my day, in what sort of sense? You know - generally? It wasn't asking me specifically what I was doing these things in."*
> (Beth 21)

Di identifies that her perception of her injured ankle lingers. After performing both the physical tests that she had identified as difficult tasks, she declares that the lack of confidence is only in her mind. The questionnaire has not been able to clarify the reality for her. The questionnaire may in fact be reinforcing her lack of confidence. Di still has the perception that the ankle is still damaged. The recovery of the ankle is not complete. Despite being discharged from treatment with the knowledge that the ankle is healed, Di still lacks confidence. Additionally Beth further identifies that while the questionnaire asked specific questions related to functional activities these may not be relevant to her daily activities. The functional

questions may not be specific enough to identify activities that she had difficulty with.

In contrast Terry explained how the questionnaire impacted upon his experience:

> *"I was a bit relieved actually, because I probably had a perception that it would be far more difficult, or that it would have far more effect on my injury than it in fact did at the time."* (Terry 25)

Terry identifies that the physical performing of the tasks has given him some confidence and has altered his perception and understanding of his ability. Terry identifies some anxiety based upon his perception of his ankle that was based on the answers from the questionnaires. The physical functional tests gave him 'relief'. This anxiety has perhaps held Terry back from partaking in daily activities. His perception and memory of the particular task are linked to the injury and have not been 'reset' by his rehabilitation. The questionnaire has allowed him to refocus on the functional task and evaluate his ability in relation to ankle tasks. His ankle showed itself to be stronger than he imagined. In 'seeing' he took on a new level of confidence in the recovery process.

The performing of functional tasks helping to alter the perception for the subject is further illustrated. Subjects carry that perception of their ankle as being weak and not normal.

> *"No, I've sort of been avoiding doing that cos I was pretty sure that it would hurt too much. It might have hurt a bit a while ago so I haven't tried again. I just think that I would have kept on not doing those things. I mean I've*

> *really tried not to make myself do those twisting movements and even when like kicking the ball thing I've been using my left foot way more than I used to have."* (Ross 107)

and

> *"Yip, I thought I had extremely weak ankles, and then apparently I'm quite average, so that's good."* (Jenny 19)

Ross identifies that he has been avoiding certain activities. Jenny has the perception that her ankles are weak yet doing the physical tasks has shown her that she is capable of performing these activities. Many participants indicated that they were surprised that they could manage the difficult tasks so well. They carried a perception that the tasks would be more difficult on the injured leg.

Questionnaires are not able to identify all aspects of concern for individuals. The questionnaires were not able to illustrate some participant's concerns in particular their fear and caution of reinjury:

> *"Probably, the fear of doing it again. That affects me when I do go for a run, I'm scared that I will do it again. Or if I am doing some sort of exercise."* (Jenny 19)

Jenny identifies that her fear of reinjury was not captured in the questioning and that this still affected her thinking. The level of fear and caution was not identified and therefore the therapist has no way of appreciating how this affects the patient. However, while the questionnaire allowed the participants to reconsider their ankle, their perceived ability did not appear to match their physical ability.

Participants described how performing the tests gave them confidence that the questionnaires were not able to give them. The questionnaires illustrated how cautious and apprehensive they had become with their ankles:

> *"Like just now it was funny because I thought there were some of these things that I would not be able to do but when you got me to do them I was surprised that I couldn't feel my ankle hardly at all, it was really good you know."* (Paul 113)

Paul illustrates that the reality of performing the tasks would have had an impact on how he answered the questions. The questionnaires did not fully reveal that the participants had a separation from their physical understanding and their perceived understanding. Paul describes 'not feeling' his ankle at all. Paul recognises that as the ankle has regained normality, it is the pain or discomfort that he does not feel. We are not conscious of the 'healthy' body. He had the perception when he thought about the tasks that they would hurt. He had memories of previous activities when the ankle had caused him discomfort.

The injured body part only becomes apparent at the time of injury. Heidegger uses the term 'ready to hand' in relation to tools; however, this term fits the notion of the body as a whole and the individual parts only come into the conscious when they are 'not ready to hand' or injured (Heidegger, 1996). When the part is 'not ready to hand' we tend to separate the injured part. Separating the injured part from the healthy body is illustrated in the participant's conversations:

> "*…I just call it him when it's sore."* (Paul 113)

and

> *"…I didn't feel like I had any strength in it and like it couldn't hold up against itself, it would just kinda of, it felt floppy."* (Di 06)

Paul has separated the injured part completely from the rest of the body and the ankle has now become a distinct person or entity. When the ankle is injured or not functioning correctly the ankle is given a separate identity. Di also illustrates this distancing herself from the ankle when she uses the impersonal words "*it*" and "*itself*" in reference to the ankle. Within the 'lived experience' the ankle has an assumed taken for granted aspect that does not require us to think about our ankle.

Once injured while still not thinking about the ankle all the time, Di still had a feeling that it was not 'right' for some things. The ankle is not seen as a separate part of our bodies when it is uninjured. It is not seen as a unique separation from our total body image. Descartes in the 17th Century raised the idea that the body could be broken down to separate mathematical components much like a machine (Descartes, 1911). Descartes thinking enabled the body to be considered open to experimentation and intervention as he separated the mind and body. He is acknowledged as the first to offer the suggestion of the body acting as a 'machine' (Leder, 1984). He postulated that the body could be broken down to individual parts and therefore each part could be studied as a separate entity.

Leder (1984) further develops this theme when using the term 'Body Objectification' in describing how Western medical science interacts with a patient. Stainton Rogers (1991) has further emphasised that this attention in the Western medical model to the biomechanical basis of health might be represented by the metaphor of the 'body-as-machine'. Analysis of any machine will reveal that it is made up of numerous distinct parts that are individual components. If we follow this

‘body-as-machine’ concept then once a part is broken it is simply a matter of taking out and replacing or repairing the broken part. Hence the ankle can be seen as a separate entity.

The key concept here is the broken part is not seen in the light of the whole machine, rather a discreet component that can be removed or seen in isolation. It is seen as separate or ‘disjointed’. I offer this term ‘disjointed’ not only as a play on words, but within the understanding of the Western medical philosophy. When someone presents with an injury or illness the parts involved are treated in isolation. The patient is asked specific questions that relate to the injured or ‘disjointed’ part. The importance of the investigation is fixed on the ‘disjointed’ part.

This notion is reinforced with the patient being asked to only relay information with regard to this part. The patient is further encouraged to consider the part as ‘disjointed’ from the body and that the intervention is aimed at this ‘disjointed’ area. The ‘disjointed’ part can be viewed in isolation, as something which is ‘broken’ or injured and merely needs fixing and the ‘machine’ will return to normal. The focusing of the attention onto the injured part uncovers other understandings. This notion is demonstrated by Paul who refers to the ankle as a separate person “*him*”. Paul has gone a step further in describing the injured ankle as a completely separate entity.

The emphasis and legitimisation for this separation or ‘disjointed’ concept begins for physiotherapists in our first year of physiotherapy education when in the human cadaver room we are handed an arm or a leg to examine and dissect. The limb has been separated or ‘disjointed’ from the cadaver and no longer belongs to the body. The body is seen in separate components much like machine parts. We finish examining one ‘disjointed’ part and move on to examine another ‘disjointed’ part.

This ‘disjointed’ belief continues throughout our education as we are continually examined and assessed on distinct body parts. Even when we are faced with a whole cadaver we still tend to isolate a specific joint to examine. It is not surprising that this notion influences how we may view patients.

The initial examination cues that the therapist intuitively brings into the first interaction with the patient’s newly injured part set the scene for the treatment interaction. One of the first questions that the therapist will ask is, “what is wrong with your ankle?” We are taught that this line of questioning needs to become more specific to the injured part. The injured part is what we must focus our attention upon. The process of the ‘disjointed’ part has begun. The initial cues the patient gives in response to specific questions and examination are interpreted by the therapist as confirming what is broken and more importantly what the therapist can fix. As the patient recovers the therapist looks for these initial signals to lessen as the anatomical structures repair. This again gives confirmation that the repair process is continuing.

At a stage when there are no more signals being given, the therapist through experience or learning makes the conclusion that the broken part is recovered. The part is fixed therefore the ‘machine’ is ready to go. The notion of the therapist role in aiding the perception of recovery is further emphasised:

> *“Up until now it has been a physio thing, yip you’re ok to go, and I’ve noticed gradually there have been things that have been a little bit niggly but over time most of that has actually disappeared, which is great.”* (Beth 21)

Beth identifies that the physiotherapist has taken over the lead responsibility and the authority for her recovery process while she was undergoing treatment. This

perception of the ankle being ‘disjointed’ and the therapist emphasising and taking responsibility for the recovery is demonstrated in Beth’s response on being discharged. Following discharge this responsibility has been handed back to Beth who has had to re-evaluate this notion and identified that being told “*yip you’re ok to go”* in reality did not match her perceptions. However, over time Beth has been able to accept her recovery.

However, the analogy of the ‘body as a machine’ has dilemmas for the therapist when the part does not heal as it should or the patient does not share the belief that their ankle is recovered. The therapist’s frustration is shown when the recovery process is not as normal or the patient complains that they still have pain. The therapist will investigate the physical testing of the relevant anatomical structures and if the testing does not reveal any significant problems declare that everything is normal. The recovery process, in the view of the therapist, is therefore complete.

We attempt to ‘disjoint’ the body in a number of ways. The following two examples illustrate how subjects are pressured to accept this ‘disjointed’ concept:

The Orthopaedic Surgeon says to the patient that the bone has healed or the replacement joint looks good on X-ray and the message that is given is that the part is fixed and the patient must be OK. The overall well being of the patient takes reduced importance and at times may seem irrelevant.

Similarly, the physiotherapist is considering discharging a patient with a sprained ankle who has had several weeks treatment. The focus has been on the ‘part’. The patient is now viewed from the perspective of having a non-swollen ankle, they can balance, have minimal local tenderness and have a normal gait and are then informed that their ankle is recovered. The ‘disjointed’ ankle is now fixed.

The recovery process is also seen as distinct. Once the therapist is satisfied that the mechanical structures are intact then in their mind the treatment 'contract' is complete. Their interaction with the broken or 'disjointed' part ceases at this point and the patient is discharged as being recovered. The therapist has focused on their experience and education of the repair process of the anatomical structures. Their knowledge allows them the confidence to 'know' that the ankle is fixed, that the part is intact and that they do not have any more tools to fix anything else.

While our physiotherapy education will identify that we are continually reminded that the whole person needs to be considered, an analysis of any physiotherapy curriculum will provide evidence that there is clear emphasis on separating the 'disjointed' body whether it be in the form of joint specific or condition specific categorisation. This separation process is passed onto the patient in the treatment process. Participants in this study have realised that it was not until they had completed the physical tasks that this separation became apparent.

Within the educational curriculum there is little emphasis placed on 'reuniting' the whole person. MacLeod and McPherson (2007) argue that with the emphasis on evidence based practice, technological advances and the 'right way of dealing with things' there is little emphasis placed on 'healing' of the person. There is an emphasis that when the therapist has obtained satisfactory measures of improvement then the treatment contract is completed. The perception of how the patient feels is held in less esteem. Although participants in this study had completed treatment and been discharged with the understanding that they were recovered, they did not have total confidence in their therapists' evaluation of their ankle. The therapists were responsible for declaring the participants' recovery.

Despite these potential limitations, questionnaires were able to focus the participant on their injured ankle and could have helped in the 'reconnecting' of the injured part:

> *"Made me probably think on different levels, such as how it affected all my other areas of well being, and all the activities I do and how important they are to me and how important my ankle is, so it brought that to light a bit more."* (Bill 112)

and

> *"It made me realise how timid and reserved I have become about any form of strenuous or questionable strenuous activity because of the vulnerability I feel and the whole implications that I explained earlier, my work and all of those things so that I'm highly cautious about not jeopardising those areas that mean a lot to me, and I seem to be timid for that reason."* (Terry 25)

Bill is able to relate how the questionnaires were able to focus his thinking on his injured ankle. He is also able to illustrate that we generally do not consider the ankle in isolation or even consider it when undertaking activities. Terry also identifies that the injury to his ankle has affected his general demeanour, leaving him with a feeling of timidness and vulnerability. The possibility of reinjuring his ankle has made Terry re-evaluate his participation in activities. He now considers activities in light of the potential affect on his ankle. Terry has been able to identify that he is apprehensive about reinjuring his ankle.

Prior to an injury we have the intuitive assumption that the ankle will 'just do' what we want it to do. It is not until the ankle has been injured and does not work that the 'taken for granted' aspect is lost and the importance of the ankle becomes apparent. This loss of the 'taken for granted' attitude is also acknowledged and taken a step further when Terry identifies that it is not only his ankle that he thinks about, but he does not want to jeopardise "*those areas that mean a lot to me"*.

Performing the functional tests did not improve all subjects' perception. If they had been performing the tasks then their perception between their function and their perception remained unchanged.

> *"No, I thought it would be like it was, I had done quite a bit of balancing at home as well, while I am cooking, I usually cook with one foot. My sore ankle is definitely harder to balance on."* (Owen 42)

Owen has been performing the tasks and his perception remained unchanged following the test. The point of difference for Owen is the fact that he has continued to use and test the ankle and has not been avoiding the activity. He had been continually 'testing' for himself.

The questionnaires also altered the subjects' notion of taking the ankle for granted. The questionnaires helped to reinforce the ankle taking on an entity and becoming a significant aspect of their body.

> *"After doing the very first one when my ankle was injured I realised how much I really needed my ankle, and probably looking at it now just how much it has improved and how much easier it is because of the job I do."*(Bill 112)

When questioned on the scoring of the questionnaires participants gave examples of concerns and potential confusion. The participant's understanding of the questionnaires changed. Although the participant has scored the question the same on two occasions the interpretation of the scores should be different and this is not captured by the scoring.

> *"The reason I marked it the same was for a different reason though, in that my co-ordination and working it out was more of an issue than my ability to cope with the injury that I have."* (Terry 25)
>
> and
>
> *"I feel more sure about the left one and probably the right one also. Some of the questions I answered about my left ankle, but I thought that I might give a different answer if it was asking about my right ankle."* (Anne 73)

Both Terry and Anne have identified that their scores may not be a true reflection of their feelings or their ability about their ankle. This has been identified previously by authors examining outcome measures (McMurray et al., 1999; J. Parker et al., 2003).

Further participants indicated that the ratings they gave on the questionnaire would be revised after the actual physical test.

> *"Yeah, now that I've done the test I would change my answer."* (Jenny 19)

Jenny clearly identifies that her score would change. A number of participants were surprised at the difference between their perception and actual performance of the physical tasks. This certainly has implications for the scoring of the

questionnaires and any resulting judgements that are drawn as a result of the questionnaire scores.

Numerous tools have been developed to evaluate patient outcomes. Many use measurements based upon a numerical system. The basis for reducing meaning to numbers sits comfortably within the positivist - quantitative epistemology that is the Western scientific medical model (Kneebone, 2002). The difficulty the patient may have of firstly understanding the concept of putting a number to a feeling and secondly being able to quantify that feeling is largely overlooked.

A further difficulty is the likelihood that the health practitioner's interpretation and the patient's interpretation may not be the same. If we are also considering third party involvement such as the health funders then their interpretation is likely to be different again. Simply noting that the patient feels better than the previous visit is not considered 'meaningfully measurable'. The question is asked how much better?

The trustworthiness of the rating scale needs to be considered. The positivist scientific paradigm relies on the ability to measure. Heidegger suggests that measuring is only possible when the 'thing' that is being measured is thought of as an object (Heidegger, 2001, p. 98). He further explains that measuring always involves comparing two things. To be measured the ankles need to become objects. The participants are asked to compare the uninjured 'healthy' ankle against the injured 'disturbed' ankle. As illustrated previously the 'healthy' body is not consciously thought about. It is just 'there'. The difficulty arises for the participants of firstly having to make the connection of giving value to the normal. They then need to compare this to the injured ankle and then give this a numerical value. Can a number adequately represent an emotion or feeling?

A further layer of complexity to questionnaires can be added depending on who is interpreting the scores. For example take pain as a simple and often used measure within outcome measurements. Pain has many descriptions, but a common description is:

> *'an unpleasant sensory and emotional experience associated with actual and potential tissue damage, or described in terms of such damage'* (Verhaak, Kerssens, Dekker, Sorbi, & Bensing, 1998).

This description of pain is relatively understood within the medical framework although each health practitioner would bring their own individual interpretation to bear on this meaning. It would be reasonable to assume that most people would have little understanding or appreciation of this meaning. Indeed for normal everyday life, pain is something that people encounter fleetingly and episodically and would not generally focus on its meaning in any depth. However, for the purposes of this discussion this definition of pain will be used as a reference in discussion of the dilemmas previously mentioned.

The patient's ability to quantify their feelings may bear no relationship to what they are experiencing. The feeling of pain is so complicated and complex that to simplify this experience to an arbitrary number should be seriously questioned. The patient's interactions that come into play with this experience need considering. Factors within the patient's own personal experiences will come to bear on their interpretation. If the patient's previous experiences of pain was short lived and resulted in a full resolution quickly, then their present interpretation may be completely different than the patient who experiences chronic pain that is not resolving.

Anecdotally, I have seen patients with a relatively simple sprained ankle and not previously having had any significant injuries, describing their pain/discomfort as a 9/10. Conversely, I have seen patients with a relatively 'similar' ankle sprain, but with significant co-morbidities rating their pain as 2/10. I am not wishing to prejudge or make a conclusion with this example, but merely emphasis how different past experiences may influence the patient's ability to quantify their pain. We could surmise that the patient who scored 9/10 has significant disruption to their enjoyment of life, whereas for the patient scoring 2/10, the injury may have less importance or inconvenience. However, the 9/10 patient may be still able to function at a reasonably high level of activity, but is unable to participate in an upcoming sporting event, whereas the 2/10 patient may lead a relatively sedentary life and suffers from a high level of chronic pain normally and just adds this problem to their other disabilities.

In this scenario the 9/10 and 2/10 bear no resemblance to each other as a meaningful outcome measurement for how much pain each patient is experiencing. Of course there are many other experiences that may come to bear for the patient. Work stresses, cultural and family environment and general health are but a few. The health practitioner's interaction should also not be forgotten as the patient's level of anxiety within this environment may also factor in to how the patient perceives their feelings (Griffin et al., 2004). If the patient has not met the health practitioner before and has not built up a relationship of trust, this may affect their perception. They may score the pain at a higher level to ensure that their complaint is taken seriously.

The health practitioner's perception of the previous two examples is likely to be quite different. If the practitioner is experienced in considering the 9/10 patient they may either make the conclusion that perhaps this is more serious than a simple

sprain or that the patient is over-dramatising the injury, whereas with the 2/10 patient there is a danger of not prioritising this situation as highly, particularly if resources are scarce. It is likely that in subsequent treatments the 9/10 patient will show significant change in their score and may quickly move to a 3/10. The 2/10 patient is far less likely to alter their score markedly and it may take a number of treatments to change to a 1/10. From the practitioners perspective it is likely to be more gratifying to see a change from 9 to 3 as opposed to a 2 to 1 and certainly "looks better" on any collected statistics.

Health funders make use of these measurements in completely different ways. The patient who rates at a 9/10 is very likely to be given priority particularly if the patient is off work. Any recommendation for a continuation of treatment is likely to be forthcoming in this instance because significant change score can be demonstrated. In contrast the funders are likely to take a far less sympathetic view of the 2/10 patient and extension of treatment interventions are less likely to be approved as they would perceive that little change in score has resulted from previous intervention.

However, the important consideration is, how relevant to the patient is a change on this score line. There is no agreed understanding to know if a change from an 8 to a 6 is either clinically important to the practitioner or meaningful to the patient (Farrar et al., 2001; Haywood, Hargreaves, & Lamb, 2004; Kelleher et al., 2004). There are few studies within the literature that consider this aspect (Kelleher et al., 2004).

I have used the above VAS scale for pain, as an example to illustrate how the scoring and interpretation of outcome measurements has potential weaknesses. A similar scenario could be made for many if not all other scales used.

The notion that the questionnaires place a value on reality is questioned. Some of the questions in the questionnaires are identified as being irrelevant to the subjects.

> *"There were some questions about sleeping and things like that, that didn't effect me, I wasn't affected by it, but the running and the walking and stuff like that is a huge part of my everyday life, so that was quite relevant."* (Jenny 19)
>
> and
>
> *"Yeah a lot of them, some silly questions in there – getting out of bed in the morning is a bad one."* (Owen 42)
>
> and
>
> *"Oh no, not really 'cause I thought they would probably apply to a lot of people. So perhaps some of them weren't as relevant to me as they would be to other people."* (Beth 21)
>
> and
>
> *"Most of them were quite useful, it was a bit weird, 4 weeks previously when you just done your ankle, and the 4 weeks before that were just normal."* (Mike 32)
>
> and
>
> *"I think that they were angled more at your overall well-being so that you're getting a feel of how your perception of what - how it affected you"* (Di 06)

Both Jenny and Owen identify that some questions were not relevant to them. Despite the questions not being relevant the questions are added into their overall score. The questionnaires are not able to differentiate what values are important to either Jenny or Owen. Beth can appreciate that some of the questions may have importance to others, but again reinforces that some questions were not relevant to her.

Mike adds further evidence that the particular questionnaire may not have relevance to his particular situation. The acute nature of Mike's injury is not addressed in a questionnaire that considers wider aspects of health. Di identifies that the questionnaire is maybe "looking at one's overall health" although she expresses some uncertainty and is not completely confident that this is the case.

Many measurements are detailed and require time and understanding to complete. Studies have identified discrepancies in how researchers, practitioners and patients interpret measurements (Hagg et al., 2002; McMurray et al., 1999). This study identified further support for the difficulty participants have in interpreting questions. This difficulty was in relation to the SF-36 questionnaire. While this questionnaire is one of the most common outcome questionnaires used there still needs to be caution interpreting the results.

There are few studies that have looked at the patients' understanding and interpretation of the outcome measurements. In most Western countries there is considerable cultural mix and the understanding and interpretation of the 'one size fits all' tool to a variety of cultural settings is highly questionable.

Parker coherently captures this sentiment in her description of outcome measurements for foot and ankle surgery:

> *'Quality outcome measures are the cornerstone of clinical research. A review of outcome measures used in foot and ankle surgery research reveals that the issues of validity, reliability and responsiveness of outcome measures have not been addressed. Most reports in the literature have attempted to evaluate patient perceptions of outcome following foot surgery. Underlying the many difficulties with these outcome measures is a lack of understanding of what patients perceive to be important in terms of outcome. Consequently none of the existing outcome measures can claim to be valid measures of patient perceptions of outcome, as there has been no research uncovering these perceptions. In addition, measures of general health status and quality of life in relation to outcome of foot and ankle surgery have been largely ignored to date' (J. Parker et al., 2003).*

Summary

Patients' feelings at time of discharge and their understanding of questionnaires in relation to ankle sprains have received little attention in the literature. The participant interviews identified three key concerns. Firstly that participants have a potential gap in their understanding of questionnaires. Secondly, that there is a difference in understanding of recovery between the therapist and the patient at time of discharge. Thirdly there is a need to link outcome measures to the patient's perception of their own recovery. In this study participants identified these concerns in a number of sub themes all relating to the questionnaires.

Participants identified that the questionnaires created some confusion and they were unable to get clarity as to the understanding when answering specific questions. As a result this raises the question as to how often this confusion occurs when answering a questionnaire and therefore how accurate is the final score. McMurray (1999) has previously identified this issue in relation to the Oxford Hip score. The participants added further insight as to the possibility of misinterpretation of the questions. The interviews also provided evidence that some questions are inappropriate and lack relevance for the participants. This may be unavoidable but does highlight that accepting questionnaires as generic outcome measures is likely to have limitations. This also raises the possibility of affecting the scoring of the questionnaires.

The questionnaires were not able to identify participants fear and avoidance of activities at time of discharge. This may or may not have been conveyed to the therapist. This has implications if patients continue to hold onto this fear following discharge. However, some of the functional questions were of benefit as they were able to expose this avoidance to the participants. Being able to perform these identified tasks has potential benefit to assist the patient's recovery. The interviews confirmed that the perception of function as scored in the questionnaires did not did not always match the actual performance of the task. The implication of this finding is relevant for therapists if they are relying on questionnaires to provide patient's levels of function particularly in relation to discharge.

The interviews also uncovered that participants separated their injured ankle from their body. Their ankle had lost the 'taken for granted' notion and had become 'disjointed' from the rest of their body and as a result their ankle took on a new

understanding. The interviews were able to identify that participants still had this ‘disjointed’ appreciation of their ankle even after discharge from treatment.

Despite the reassurance from their therapist that the ankle was recovered participants still had a fear and apprehension that the ankle had not returned to normal. It is important that as therapists we are aware that patient’s appreciation and understanding of their recovery is a complex issue. The difficulty of differentiating these concepts is perhaps at the heart of the thesis investigation. As therapists we have a notion of when the injury is healed. We can attempt to indicate this to the patient by a number of methods. As outlined above, this had been communicated to the patient that the injured ‘disjointed’ part was fixed and ready to be part of the whole and to join the body. However, perhaps this connection of joining and recovery had not been made by the patient. Certainly in the participant interviews this was a recurring theme.

Chapter 7: Summary, Recommendations for Clinical Practice, Clinical Education and Future Research and the Conclusions

This chapter contains the combined summary for the quantitative and qualitative aspects of the study. Firstly the summaries of the findings of the seven key questions link the respective methodologies to support the findings. This is followed by a section entitled 'emergent insights'. Recommendations specific to clinical practice and clinical education along with recommendations for future research are then presented. Finally an overall conclusion for the study is presented.

Seven key questions were identified in relation to the study aims:

Are there differences and associations between outcome questionnaires that investigate similar domains of pain and function with regard to the participant's perception at the initial assessment, discharge and six week follow up visits?

There were notable differences in scores for similar domains across the questionnaires and furthermore questionnaires were not associated consistently. There was minimal association with respect to pain scores between the Global patient VAS and SF-36 across the three time points. The functional domains of the Patient global questionnaire, the LLTQ ADL, LLTQ Rec and the SF-36 Physical Function showed acceptable associations across the three time points; however, this was not maintained for the SF-36 Role Physical which showed poor association particularly in relation to the Patient global questionnaire, the LLTQ ADL, LLTQ Rec questionnaire domains.

Despite the questionnaire scores demonstrating improvement across a number of domains, the semi-structured interviews highlighted that participants continued to

have concerns regarding the function of their recovering ankle. The scores from the questionnaires were not able to identify these concerns, and participants continued to improve their appreciation of their level of function long after discharge.

While the statistical results identified concerns with respect to using the SF-36 for an acute ankle sprain population, the participant interviews specifically highlighted problems regarding the interpretations of some of the questions. Participants identified that some of the questions had little relevance to ankle function yet the scores from these questions are still combined for a total score. These findings raise the issue of relying on questionnaire scores to provide meaningful discharge information. The participants' perception of recovery is a complicated process. Clearly questionnaire scores in isolation are not able to provide sufficient information to allow clinicians to make best practice decisions with respect to discharge. This has implications for both clinicians and funders who rely on outcome questionnaires to demonstrate clinical effectiveness.

Do participants and physiotherapists have a similar perception of limitations, at initial assessment and discharge?

Previous research has highlighted poor patient satisfaction at the time of discharge following an ankle injury and the findings of the current study have identified aspects that may contribute to this lack of satisfaction. Specifically, while participants and physiotherapists have similar perception as to the limitations of the ankle injury on the initial visit this is not maintained at discharge. Participants have a lower self perception of their injury recovery at discharge than the physiotherapist. However, six weeks thereafter participant's scores matched the therapist's discharge score. The important clinical message is that clinicians should ensure that they do not interpret the discharge questionnaire scores as necessarily reflecting the patient's

recovery perception. This lower participant score on discharge is also reflected and reinforced in the interviews where participants indicated that they still perceived that their ankle was not yet 'healed'. Participants indicated that they did not share the same level of confidence in their ankle as the physiotherapist at time of discharge. The fear and apprehension that participants still voiced could not be identified from the questionnaire scores. Clinicians need to be aware of this finding if they wish to provide a more effective management plan.

Are there deficits in and associations between measures of proprioception, balance, strength and functional performance across injured and uninjured limbs at six weeks following discharge from treatment for an ankle sprain?

This study found significant differences for joint position sense and performance agility testing between the injured and uninjured ankles and for the parallel dynamic phase of the postural control testing; however, the latter result appeared to be an anomaly. The clinical implications of the joint position sense and performance agility testing findings are still unclear and in particular what influence these deficits have on patient's perceptions of their recovery or additionally any influence on the high recurrence of ankle sprains. Further research into this area is warranted to identify if more attention should be paid to these problems in the management of ankle sprains. Furthermore there were no significant differences for the remaining postural control testing or for strength testing between the injured and uninjured ankles. Importantly there were also no associations between impairment and performance measures.

While variations in the procedures and equipment commonly used to evaluate ankle sprain recovery are apparent, their application and availability in the clinical practice situation should be questioned. The Biodex and force plate equipment is

rarely seen outside a research department. Additionally the time involved in proprioception testing using electro goniometers is likely to be a barrier for clinicians. The agility hop test is an easy and inexpensive practical functional test that is able to be performed within a practice setting. Furthermore the study interviews identified that participants were still apprehensive undertaking particular functional tasks at time of discharge. The possibility exists that the joint position and performance agility deficit may have some bearing on this apprehension; however, this requires further research.

Are there associations between questionnaire results related to function and impairment measures, the latter measured by percentage of deficits across limbs at six weeks following discharge from treatment for an ankle sprain?

Comparisons of questionnaire scores and impairment results found no association between these two measures. This finding demonstrated that questionnaires scores are not specific enough to identify participants with a measurable impairment, nor may the impairment scores across limbs be utilised to identify a specific loss of function.

Do participant's perceptions of ability to perform physical tasks change after performing the tasks?

This study found that participants had a lower perception of their ability to perform functional tasks prior to performing the actual task as scored on the LLTQ. The relevance of this lower perception is highlighted for the participants when they performed the physical tasks. Additionally this finding was reinforced by the interviews where participants were surprised at their level of achievement. It should be noted that the identified physical tasks were also rated by the participant as being the most important. The relationship between the identified task and the importance

is not fully understood and this area would also benefit from further research. The clinical implication for this finding is likely to provide an additional tool for physiotherapists to use at the time of discharge. While traditional outcome impairment measures may be useful in the research environment, identifying physical tasks that patients recognise as both difficult and important may have greater benefit in improving patient's appreciation of their ability in their recovery.

Do participants who have had a previous ankle injury have differences in questionnaire scores and impairment measures from participants with a first occurrence of an ankle injury?

This study was not able to identify any significant differences in impairment and questionnaire scores between participants who had had a previous ankle injury and those participants who were presenting with a first occurrence. Additionally, as this finding was not apparent until analysis had been completed, this aspect of previous injury was not explored in the participant interviews to see if participants with a previous injury had any different perceptions from participants with a first time sprain. Not withstanding, as this is the first time that this result has been reported there may be value in further research into this finding to confirm these results.

How do participants feel about their recovered ankle?

This study identified that no previous studies have investigated participant's feelings following discharge for an acute ankle sprain. Interviewing and interpreting participant's conversations revealed insights that are not apparent from traditional outcome measurements. Participant's concerns about their recovering ankle lingered long after discharge. Two key themes were identified from the interviews that centred round the questionnaires. Firstly, participants revealed that there was a gap in

the level of perception of their recovery that they were not able to convey to the physiotherapist at time of discharge. Their fears or lack of confidence in their recovering ankle was not able to be acknowledged in the questionnaires. This highlighted that there is a greater need for physiotherapists to be aware of and link outcome measures to patients' perception of their recovery. Secondly, participants acknowledged difficulties in interpreting questionnaires. The fact that participants recognised that they were unsure what particular questions meant and that this affected how they scored the questions should alert clinicians to be cautious in accepting questionnaire scores as the defining criteria for discharge or the level of recovery.

The major findings have important implications for clinical practice. The relevance of these findings indicate that physiotherapists need to be aware that patients are likely to have lower self expectations of the ability of their recovering ankle at discharge. Hence there is a need for physiotherapists to spend more time clarifying patient's concerns and fears prior to discharge. Additionally there may be benefit in reassessing patients at a subsequent visit following discharge. If patients performed specific identified physical tasks they maybe reassured of their abilities and any lingering concerns may be allayed.

Emergent insights

> *"The qualities of the body: its measurements, its ability, its efficiency and vulnerability can only become apparent when the body itself is forgotten…"* (van den Berg, 1952, p. 65)

Traditionally physiotherapy has relied on quantitative methodology to evaluate treatment. This has placed an emphasis on measuring. The mixed methods approach adopted in the current study has illustrated aspects of patient understanding that we as clinicians, educators and researchers often fail to recognise or value. The challenge is to recognise and take up the challenge of some of the posed questions and recommendations. How can we value and better understand the patient's perceptions and feedback? Typically physiotherapy treatment has had an emphasis on interacting with the injured person in the context of their injured part being an 'object'. Examples of this notion are often apparent in the physiotherapy environment. "My next appointment is an ankle" is a familiar statement amongst therapists. We, as therapists have created this 'disjointed' perception when providing treatment.

Furthermore, we may sometimes accept outcome measurement results as providing a significant component of how we define when an injury is healed. However, while as therapists we may be satisfied that the injury is 'healed', it is apparent that the patient may not have accepted that the injury is 'recovered'. As such a number of questions can be posed. For instance: do we fully understand the difference between when we as a therapist decide the injury is 'healed' and when a patient has decided that they are 'recovered'? How can we better understand when a patient has finally forgotten their injury and regained the 'taken for granted' aspect of normal life? What occurs for the injury to be forgotten? How can we assist the patient to improve their confidence? As Van Den Berg (1952) suggests in the earlier quote the qualities of the body can only be appreciated when they are forgotten. This notion of 'recovery' is an interpretative process and as such each individual will bring a different meaning and understanding. Raising the awareness of this

understanding may improve our treatment decisions in relation to discharge and as a result improve the patient's experience of their recovery.

Additionally while the traditional physiotherapy measures have used numbers and scales the limitations of these need to be appreciated. How can feelings ever be adequately captured with numbers? The challenge is to assist the person to explain their feelings in a meaningful way that provides understanding for both the therapist and the person.

The mixed methods approach

The particular approach of a smaller qualitative study contained within a larger quantitative study is relatively new to studies of musculoskeletal injuries. Little has been written about mixed methods approach or how to resolve discrepancies, eg: when priorities are different or there is contrasting evidence (Creswell, 2003). While the rationale for this design has previously been discussed earlier, the results of this combined study have justified this approach. The findings of this study have highlighted a number of concerns that have not been reported previously. These may not have been found without this particular approach.

Limitation is that not all participants were interviewed. As a result, to what extent the findings from the interviews can be generalised to the study population is not known. The intent of the interviews was to explore a selected sample of participants. Care was taken to attempt to interview a cross section of participants and this was largely achieved. However, it would be incorrect to attempt to take the findings of the interviews and make generalised conclusions. The findings of the interviews have been raised to highlight issues that participants identified that would not be apparent in a quantitative study.

Recommendations

A number of recommendations can be made regarding the physiotherapy management of acute ankle sprains. These include recommendations for the clinical physiotherapy management of ankle sprains and for physiotherapy education along with recommendations for further areas of research. The implementation of these recommendations may lead to improved patient care regarding the physiotherapy management of acute ankle sprains. It is also suggested that some of these recommendations have implications wider than just the treatment of ankle sprains.

Recommendations for clinical practice:

- To clearly identify the patient's perception prior to discharge to ensure that their level of confidence is such that they have a more accurate understanding of their physical ability.
- To perform physical tasks that are difficult and important to the patient prior to discharge for their ankle injury to assist the patient in their understanding of their functional ability to undertake physical tasks.
- To take a cautious approach in interpreting scores from questionnaires, particularly in relation to discharge status to ensure that a greater appreciation of the patient's perceptions are understood.
- To ensure that questionnaire scores are not used in isolation to measure patient recovery.

Recommendations for clinical education:

- To encourage students to reflect on their interaction with the patient to better appreciate how the patient understands their injury and recovery.

- To enable students to appreciate that while outcome measurements are important to assist in treatment planning they are only part of the information needed to decide when a patient is ready for discharge.
- To bring to students an appreciation of the complexities of the treatment interaction and the importance of valuing the individual's experiences.
- To enable students to appreciate the strengths and limitations of each of the quantitative and qualitative philosophies and methodologies.

Recommendations for future research:

- To investigate if patients who complete physical tasks at the time of discharge maintain their perception of improvement and recovery at a later follow up.
- To further investigate the relationship between the importance scale and task difficulty scale of the Lower Limb Task Questionnaire.
- To investigate if patient's perceptions at time of discharge for other musculoskeletal injuries produce similar findings to this study.
- To investigate the role of joint position sense in relation to patient's perceptions and the high recurrence of ankle sprain.
- To investigate the validity and reliability of the agility hop test for use in the clinical setting.
- To further investigate if patients with a previous sprain have different perceptions about their ankle from subjects with a first time sprain.
- To engage in phenomenological research to further investigate the complexities of patient's perceptions and how they influence their sense of recovery at time of discharge.

Conclusion

The primary aim of this study was to investigate patient's perceptions and performance of physical tasks following ankle sprains using a mixed methods approach. The findings from this study have demonstrated that the use of a mixed methods approach is able to provide insights that would not have been possible with a single research approach. This mixed methods study has provided original findings in relation into patient perception after discharge following an ankle sprain. The findings have demonstrated that patients have a perception of a lack confidence in their recovery at the time of discharge.

It was apparent that questionnaires purporting to measure similar constructs are at times dissimilar in scores and are not strongly related. Thus care needs to be taken in selecting and interpreting such outcome measures. Additionally, physiotherapists should pay closer attention in treatment planning to identify limitations in function that are important to the patient and ensure that patients have a good appreciation of their ability prior to discharge.

References

Abrams, D., Davidson, M., Harrick, J., Harcourt, P., Zylinski, M., & Clancy, J. (2006). Monitoring the change: Current trends in outcome measure usage in physiotherapy. *Manual Therapy, 11*(1), 46-53.

Accident Compensation Corporation. (2000). *Treatment profiles 2001*. Wellington, New Zealand: Author.

Accident Compensation Corporation. (2006). *ACC Injury Statistics 2006*. Wellington, New Zealand: Author.

Accident Compensation Corporation. (2007). *Physiotherapy background information*. Wellington, New Zealand: Author.

Aiken, A. B., Pelland, L., Brison, R., Pickett, W., & Brouwer, B. (2008). Short-term natural recovery of ankle sprains following discharge from emergency departments. *Journal of Orthopaedic and Sports Physical Therapy, 38*(9), 566-571.

Airaksinen, O. V., Kyrklund, N., Latvala, K., Kouri, J. P., Gronblad, M., & Kolari, P. (2003). Efficacy of cold gel for soft tissue injuries: A prospective randomized double-blinded trial. *American Journal of Sports Medicine, 31*(5), 680-684.

Akbari, M., Karimi, H., Farahini, H., & Faghihzadeh, S. (2006). Balance problems after unilateral lateral ankle sprains. *Journal of Rehabilitation Research and Development, 43*(7), 819-824.

Anderson, E. M. (1977). *Golden jubilee history 1923-1973*. Dunedin, New Zealand: Tablet Printing.

Atkins, D., Eccles, M., Flottorp, S., Guyatt, G. H., Henry, D., Hill, S., et al. (2004). Systems for grading the quality of evidence and the strength of recommendations I: Critical

appraisal of existing approaches: The GRADE Working Group. *BMC Health Services Research, 4*(1), 38.

Aydog, E., Aydog, S. T., Cakci, A., & Doral, M. N. (2004). Reliability of isokinetic ankle inversion- and eversion-strength measurement in neutral foot position, using the Biodex dynamometer. *Knee Surgery, Sports Traumatology, Arthroscopy, 12*(5), 478-481.

Baier, M., & Hopf, T. (1998). Ankle orthoses effect on single-limb standing balance in athletes with functional ankle instability. *Archives of Physical Medicine and Rehabilitation, 79*(8), 939-944.

Barber-Westin, S. D., Noyes, F. R., & McCloskey, J. W. (1999). Rigorous statistical reliability, validity, and responsiveness testing of the Cincinnati knee rating system in 350 subjects with uninjured, injured, or anterior cruciate ligament-reconstructed knees. *American Journal of Sports Medicine, 27*(4), 402-416.

Bassett, S. F. (1995). Physiotherapy - what is it? *New Zealand Journal of Physiotherapy, 23*(2), 7 -10.

Bassett, S. F., & Prapavessis, H. (2007). Home-based physical therapy intervention with adherence-enhancing strategies versus clinic-based management for patients with ankle sprains. *Physical Therapy, 87*(9), 1132-1143.

Baumberg, L., Long, A., & Jefferson, J. (1995). *International workshop: Culture and outcomes.* Retrieved February 1, 2006, from http:www.leeds.ac.uk/nuffield/infoservices/UKCH/define.html

Beatty, P. W., Neri, M. T., Bell, K., & DeJong, G. (2004). Use of outcomes information in acute inpatient rehabilitation. *American Journal of Physical Medicine and Rehabilitation, 83*(6), 468-478.

Bentz, V., & Shapiro, J. (1998). *Mindful Inquiry in Social Research*. Thousand Oaks, CA: Sage.

Bernier, J. N., & Perrin, D. H. (1998). Effect of coordination training on proprioception of the functionally unstable ankle. *Journal of Orthopaedic and Sports Physical Therapy, 27*(4), 264-275.

Bernier, J. N., Perrin, D. H., & Rijke, A. M. (1997). Effect of unilateral functional instability of the ankle on postural sway and inversion and eversion strength. *Journal of Athletic Training, 32*(3), 226-232.

Beynnon, B. D., Renstrom, P. A., Haugh, L., Uh, B. S., & 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.

Bialocerkowski, A. E., Grimmer, K. A., Milanese, S. F., & Kumar, V. S. (2004). Application of current research evidence to clinical physiotherapy practice. *Journal of Allied Health, 33*(4), 230-237.

Bijur, P. E., Silver, W., & Gallagher, E. J. (2001). Reliability of the visual analog scale for measurement of acute pain. *Academic Emergency Medicine, 8*(12), 1153-1157.

Binkley, J. M., Stratford, P. W., Lott, S. A., & Riddle, D. L. (1999). The Lower Extremity Functional Scale (LEFS): Scale development, measurement properties, and clinical application: North American Orthopaedic Rehabilitation Research Network. *Physical Therapy, 79*(4), 371-383.

Birrer, R. B., Fani-Salek, M. H., Totten, V. Y., Herman, L. M., & Politi, V. (1999). Managing ankle injuries in the emergency department. *Journal of Emergency Medicine, 17*(4), 651-660.

Bland, J. M., & Altman, D. G. (2002). Statistics notes: Validating scales and indexes. *British Medical Journal, 324*(7337), 606-607.

Bleakley, C. M., McDonough, S. M., & MacAuley, D. C. (2008). Some conservative strategies are effective when added to controlled mobilisation with external support

after acute ankle sprain: A systematic review. *Australian Journal of Physiotherapy, 54*(1), 7-20.

Borkan, J. M. (2004). Mixed methods studies: A foundation for primary care research. *Annals of Family Medicine, 2*(1), 4-6.

Borromeo, C. N., Ryan, J. L., Marchetto, P. A., Peterson, R., & Bove, A. A. (1997). Hyperbaric oxygen therapy for acute ankle sprains. *American Journal of Sports Medicine, 25*(5), 619-625.

Bosien, W. R., Staples, O. S., & Russell, S. W. (1955). Residual disability following acute ankle sprains. *Journal of Bone and Joint Surgery: American Volume, 37-A*(6), 1237-1243.

Boyle, J., & Negus, V. (1998). Joint position sense in the recurrently sprained ankle. *Australian Journal of Physiotherapy, 44*(3), 159-163.

Braun, B. L. (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.

Brazier, J. E., Harper, R., Jones, N. M. B., O'Cathain, A., Thomas, K. J., Usherwood, T., et al. (1992). Validating the SF-36 health survey questionnaire: New outcome measure for primary care. *British Medical Journal, 305*(6846), 160-164.

Broad, J., Robb, G., Ameratunga, S., Larmer, P. J., & Jackson, R. (2001). *Managing soft tissue ankle injuries: A summary of recent research.* Wellington, New Zealand: Effective Practice Institute, Division of Community Health, University of Auckland.

Brodsky, A. R., O'Malley M, J., Bohne, W. H., Deland, J. A., & Kennedy, J. G. (2005). An analysis of outcome measures following the brostrom-gould procedure for chronic lateral ankle instability. *Foot and Ankle International, 26*(10), 816-819.

Buchanan, A. S., Docherty, C. L., & Schrader, J. (2008). Functional performance testing in participants with functional ankle instability and in a healthy control group. *Journal of Athletic Training, 43*(4), 342-346.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin, 56*(2), 81-105.

Chartered Society of Physiotherapy, Core Standards, (2000).

Chartered Society of Physiotherapy. (2005). *Core standards of physiotherapy practice 2005*. Retrieved June 22 2007, from http://www.csp.org.uk/director/effectivepractice/outcomemeasures.cfm#standards

Chladenius, J. M. (2002). On the concept of interpretation. In K. Mueller-Vollmer (Ed.), *The Hermeneutics Reader* (pp. 380). New York: Continuum.

Clark, P. A., Drain, M., Gesell, S. B., Mylod, D. M., Kaldenberg, D. O., & Hamilton, J. (2005). Patient perceptions of quality in discharge instruction. *Patient Education and Counseling, 59*(1), 56-68.

Clark, V. M., & Burden, A. M. (2005). A 4-week wobble board exercise programme improved muscle onset latency and perceived stability in individuals with a functionally unstable ankle. *Physical Therapy in Sport, 6*(4), 181-187.

Clarke, M. (2007). The Cochrane Collaboration and systematic reviews. *The British Journal of Surgery, 94*(4), 391-392.

Cleather, J. (1995). *Head, heart and hands : the story of physiotherapy in Canada*. Toronto, Canada: Canadian Physiotherapy Association.

Cooke, M. W., Lamb, S. E., Marsh, J., & Dale, J. (2003). A survey of current consultant practice of treatment of severe ankle sprains in emergency departments in the United Kingdom. *Emergency Medicine Journal, 20*(6), 505-507.

Cornwall, M. W., & McPoil, T. G. (2003). Reliability and validity of center-of-pressure quantification. *Journal of the American podiatric medical association, 93*(2), 142-149.

Creswell, J. W. (2003). *Research Design, Qualitative, Quantitative, and Mixed Methods Approaches* (2nd ed.). Thousand Oaks, CA: Sage

Cronbach, L. J., & Warrington, W. G. (1951). Time-limit tests: estimating their reliability and degree of speeding. *Psychometrika, 16*(2), 167-188.

Cross, K. M., Worrell, T. W., Leslie, J. E., & Van Veld, K. R. (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 and Sports Physical Therapy, 32*(1), 16-23.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective on research process.* Sydney, Australia: Allen & Unwin.

Croxford, P., Jones, K., & Barker, K. (1998). Inter-tester comparison between visual estimation and goniometric measurement of ankle dorsiflexion. *Physiotherapy Theory and Practice, 14*(2), 107-113.

D'Amico, R., Deeks, J. J., & Altman, D. G. (1998). Effect of length of follow-up on meta-analysis [Abstract]. *Cochrane Database of Systematic Reviews*. Retrieved May 4, 2008, from http://www.cochrane.org/colloquia/abstracts/baltimore/Maryland25.htm

D'Amico, R., Deeks, J. J., & Altman, D. G. (1999). Numbers needed to treat derived from meta-analysis. Length of follow up is poorly reported. *British Medical Journal, 319*(7218), 1200.

de Jong, A., Kilbreath, S. L., Refshauge, K. M., & Adams, R. (2005). Performance in different proprioceptive tests does not correlate in ankles with recurrent sprain. *Archives of Physical Medicine and Rehabilitation, 86*(11), 2101-2105.

de Noronha, M., Refshauge, K. M., Crosbie, J., & Kilbreath, S. L. (2008). Relationship between functional ankle instability and postural control. *Journal of Orthopaedic and Sports Physical Therapy, 38*(12), 782-789.

de Noronha, M., Refshauge, K. M., Herbert, R. D., & Kilbreath, S. L. (2006). Do voluntary strength, proprioception, range of motion, or postural sway predict occurrence of lateral ankle sprain? *British Journal of Sports Medicine, 40*(10), 824-828.

de Noronha, M., Refshauge, K. M., Kilbreath, S. L., & Crosbie, J. (2007). Loss of proprioception or motor control is not related to functional ankle instability: An observational study. *Australian Journal of Physiotherapy, 53*(3), 193-198.

de Vries, J. S., Krips, R., Sierevelt, I. N., & Blankevoort, L. (2006). Interventions for treating chronic ankle instability. *Cochrane Database of Systematic Reviews, 2006*(4). Retrieved from Cochrane Database of Systematic Reviews.

Demeritt, K. M., Shultz, S. J., Docherty, C. L., Gansneder, B. M., & Perrin, D. H. (2002). Chronic ankle instability does not affect lower extremity functional performance. *Journal of Athletic Training, 37*(4), 507-511.

Derscheid, G. L., & Brown, W. C. (1985). Rehabilitation of the ankle. *Clinical Journal of Sport Medicine, 4*(3), 527-544.

Descartes, R. (1911). *The Philosophical Works of Descartes* (Haldane and Ross, Trans. Vol. 1). London, United Kingdom: Cambridge University Press.

Docherty, C. L., Gansneder, B. M., Arnold, B. L., & Hurwitz, S. R. (2006). Development and reliability of the ankle instability instrument. *Journal of Athletic Training, 41*(2), 154-158.

Docherty, C. L., Moore, J. H., & Arnold, B. L. (1998). Effects of strength training on strength development and joint position sense in functionally unstable ankles. *Journal of Athletic Training, 33*(4), 310-314.

Docherty, C. L., Valovich McLeod, T. C., & Shultz, S. J. (2006). Postural control deficits in participants with functional ankle instability as measured by the Balance Error Scoring System. *Clinical Journal of Sport Medicine, 16*(3), 203-208.

Domholdt, E. (2005). *Rehabilitation research : Principles and applications* (3rd ed.). St. Louis, MO: Elsevier Saunders.

Dowrick, A. S., Gabbe, B. J., Williamson, O. D., Wolfe, R., & Cameron, P. A. (2006). A comparison of self-reported and independently observed disability in an orthopedic trauma population. *Journal of Trauma, 61*(6), 1447-1452.

Drouin, J. M., Valovich-McLeod, T. C., Shultz, S. J., Gansneder, B. M., & Perrin, D. H. (2004). Reliability and validity of the Biodex system 3 pro isokinetic dynamometer velocity, torque and position measurements. *European Journal of Applied Physiology, 91*(1), 22-29.

Duckworth, M. (1999). Outcome measurement selection and typology. *Physiotherapy, 85*(1), 21-27.

Dunne, J. (1997). *Back to the rough ground : Practical judgment and the lure of technique*. Notre Dame, IN: University of Notre Dame Press.

Edgar, D., Finlay, V., Wu, A., & Wood, F. (2008). Goniometry and linear assessments to monitor movement outcomes: Are they reliable tools in burn survivors? *Burns, 35*(1), 58-62.

Eechaute, C., Vaes, P., & Duquet, W. (2008). Functional performance deficits in patients with CAI: Validity of the multiple hop test. *Clinical Journal of Sport Medicine, 18*(2), 124-129.

Eechaute, C., Vaes, P., Van Aerschot, L., Asman, S., & Duquet, W. (2007). The clinimetric qualities of patient-assessed instruments for measuring chronic ankle instability: A systematic review. *BMC Musculoskeletal Disorders, 8*, 6.

Eils, E., Demming, C., Kollmeier, G., Thorwesten, L., Volker, K., & Rosenbaum, D. (2002). Comprehensive testing of 10 different ankle braces. Evaluation of passive and rapidly induced stability in subjects with chronic ankle instability. *Clinical Biomechanics, 17*(7), 526-535.

Eils, E., & Rosenbaum, D. (2001). A multi-station proprioceptive exercise program in patients with ankle instability. *Medicine and Science in Sports and Exercise, 33*(12), 1991-1998.

Ekdahl, C., & Nilstun, T. (1998). Paradigms in physiotherapy research: An analysis of 68 Swedish doctoral dissertations. *Physiotherapy Theory and Practice, 13*(3), 159 - 169.

Evans, T., Hertel, J., & Sebastianelli, W. (2004). Bilateral deficits in postural control following lateral ankle sprain. *Foot and Ankle International, 25*(11), 833-839.

Farrar, J. T., Young, J. P., Jr., LaMoreaux, L., Werth, J. L., & Poole, R. M. (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain, 94*(2), 149-158.

Fitzpatrick, R., Davey, C., Buxton, M. J., & Jones, D. R. (1998). Evaluating patient-based outcome measures for use in clinical trials. *Health Technology Assessment, 2*(14), 1-74.

Forsyth, L., Graham, K., Harbour, R. T., Lowe, G., Qureshi, S., Stein, A., et al. (Jan 2008). *A guideline developer's handbook.* Retrieved July 5 2008, from http://www.sign.ac.uk/pdf/sign50.pdf

Freeman, M. (1965). Instability of the foot after injuries to the lateral ligament of the ankle. *Journal of Bone and Joint Surgery - British Volume, 47B*(4), 669-677.

Fu, A. S., & Hui-Chan, C. W. (2005). Ankle joint proprioception and postural control in basketball players with bilateral ankle sprains. *American Journal of Sports Medicine, 33*(8), 1174-1182.

Gadamer, H.-G. (1995). *Truth and Method* (J. Weinsheimer & D. Marshall, Trans. Second ed.). New York: Continuum Publishing.

Gadamer, H.-G. (1996). *The enigma of health: The art of healing in a scientific age* (J. Gaiger & N. Walker, Trans.). Stanford, CA: Stanford University Press.

Gadamer, H.-G. (2002). The discrediting of prejudice by the enlightenment. In K. Mueller-Vollmer (Ed.), *The Hermeneutics Reader* (pp. 380). New York: Continuum.

Garn, S. N., & Newton, R. A. (1988). Kinesthetic awareness in subjects with multiple ankle sprains. *Physical Therapy, 68*(11), 1667-1671.

Gerber, J. P., Williams, G. N., Scoville, C. R., Arciero, R. A., & Taylor, D. C. (1998). Persistent disability associated with ankle sprains: A prospective examination of an athletic population. *Foot and Ankle International, 19*(10), 653-660.

Gerszten, P. C. (1998). Outcomes research: A review. *Neurosurgery, 43*(5), 1146-1156.

Glencross, D., & Thornton, E. (1981). Position sense following joint injury. *Journal of Sports Medicine & Physical Fitness, 21*(1), 23-27.

Goldie, P. A., Evans, O. M., & Bach, T. M. (1994). Postural control following inversion injuries of the ankle. *Archives of Physical Medicine and Rehabilitation, 75*(9), 969-975.

Grana, W. A. (1995). Chronic pain after sprain: Consider the differential diagnosis. *Physician and Sportsmedicine, 23*(5), 67.

Griffin, S. J., Kinmonth, A. L., Veltman, M. W., Gillard, S., Grant, J., & Stewart, M. (2004). Effect on health-related outcomes of interventions to alter the interaction between patients and practitioners: A systematic review of trials. *Annals of Family Medicine, 2*(6), 595-608.

Grimmer, K., Bialocerkowski, A., Kumar, S., & Milanese, S. (2004). Implementing evidence in clinical practice: The 'therapies' dilemma. *Physiotherapy, 90*(4), 189-194.

Grotle, M., Brox, J. I., & Vollestad, N. K. (2005). Functional status and disability questionnaires: What do they assess? A systematic review of back-specific outcome questionnaires. *Spine, 30*(1), 130-140.

Guyatt, G. H., Feeny, D. H., & Patrick, D. L. (1993). Measuring health-related quality of life. *Annals of Internal Medicine, 118*(8), 622-629.

Guyatt, G. H., Walter, S., & Norman, G. (1987). Measuring change over time: Assessing the usefulness of evaluative instruments. *Journal of Chronic Diseases, 40*(2), 171-178.

Hadley, C. M. (1988). Complementary medicine and the general practitioner: A survey of general practitioners in the Wellington area. *New Zealand Medical Journal, 101*(857), 766-768.

Hagg, O., Fritzell, P., Oden, A., & Nordwall, A. (2002). Simplifying outcome measurement: Evaluation of instruments for measuring outcome after fusion surgery for chronic low back pain. *Spine, 27*(11), 1213-1222.

Hale, S., & Hertel, J. (2005). Reliability and sensitivity of the Foot and Ankle Disability Index in subjects with chronic ankle instability. *Journal of Athletic Training, 40*(1), 35-40.

Handoll, H. H., Rowe, B. H., Quinn, K. M., & de Bie, R. (2001). Interventions for preventing ankle ligament injuries (Cochrane Review). *Cochrane Database of Systematic Reviews, 3*.

Hansen, H., Damholt, V., & Termansen, N. B. (1979). Clinical and social status following injury to the lateral ligaments of the ankle. Follow-up of 144 patients treated conservatively. *Acta Orthopaedica Scandinavica, 50*(6, Pt. 1), 699-704.

Hatala, R., Keitz, S., Wyer, P., & Guyatt, G. H. (2005). Tips for learners of evidence-based medicine: 4. Assessing heterogeneity of primary studies in systematic reviews and

whether to combine their results. *Canadian Medical Association Journal, 172*(5), 661-665.

Hays, R. D., Hahn, H., & Marshall, G. (2002). Use of the SF-36 and other health-related quality of life measures to assess persons with disabilities. *Archives of Physical Medicine and Rehabilitation, 83*(12, Suppl. 2), S4-9.

Haywood, K. L., Hargreaves, J., & Lamb, S. E. (2004). Multi-item outcome measures for lateral ligament injury of the ankle: A structured review. *Journal of Evaluation in Clinical Practice, 10*(2), 339-352.

Haywood, K. L., Hargreaves, J., White, R., & Lamb, S. E. (2004). Reviewing measures of outcome: Reliability of data extraction. *Journal of Evaluation in Clinical Practice, 10*(2), 329-337.

Heidegger, M. (1996). *Being and time: A translation of Sein und Zeit*. Albany, NY: State University of New York Press.

Heidegger, M. (2001). *Zollikon seminars: Protocols, conversations, letters*. Evanston, IL.: Northwestern University Press.

Heidegger, M. (2002). Assertion as a derivative mode of interpretation. In K. Mueller-Vollmer (Ed.), *The Hermeneutics Reader* (pp. 380). New York: Continuum.

Hergenroeder, A. C. (1990). Diagnosis and treatment of ankle sprains. A review. *American Journal of Diseases of Children, 144*(7), 809-814.

Hertel, J. (2000). Functional instability following lateral ankle sprain. *Sports Medicine, 29*(5), 361-371.

Hertel, J. (2002). Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability. *Journal of Athletic Training, 37*(4), 364-375.

Hertel, J., Buckley, W. E., & Denegar, C. R. (2001). Serial testing of postural control after acute lateral ankle sprain. *Journal of Athletic Training, 36*(4), 363-368.

Hess, D. M., Joyce, C. J., Arnold, B. L., & Gansneder, B. M. (2001). Effect of a 4-week agility training programm on postural sway in the functionally unstable ankle. *Journal of Sport Rehabilitation, 10*(1), 24-35.

Hicks, J. E. (2000). Rehabilitation strategies for patients with rheumatoid arthritis. Part 2: Modalities, orthoses, and assistive devices. *Journal of Musculoskeletal Medicine, 17*(7), 385-387.

Higgins, J., & Green, S. (September 2008). *Cochrane Handbook for Systematic Reviews of Interventions*. Retrieved December 9, 2008, from http://www.cochrane-handbook.org/

Hiller, C. E., Refshauge, K. M., Bundy, A. C., Herbert, R. D., & Kilbreath, S. L. (2006). The Cumberland Ankle Instability Tool: A report of validity and reliability testing. *Archives of Physical Medicine and Rehabilitation, 87*(9), 1235-1241.

Hiller, C. E., Refshauge, K. M., Herbert, R. D., & Kilbreath, S. L. (2007). Balance and recovery from a perturbation are impaired in people with functional ankle instability. *Clinical Journal of Sport Medicine, 17*(4), 269-275.

Hoiness, P., Glott, T., & Ingjer, F. (2003). High-intensity training with a bi-directional bicycle pedal improves performance in mechanically unstable ankles: A prospective randomized study of 19 subjects. *Scandinavian Journal of Medicine and Science in Sports, 13*(4), 266-271.

Holme, E., Magnusson, S. P., Becher, K., Bieler, T., Aagaard, P., & 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.

Hubbard, T. J., & Hicks-Little, C. A. (2008). Ankle ligament healing after an acute ankle sprain: An evidence-based approach. *Journal of Athletic Training, 43*(5), 523-529.

Hubbard, T. J., Kramer, L. C., Denegar, C. R., & Hertel, J. (2007). Correlations among multiple measures of functional and mechanical instability in subjects with chronic ankle instability. *Journal of Athletic Training, 42*(3), 361-366.

Huijbregts, M. P. J., Myers, A. M., Kay, T. M., & Gavin, T. S. (2002). Systematic outcome measurement in clinical practice: Challenges experienced by physiotherapists. *Physiotherapy Canada, 54*(1), 25-31.

Iles, R., & Davidson, M. (2006). Evidence based practice: A survey of physiotherapists' current practice. *Physiotherapy Research International, 11*(2), 93-103.

Isakov, E., & Mizrahi, J. (1997). Is balance impaired by recurrent sprained ankle? *British Journal of Sports Medicine, 31*(1), 65-67.

Jamtvedt, G., Dahm, K. T., Christie, A., Moe, R. H., Haavardsholm, E., Holm, I., et al. (2008). Physical therapy interventions for patients with osteoarthritis of the knee: An overview of systematic reviews. *Physical Therapy, 88*(1), 123-136.

Jenkinson, C., Coulter, A., & Wright, L. (1993). Short Form-36 (SF-36) health survey questionnaire: Normative data for adults of working age. *British Medical Journal, 306*(6890), 1437-1440.

Johnson, M. R., & Stoneman, P. D. (2007). Comparison of a lateral hop test versus a forward hop test for functional evaluation of lateral ankle sprains. *Journal of Foot and Ankle Surgery, 46*(3), 162-174.

Jones, G. A. (1983). Musculoskeletal problems at an accident and emergency department, and in general practice. *New Zealand Medical Journal, 96*(735), 529-531.

Jones, M. H., & Amendola, A. S. (2007a). Acute treatment of inversion ankle sprains: immobilization versus functional treatment. *Clinical Orthopaedics and Related Research, 455*, 169-172.

Jones, M. H., & Amendola, A. S. (2007b). Syndesmosis sprains of the ankle: A systematic review. *Clinical Orthopaedics and Related Research, 455*, 173-175.

Jones, M. H., Grimmer, K., Edwards, I., Higgs, J., & Trede, F. (2006). Challenges in applying best evidence to physiotherapy. *Internet Journal of Allied Health Sciences & Practice, 4*(3), 8.

Jonsson, E., Seiger, A., & Hirschfeld, H. (2004). One-leg stance in healthy young and elderly adults: A measure of postural steadiness? *Clinical Biomechanics, 19*(7), 688-694.

Jonsson, E., Seiger, A., & Hirschfeld, H. (2005). Postural steadiness and weight distribution during tandem stance in healthy young and elderly adults. *Clinical Biomechanics, 20*(2), 202-208.

Kaikkonen, A., Kannus, P., & Jarvinen, M. (1994). A performance test protocol and scoring scale for the evaluation of ankle injuries. *American Journal of Sports Medicine, 22*(4), 462-469.

Kaminski, T. W., Perrin, D. H., & Gansneder, B. M. (1999). Eversion strength analysis of uninjured and functionally unstable ankles. *Journal of Athletic Training, 34*(3), 239-245.

Kannus, P., & Renstrom, P. (1991). Current concepts review: Treatment for acute tears of the lateral ligaments of the ankle. *Journal of Bone and Joint Surgery: American Volume, 73 A*(2), 305-312.

Karlsson, J., Eriksson, B. I., & 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.

Karlsson, J., & Peterson, L. (1991). Evaluation of Ankle Joint Function: The use of a scoring scale. *The Foot, 1*, 15-19.

Karnofel, H., Wilkinson, K., & Lentell, G. L. (1989). Reliability of isokinetic muscle testing at the ankle. *Journal of Orthopaedic and Sports Physical Therapy, 11*(4), 150-154.

Katrak, P., Bialocerkowski, A. E., Massy-Westropp, N., Kumar, S., & Grimmer, K. A. (2004). A systematic review of the content of critical appraisal tools. *BMC Medical Research Methodology, 4*, 22.

Kay, T. M., Myers, A. M., & Huijbregts, M. P. J. (2001). How far have we come since 1992? A comparative survey of physiotherapists' use of outcome measures. *Physiotherapy Canada, 53*(4), 268-275.

Kelleher, C. J., Pleil, A. M., Reese, P. R., Burgess, S. M., & Brodish, P. H. (2004). How much is enough and who says so? *International Journal of Obstetrics and Gynaecology, 111*(6), 605-612.

Keller, S. D., Ware, J. E., Jr., Hatoum, H. T., & Kong, S. X. (1999). The SF-36 Arthritis-Specific Health Index (ASHI): II. Tests of validity in four clinical trials. *Medical Care, 37*(Suppl. 5), MS51-60.

Kerkhoffs, G. M., Handoll, H. H., de Bie, R., Rowe, B. H., & Struijs, P. A. (2007). Surgical versus conservative treatment for acute injuries of the lateral ligament complex of the ankle in adults. *Cochrane Database of Systematic Reviews*,(2), CD000380.

Kerkhoffs, G. M., Rowe, B. H., Assendelft, W. J., Kelly, K., Struijs, P. A., & van Dijk, C. N. (2002). Immobilisation and functional treatment for acute lateral ankle ligament injuries in adults. *Cochrane Database of Systematic Reviews*,(3), CD003762.

Kerkhoffs, G. M., Rowe, B. H., Assendelft, W. J., Kelly, K. D., Struijs, P. A., & van Dijk, C. N. (2001). Immobilisation for acute ankle sprain: A systematic review. *Archives of Orthopaedic & Trauma Surgery, 121*(8), 462-471.

Kerkhoffs, G. M., Struijs, P. A., Marti, R. K., Assendelft, W. J., Blankevoort, L., & van Dijk, C. N. (2002). Different functional treatment strategies for acute lateral ankle ligament injuries in adults. *Cochrane Database of Systematic Reviews,*(3), CD002938.

Kidgell, D. J., Horvath, D. M., Jackson, B. M., & Seymour, P. J. (2007). Effect of six weeks of dura disc and mini-trampoline balance training on postural sway in athletes with functional ankle instability. *Journal of Strength and Conditioning Research, 21*(2), 466-469.

Klevsgard, R., Froberg, B. L., Risberg, B., & Hallberg, I. R. (2002). Nottingham Health Profile and Short-Form 36 Health Survey questionnaires in patients with chronic lower limb ischemia: Before and after revascularization. *Journal of Vascular Surgery, 36*(2), 310-317.

Kneebone, R. (2002). Total internal reflection: An essay on paradigms. *Medical Education, 36*(6), 514-518.

Koch, T. (1996). Implementation of a hermeneutic inquiry in nursing: Philosophy, rigour and representation. *Journal of Advanced Nursing, 24*(1), 174-184.

Koch, T. (2006). Establishing rigour in qualitative research: The decision trail. *Journal of Advanced Nursing, 53*(1), 91-103.

Koch, T., & Harrington, A. (1998). Reconceptualizing rigour: the case for reflexivity. *Journal of Advanced Nursing, 28*(4), 882-890.

Koll, R., Buhr, M., Dieter, R., Pabst, H., Predel, H. G., Petrowicz, O., et al. (2004). Efficacy and tolerance of a comfrey root extract (Extr. Rad. Symphyti) in the treatment of ankle distorsions: Results of a multicenter, randomized, placebo-controlled, double-blind study. *Phytomedicine, 11*(6), 470-477.

Konradsen, L., Olesen, S., & Hansen, H. M. (1998). Ankle sensorimotor control and eversion strength after acute ankle inversion injuries. *American Journal of Sports Medicine, 26*(1), 72-77.

Kuhn, T. S. (1996). *The structure of scientific revolutions* (3rd ed.). Chicago: University of Chicago Press.

Larmer, P. J., Robb, G., Hing, W., Reid, D., & McNair, P. J. (2002). Use of a vignette to investigate the physiotherapy treatment of an acute ankle sprain: Report of a survey of New Zealand physiotherapists. *New Zealand Journal of Physiotherapy, 30*(2), 36 -41.

Le Clair, K., & Riach, C. (1996). Postural stability measures: What to measure and for how long. *Clinical Biomechanics, 11*(3), 176-178.

Leanderson, J., Bergqvist, M., Rolf, C., Westblad, P., Wigelius-Roovers, S., & Wredmark, T. (1999). Early influence of an ankle sprain on objective measures of ankle joint function: A prospective randomised study of ankle brace treatment. *Knee Surgery, Sports Traumatology, Arthroscopy, 7*(1), 51-58.

Leanderson, J., & 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.

Leder, D. (1984). Medicine and paradigms of embodiment. *Journal of Medicine and Philosophy, 9*(1), 29-43.

Lee, S., James, W. C., Cohen, B. E., Davis, W. H., & Anderson, R. B. (2005). Evaluation of hallux alignment and functional outcome after isolated tibial sesamoidectomy. *Foot and Ankle International, 26*(10), 803-809.

Legnani, G., Zappa, B., Casolo, F., Adamini, R., & Magnani, P. L. (2000). A model of an electro-goniometer and its calibration for biomechanical applications. *Medical Engineering and Physics, 22*(10), 711-722.

Lentell, G. L., Baas, B., Lopez, D., McGuire, L., Sarrels, M., & Snyder, P. (1995). The contributions of proprioceptive deficits, muscle function, and anatomic laxity to functional instability of the ankle. *Journal of Orthopaedic and Sports Physical Therapy, 21*(4), 206-215.

Lentell, G. L., Katzman, L. L., & Walters, M. R. (1990). The relationship between muscle function and ankle stability. *Journal of Orthopaedic and Sports Physical Therapy, 11*(12), 605-611.

Leslie, M., Zachazewski, J., & Browne, P. (1990). Reliability of isokinetic torque values for ankle invertors and evertors. *Journal of Orthopaedic and Sports Physical Therapy, 11*(12), 612-616.

Liang, M. H. (2000). Longitudinal construct validity: Establishment of clinical meaning in patient evaluative instruments. *Medical Care, 38*(Suppl. 9), 1184-1190.

Liang, M. H., Lew, R. A., Stucki, G., Fortin, P. R., & Daltroy, L. (2002). Measuring clinically important changes with patient-oriented questionnaires. *Medical Care, 40*(Suppl. 4), 1145-1151.

Loudon, J. K., Santos, M. J., Franks, L., & Liu, W. (2008). The effectiveness of active exercise as an intervention for functional ankle instability: A systematic review. *Sports Medicine, 38*(7), 553-563.

Lynch, S. A., & Renstrom, P. (1999). Treatment of acute lateral ankle ligament rupture in the athlete- Conservative versus surgical treatment. *Sports Medicine, 27*(1), 61-71.

Lysholm, J., & Gillquist, J. (1982). Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *American Journal of Sports Medicine, 10*(3), 150-154.

MacLeod, R., & McPherson, K. M. (2007). Care and compassion: part of person-centred rehabilitation, inappropriate response or a forgotten art? *Disability Rehabilitation, 29*(20-21), 1589-1595.

Man, I. O., Morrissey, M. C., & Cywinski, J. K. (2007). Effect of neuromuscular electrical stimulation on ankle swelling in the early period after ankle sprain. *Physical Therapy, 87*(1), 53-65.

Mann, G., Nyska, M., Hetsroni, I., & Karlsson, J. (2006). Scoring systems for evaluating ankle function. *Foot and Ankle Clinics, 11*(3), 509-519.

Marshall, J. D. (1987). *Positivism or pragmatism: Philosophy of education in New Zealand* (Vol. 2). Auckland, New Zealand: New Zealand Association for Research in Education.

Marshall, R. J., Gee, R., Israel, M., Neave, D., Edwards, F., Dumble, J., et al. (1990). The use of alternative therapies by Auckland general practitioners. *New Zealand Medical Journal, 103*(889), 213-215.

Martin, R. L., & Irrgang, J. J. (2007). A survey of self-reported outcome instruments for the foot and ankle. *Journal of Orthopaedic and Sports Physical Therapy, 37*(2), 72-84.

Martin, R. L., Irrgang, J. J., Lalonde, K. A., & Conti, S. (2006). Current concepts review: Foot and ankle outcome instruments. *Foot and Ankle International, 27*(5), 383-390.

Martin, R. L., Manning, C. M., Carcia, C. R., & Conti, S. F. (2005). An outcome study of chronic achilles tendinosis after excision of the Achilles tendon and flexor hallucis longus tendon transfer. *Foot and Ankle International, 26*(9), 691-697.

Martin, R. L., Stewart, G. W., & Conti, S. F. (2007). Posttraumatic ankle arthritis: An update on conservative and surgical management. *Journal of Orthopaedic and Sports Physical Therapy, 37*(5), 253-259.

Mayo, N. E. (1994). Outcome measures or measuring outcome. *Physiotherapy Canada, 46*(3), 145-146, 148-151.

McKeon, P. O., & Hertel, J. (2008). Systematic review of postural control and lateral ankle instability. Part I: Can deficits be detected with instrumented testing. *Journal of Athletic Training, 43*(3), 293-304.

McKibbon, K. A., & Gadd, C. S. (2004). A quantitative analysis of qualitative studies in clinical journals for the 2000 publishing year. *BMC Medical Informatics and Decision Making, 4*(1), 11.

McKnight, C. M., & Armstrong, C. W. (1997). The role of ankle strength in functional ankle instability. *Journal of Sport Rehabilitation, 6*(1), 21-29.

McMurray, R., Heaton, J., Sloper, P., & Nettleton, S. (1999). Measurement of patient perceptions of pain and disability in relation to total hip replacement: The place of the Oxford hip score in mixed methods. *Quality in Health Care, 8*(4), 228-233.

McNair, P. J., Prapavessis, H., Collier, J., Bassett, S. F., Bryant, A., & Larmer, P. J. (2007). The lower-limb tasks questionnaire: An assessment of validity, reliability, responsiveness, and minimal important differences. *Archives of Physical Medicine and Rehabilitation, 88*(8), 993-1001.

McPherson, K., & Lord, S. (2000). Clinician's guide to research part 2: Matching the method to the question. *New Zealand Journal of Physiotherapy, 28*(2), 20- 28.

Middleton, J., Sinclair, P., & Patton, R. (1999). Accuracy of centre of pressure measurement using a piezoelectric force platform. *Clinical Biomechanics, 14*(5), 357-360.

Moe, R. H., Haavardsholm, E. A., Christie, A., Jamtvedt, G., Dahm, K. T., & Hagen, K. B. (2007). Effectiveness of nonpharmacological and nonsurgical interventions for hip osteoarthritis: An umbrella review of high-quality systematic reviews. *Physical Therapy, 87*(12), 1716-1727.

Moseley, A. M., Herbert, R. D., Sherrington, C., & Maher, C. G. (2002). Evidence for physiotherapy practice: A survey of the Physiotherapy Evidence Database (PEDro). *Australian Journal of Physiotherapy, 48*(1), 43-49.

Mueller-Vollmer, K. (2002). *The Hermeneutics reader : Texts of the German tradition from the Enlightenment to the present*. New York: Continuum.

Munn, J., Beard, D. J., Refshauge, K. M., & Lee, R. W. Y. (2002). Do functional-performance tests detect impairment in subjects with ankle instability? *Journal of Sport Rehabilitation, 11*(1), 40-50.

Munn, J., Beard, D. J., Refshauge, K. M., & Lee, R. Y. W. (2003). Eccentric muscle strength in functional ankle instability. *Medicine and Science in Sports and Exercise, 35*(2), 245-250.

National Research Council, & Institute of Medicine. (2001). *Musculoskeletal disorders and the workplace: Low back and upper extremities. Panel on Musculoskeletal Disorders and the Workplace, Commission on Behavioral and Social Sciences and Education.* Washington, DC: National Academy Press

Nicholls, D. A., & Larmer, P. J. (2005). Possible futures for physiotherapy: an exploration of the New Zealand context. *New Zealand Journal of Physiotherapy, 33*(2), 55-60.

Noyes, F. R., Barber, S. D., & Mangine, R. E. (1991). Abnormal lower limb symmetry determined by function hop tests after anterior cruciate ligament rupture. *American Journal of Sports Medicine, 19*(5), 513-518.

Nyska, M., Weisel, Y., Halperin, N., Mann, G., & Segal, D. (1999). Controlled mobilization after acute ankle inversion injury. *Journal of Sports Traumatology & Related Research, 21*(2), 114-120.

O'Connor, P. A., Yeap, S., Noel, J., Khayyat, G., Kennedy, J. G., Arivindan, S., et al. (2003). Lisfranc injuries: Patient- and physician-based functional outcomes. *International Orthopaedics, 27*(2), 98-102.

O'Donoghue, D. H. (1976). *Treatment of injuries to athletes* (3rd ed.). Philadelphia: Saunders.

Obremskey, W. T., Brown, O., Driver, R., & Dirschl, D. R. (2007). Comparison of SF-36 and Short Musculoskeletal Functional Assessment in recovery from fixation of unstable ankle fractures. *Orthopedics, 30*(2), 145-151.

Ogilvie-Harris, D. J., & Gilbart, M. (1995). Treatment modalities for soft tissue injuries of the ankle: A critical review. *Clinical Journal of Sport Medicine, 5*(3), 175-186.

Olerud, C., & Molander, H. (1984). A scoring scale for symptom evaluation after ankle fracture. *Archives of Orthopaedic & Trauma Surgery, 103*(3), 190-194.

Oxman, A. D., & Guyatt, G. H. (1991). Validation of an index of the quality of review articles. *Journal of Clinical Epidemiology, 44*(11), 1271-1278.

Oxman, A. D., Guyatt, G. H., Singer, J., Goldsmith, C. H., Hutchison, B. G., Milner, R. A., et al. (1991). Agreement among reviewers of review articles. *Journal of Clinical Epidemiology, 44*(1), 91-98.

Parker, J., Nester, C. J., Long, A. F., & Barrie, J. (2003). The problem with measuring patient perceptions of outcome with existing outcome measures in foot and ankle surgery. *Foot and Ankle International, 24*(1), 56-60.

Parker, S. P. (Ed.). (2002). *McGraw-Hill dictionary of scientific and technical terms* (6th ed.). London: McGraw-Hill.

Parry, R. H. (2003). Assessing qualitative research in rehabilitation: Guidelines from the society for research in rehabilitation. *Clinical Rehabilitation, 17*(3), 231-233.

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Services Research, 34*(5, Pt. 2), 1189-1208.

Pellow, J. E., & Brantingham, J. W. (2001). The efficacy of adjusting the ankle in the treatment of subacute and chronic grade I and grade II ankle inversion sprains. *Journal of Manipulative and Physiological Therapeutics, 24*(1), 17-24.

Pengel, L. H., Refshauge, K. M., Maher, C. G., Nicholas, M. K., Herbert, R. D., & McNair, P. (2007). Physiotherapist-directed exercise, advice, or both for subacute low back pain: A randomized trial. *Annals of Internal Medicine, 146*(11), 787-796.

Perron, M., Hebert, L. J., McFadyen, B. J., Belzile, S., & Regniere, M. (2007). The ability of the Biodex Stability System to distinguish level of function in subjects with a second-degree ankle sprain. *Clinical Rehabilitation, 21*(1), 73-81.

Pijnenburg, A. C. M., Bogaard, K., Krips, R., Marti, R. K., Bossuyt, P. M., & van Dijk, C. N. (2003). Operative and functional treatment of rupture of the lateral ligament of the ankle: A randomised, prospective trial. *Journal of Bone and Joint Surgery: British Volume, 85*(4), 525-530.

Pijnenburg, A. C. M., van Dijk, C. N., Bossuyt, P. M., & Marti, R. K. (2000). Treatment of ruptures of the lateral ankle ligaments: A meta-analysis. *Journal of Bone and Joint Surgery: British Volume, 82-A*(6), 761-773.

Pincus, T., Callahan, L. F., Brooks, R. H., Fuchs, H. A., Olsen, N. J., & Kaye, J. J. (1989). Self-report questionnaire scores in rheumatoid arthritis compared with traditional physical, radiographic, and laboratory measures. *Annals of Internal Medicine, 110*(4), 259-266.

Polkinghorne, D. (1983). *Methodology for the human sciences : Systems of inquiry*. Albany, N.Y.: State University of New York Press.

Pollard, B., Johnston, M., & Dixon, D. (2007). Theoretical framework and methodological development of common subjective health outcome measures in osteoarthritis: A critical review. *Health and Quality of Life Outcomes, 5*, 14.

Ponzer, S., Nasell, H., Bergman, B., & Tornkvist, H. (1999). Functional outcome and quality of life in patients with Type B ankle fractures: A two-year follow-up study. *Journal of Orthopaedic Trauma, 13*(5), 363-368.

Powers, M. E., Buckley, B. D., Kaminski, T. W., Hubbard, T. J., & Ortiz, C. (2004). Six weeks of strength and proprioception training does not affect muscle fatigue and static balance in functional ankle instability. *Journal of Sport Rehabilitation, 13*(3), 201-227.

Pratt, J. W. (1989). Towards a philosophy of physiotherapy. *Physiotherapy, 75*(2), 114-120.

Pugia, M. L., Middel, C. J., Seward, S. W., Pollock, J. L., Hall, R. C., Lowe, L., et al. (2001). Comparison of acute swelling and function in subjects with lateral ankle injury. *Journal of Orthopaedic and Sports Physical Therapy, 31*(7), 384-388.

Refshauge, K. M. (2003). The role of proprioception in the secondary prevention of ankle sprains in athletes. *International SportMed Journal, 4*(5), 1-15.

Refshauge, K. M. (2008). Immobilization versus functional treatment for ankle sprains: A systematic review. *Clinical Journal of Sport Medicine, 18*(4), 376-377.

Refshauge, K. M., Kilbreath, S. L., & Raymond, J. (2003). Deficits in detection of inversion and eversion movements among subjects with recurrent ankle sprains. *Journal of Orthopaedic and Sports Physical Therapy, 33*(4), 166-176.

Relman, A. S. (1988). Assessment and accountability: The third revolution in medical care. *New England Journal of Medicine, 319*(18), 1220-1222.

Revicki, D. A., Cella, D., Hays, R. D., Sloan, J. A., Lenderking, W. R., & Aaronson, N. K. (2006). Responsiveness and minimal important differences for patient reported outcomes. *Health and Quality of Life Outcomes, 4*, 70.

Riemann, B. L. (2002). Is there a link between chronic ankle instability and postural instability? *Journal of Athletic Training, 37*(4), 386-393.

Riemann, B. L., Caggiano, N. A., & Lephart, S. M. (1999). Examination of a clinical method of assessing postural control during a functional performance task. *Journal of Sport Rehabilitation, 8*(3), 171-183.

Robbins, S., & Waked, E. (1998). Factors associated with ankle injuries: Preventive measures. *Sports Medicine, 25*(1), 63-72.

Roos, E. M., Brandsson, S., & Karlsson, J. (2001). Validation of the foot and ankle outcome score for ankle ligament reconstruction. *Foot and Ankle International, 22*(10), 788-794.

Rose, A., Lee, R. J., Williams, R. M., Thomson, L. C., & Forsyth, A. (2000). Functional instability in non-contact ankle ligament injuries. *British Journal of Sports Medicine, 34*(5), 352-358.

Ross, S. E., Guskiewicz, K. M., Gross, M. T., & Yu, B. (2008). Assessment tools for identifying functional limitations associated with functional ankle instability. *Journal of Athletic Training, 43*(1), 44-50.

Rozzi, S. L., Lephart, S. M., Sterner, R., & Kuligowski, L. (1999). Balance training for persons with functionally unstable ankles. *Journal of Orthopaedic and Sports Physical Therapy, 29*(8), 478-486.

Ryan, J. B., Hopkinson, W. J., Wheeler, J. H., Arciero, R. A., & Swain, J. H. (1989). Office management of the acute ankle sprain. *Clinical Journal of Sport Medicine, 8*(3), 477-495.

Ryan, L. (1994). Mechanical instability, muscle strength and proprioception in the functionally stable ankle. *Australian Journal of Physiotherapy, 40*, 41 - 47.

Rzonca, E. C., & Lue, B. Y. (1988). TEMPER: An acronym for ankle sprain rehabilitation. *Clinics in Podiatric Medicine and Surgery, 5*(3), 661-675.

Sackett, D. L., Stauss, S. E., Richardson, W. S., Rosenburg, W., & Haynes, R. B. (2000). *Evidence- Based Medicine* (2nd ed.). London: Churchill Livingstone.

Safran, M. R., Benedetti, R. S., Bartolozzi, A. R., & Mandelbaum, B. R. (1999). Lateral ankle sprains: A comprehensive review: Part 1: Etiology, pathoanatomy, histopathogenesis, and diagnosis. *Medicine and Science in Sports and Exercise, 31*(Suppl. 7), S429-437.

Safran, M. R., Zachazewski, R. S., Benedetti, R. S., Bartolozzi, A. R., 3rd, & Mandelbaum, B. R. (1999). Lateral ankle sprains: a comprehensive review: part 2: treatment and rehabilitation with an emphasis on the athlete. *Medicine and Science in Sports and Exercise, 31*(7 Suppl), S438 - S447.

Salaffi, F., Stancati, A., Silvestri, C. A., Ciapetti, A., & Grassi, W. (2004). Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. *European Journal of Pain, 8*(4), 283-291.

Saltzman, C. L. (2001). Why outcomes research? *Foot and Ankle International, 22*(10), 773-774.

Saltzman, C. L., Mueller, C., Zwior-Maron, K., & Hoffman, R. D. (1998). A primer on lower extremity outcome measurement instruments. *Iowa Orthopaedic Journal, 18*, 101-111.

Sarantakos, S. (1994). *Social research*. Melbourne, Australia: Macmillan.

Schaap, G. R., de Keizer, G., & Marti, K. (1989). Inversion trauma of the ankle. *Archives of Orthopaedic & Trauma Surgery, 108*(5), 273-275.

Schmitt, H., Kuni, B., & Sabo, D. (2005). Influence of professional dance training on peak torque and proprioception at the ankle. *Clinical Journal of Sport Medicine, 15*(5), 331-339.

Schon, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Sekir, U., Yildiz, Y., Hazneci, B., Ors, F., & Aydin, T. (2007). Effect of isokinetic training on strength, functionality and proprioception in athletes with functional ankle instability. *Knee Surgery, Sports Traumatology, Arthroscopy, 15*(5), 654-664.

Seymour, D. G., Ball, A. E., Russell, E. M., Primrose, W. R., Garratt, A. M., & Crawford, J. R. (2001). Problems in using health survey questionnaires in older patients with physical disabilities: The reliability and validity of the SF-36 and the effect of cognitive impairment. *Journal of Evaluation in Clinical Practice, 7*(4), 411-418.

Sholukha, V., Salvia, P., Hilal, I., Feipel, V., Rooze, M., & Jan, S. V. (2004). Calibration and validation of 6 DOFs instrumented spatial linkage for biomechanical applications. A practical approach. *Medical Engineering and Physics, 26*(3), 251-260.

Smeeth, L., Haines, A., & Ebrahim, S. (1999). Numbers needed to treat derived from meta-analyses: Sometimes informative, usually misleading. *British Medical Journal, 318*(7197), 1548-1551.

Smythe, E. A., Ironside, P. M., Sims, S. L., Swenson, M. M., & Spence, D. G. (2007). Doing Heideggerian hermeneutic research: A discussion paper. *Int J Nurs Stud*.

SooHoo, N. F., Samimi, D. B., Vyas, R. M., & Botzler, T. (2006). Evaluation of the validity of the Foot Function Index in measuring outcomes in patients with foot and ankle disorders. *Foot and Ankle International, 27*(1), 38-42.

SooHoo, N. F., Shuler, M., & Fleming, L. L. (2003). Evaluation of the validity of the AOFAS Clinical Rating Systems by correlation to the SF-36. *Foot and Ankle International, 24*(1), 50-55.

SooHoo, N. F., Vyas, R., & Samimi, D. (2006). Responsiveness of the Foot Function Index, AOFAS Clinical Rating Systems, and SF-36 after foot and ankle surgery. *Foot and Ankle International, 27*(11), 930-934.

Stainton Rogers, W. (1991). *Explaining health and illness: An exploration of diversity*. New York: Harvester Wheatsheaf.

Strand, L. I., Ljunggren, A. E., Bogen, B., Ask, T., & Johnsen, T. B. (2008). The Short-Form McGill Pain Questionnaire as an outcome measure: Test-retest reliability and responsiveness to change. *European Journal of Pain, 12*(7), 917-925.

Stratford, P. W., Spadoni, G., Kennedy, D., Westaway, M. D., & Alcock, G. K. (2002). Seven points to consider when investigating a measure's ability to detect change. *Physiotherapy Canada, 54*(1), 16-24.

Swiontkowski, M. F., Buckwalter, J. A., Keller, R. B., & Haralson, R. (1999). The outcomes movement in orthopaedic surgery: Where we are and where we should go. *Journal of Bone and Joint Surgery-American Volume, 81*(5), 732-740.

Tashakkori, A. T., C. (2003). *Handbook of mixed methods in the social and behavioural sciences.* Thousand Oaks, CA: Sage.

Tesio, L., Monzani, M., Gatti, R., & Franchignoni, F. (1995). Flexible electrogoniometers: Kinesiological advantages with respect to potentiometric goniometers. *Clinical Biomechanics, 10*(5), 275-277.

Thomson, L., Handoll, H., Cunningham, A., & Shaw, P. (2004). Physiotherapist-led programmes and interventions for rehabilitation of anterior cruciate ligament, medial collateral ligament and meniscal injuries of the knee in adults (Cochrane Review). *The Cochrane Library*(4).

Toolan, B. C., Wright Quinones, V. J., Cunningham, B. J., & Brage, M. E. (2001). An evaluation of the use of retrospectively acquired preoperative AOFAS clinical rating scores to assess surgical outcome after elective foot and ankle surgery. *Foot and Ankle International, 22*(10), 775-778.

Tran, T., & Thordarson, D. (2002). Functional outcome of multiply injured patients with associated foot injury. *Foot and Ankle International, 23*(4), 340-343.

Trevino, S. G., Davis, P., & Hecht, P. J. (1994). Management of acute and chronic lateral ligament injuries of the ankle. *Orthopedic Clinics of North America, 25*(1), 1-16.

Tropp, H. (1986). Pronator muscle weakness in functional instability of the ankle joint. *International Journal of Sports Medicine, 7*, 291 - 294.

Tropp, H., & Odenrick, P. (1988). Postural control in single- limb stance. *Journal of Orthopaedic Research, 6*, 833 - 839.

Utter, J., Scragg, R., Denny, S., & Schaaf, D. (2009). Trends in body mass index and waist circumference among New Zealand adolescents, 1997/1998-2005. *Obesity Reviews, (epub)*(Mar 24).

Valderas, J. M., Kotzeva, A., Espallargues, M., Guyatt, G. H., Ferrans, C. E., Halyard, M. Y., et al. (2008). The impact of measuring patient-reported outcomes in clinical practice: a systematic review of the literature. *Quality of Life Research, 17*(2), 179-193.

Vallance-Owen, A., & Cubbin, S. (2002). National monitoring of clinical effectiveness using the SF-36 questionnaire: Using the results for revalidation and clinical governance. *Clinician in Management, 11*(3), 137-142.

van den Berg, J. H. (1952). The human body and the significance of human movement: A phenomenological study. *Philosophy and Phenomenological Research, 13*(2), 159-183.

van der Wees, P. J., Lenssen, A. F., Hendriks, E. J., Stomp, D. J., Dekker, J., & de Bie, R. A. (2006). Effectiveness of exercise therapy and manual mobilisation in ankle sprain and functional instability: A systematic review. *Australian Journal of Physiotherapy, 52*(1), 27-37.

van Os, A. G., Bierma-Zeinstra, S. M., Verhagen, A. P., de Bie, R. A., Luijsterburg, P. A., & Koes, B. W. (2005). Comparison of conventional treatment and supervised

rehabilitation for treatment of acute lateral ankle sprains: A systematic review of the literature. *Journal of Orthopaedic and Sports Physical Therapy, 35*(2), 95-105.

van Rijn, R. M., van Os, A. G., Bernsen, R. M., Luijsterburg, P. A., Koes, B. W., & Bierma-Zeinstra, S. M. (2008). What is the clinical course of acute ankle sprains? A systematic literature review. *American Journal of Medicine, 121*(4), 324-331.

Verhaak, P. F., Kerssens, J. J., Dekker, J., Sorbi, M. J., & Bensing, J. M. (1998). Prevalence of chronic benign pain disorder among adults: A review of the literature. *Pain, 77*(3), 231-239.

Verhagen, R. A., de Keizer, G., & van Dijk, C. N. (1995). Long-term follow-up of inversion trauma of the ankle. *Archives of Orthopaedic & Trauma Surgery, 114*(2), 92-96.

Waddington, G. S., & Adams, R. D. (1999). Discrimination of active plantarflexion and inversion movements after ankle injury. *Australian Journal of Physiotherapy, 45*(1), 7-13.

Ware, J. E., Kosinski, M., & Dewey, J. E. (2000). *How to score Version 2 of the SF-36 Health Survey*. Lincoln, RI: QualityMetric Incorporated.

Ware, J. E., Kosinski, M., & Gandek, B. (2002). *SF-36 Health Survey: Manual and Interpretation Guide*. Lincoln, RI: QualityMetric Incorporated.

Ware, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care, 34*(3), 220-233.

Wilkerson, G. B., & Horn-Kingery, H. M. (1993). Treatment of the inversion ankle sprain: Comparison of different modes of compression and cryotherapy. *Journal of Orthopaedic and Sports Physical Therapy, 17*(5), 240-246.

Wilkerson, G. B., Pinerola, J. J., & Caturano, R. W. (1997). Invertor vs. evertor peak torque and power deficiencies associated with lateral ankle ligament injury. *Journal of Orthopaedic and Sports Physical Therapy, 26*(2), 78-86.

Willems, T., Witvrouw, E., Verstuyft, J., Vaes, P., & De Clercq, D. (2002). Proprioception and muscle strength in subjects with a history of ankle sprains and chronic instability. *Journal of Athletic Training, 37*(4), 487-493.

Williams, G. N., Molloy, J. M., DeBerardino, T. M., Arciero, R. A., & Taylor, D. C. (2003). Evaluation of the Sports Ankle Rating System in young, athletic individuals with acute lateral ankle sprains. *Foot and Ankle International, 24*(3), 274-282.

Wilson, R. W., Gieck, J. H., Gansneder, B. M., Perrin, D. H., Saliba, E. N., & McCue, F. C. I. (1998). Reliability and responsiveness of disablement measures following acute ankle sprains among athletes. *Journal of Orthopaedic and Sports Physical Therapy, 27*(5), 348-355.

Wong, D. L., Glasheen-Way, M., & Andrews, L. F. (1984). lsokinetic evaluation of the ankle invertors and evertors. *Journal of Orthopaedic and Sports Physical Therapy, 5*(5), 246-252.

World Health Organization. (2001). *International classification of functioning, disability and health.* Geneva, Switzerland: Author.

Wu, A., Edgar, D. W., & Wood, F. M. (2007). The QuickDASH is an appropriate tool for measuring the quality of recovery after upper limb burn injury. *Burns, 33*(7), 843-849.

Yeung, M. S., Chan, K. M., So, C. H., & Yuan, W. Y. (1994). An epidemiological survey on ankle sprain. *British Journal of Sports Medicine, 28*(2), 112-116.

Zammit, E., & 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.

Appendices

Appendix A: Scoring System for grading Systematic Reviews

The scores for individual items of the methodological quality assessment scheme range from 2,1,0 in keeping with the modified list from the Effective Practice and Orgainisation of Care (EPOC) group within the Cochrane Collaboration (Moe et al., 2007).

A. Is the search strategy described in enough detail for the search to be reproducible?
   2 = Met
   1 = Unclear/partly met
   0 = Not met

B. Was the search for evidence reasonably comprehensive? (was unpublished research as well as large databases included)
   2 = Met
   1 = Unclear/partly met
   0 = Not met

C. Were the criteria used for deciding which studies to include in the review reported?
   2 = Met
   1 = Unclear/partly met
   0 = Not met

D. Was bias in selection of articles avoided? (was explicit criteria used rather than personal judgement)
   2 = Met
   1 = Unclear/partly met
   0 = Not met

E. Were the criteria used for assessing the validity of the studies that were reviewed reported? (was explicit criteria used rather than personal judgement)
   2 = Met
   1 = Unclear/partly met
   0 = Not met

F. Was the validity of all the studies referred to in the text assessed using appropriate criteria in analysing the studies that are citied?
   2 = Met
   1 = Unclear/partly met
   0 = Not met

G. Were the methods used to combine the findings of the relevant studies (to reach a conclusion) reported?
   2 = Met
   1 = Unclear/partly met
   0 = Not met

H. Were the findings of the relevant studies combined (or not combined) and analysed appropriately relative to the primary question the review addresses and the available data?
   2 = Met
   1 = Unclear/partly met
   0 = Not met

I. Were the conclusions made by the authors(s) supported by the data and/or the analysis in the review?
   2 = Met
   1 = Unclear/partly met
   0 = Not met

Appendix B: Modified Scoring System for grading Outcome Studies

The scoring scheme for the seven aspects of the quality assessment tool is based on the Cochrane Musculoskeletal Injuries group (CMSIG) scoring scheme (Thomson et al., 2004). The questions have been adapted by the author to answer specific interest for this study.

A. Were the outcome measure questionnaires used clearly defined?
2 = clearly defined.
1 = inadequately defined.
0 = not defined.

B. Was there justifcation provided for choosing the outcomes?
2 = Yes and comprehensive
1 = Partial
0 = No or unclear

C. Was there evidence that the questionnaire been validated?
2 = Validity described.
1 = Referred to previous validity.
0 = Not mentioned or had not been validated.

D. Was there evidence that questionnaire had undergone reliability testing?
2 = Reliability described and high.
1 = Referred to previous reliability studies only.
0 = Not mentioned or no reliability undertaken.

E. Was there evidence that that the questionnaire's responsiveness?
2 = Responsiveness described and high.
1 = Referred to previous responsiveness studies only.
0 = Responsiveness was poor or not mentioned.

F. Was the questionnaire relevant to the author's research question?
2 = Questionnaire specific and highly relevant.
1 = General questionnaire only.
0 = Unclear.

G. Was there evidence that the questionnaire has been used widely?
2 = Questionnaire widely used.
1 = Questionnaire infrequently used.
0 = First time used or modified questionnaire.

H. Could clinicians easily use the questionnaires?
2 = Used often and easily performed.
1 = Used rarely or difficult to perform.
0 = Unable to assess if relevant in the clinical setting

Appendix C: Modified Scoring System for grading Intervention Studies

The scores for individual items of the methodological quality assessment scheme range from 2,1,0 in keeping with the revised Cochrane Musculoskeletal Injuries group (CMSIG) scoring scheme (Thomson et al., 2004). Questions G, H and I have been adapted by the author to answer specific interest for this study.

A. Were the outcomes of patients who withdrew described and included in the analysis (intention to treat)?
2 = withdrawals well described and accounted for in analysis.
1 = withdrawals described and analysis not possible; or no loss implied from the trial results (all participants included in analyses).
0 = no mention, inadequate mention, or obvious differences and no adjustment.

B. Were the treatment and control group comparable at entry?
The principle confounders were considered to be previous ankle injury, previous ankle surgery, current ankle injury, level of activity, age and sex.
2 = good comparability of groups, or confounding adjusted for in analysis.
1 = confounding small; mentioned but not adjusted for or control uninjured ankle.
0 = large potential for confounding, or not discussed.

C. Were care programmes, other than the trial options, identical?
Examples of clinically important differences in other interventions which could act as active measures for prevention of ankle ligament injuries, or possible risk factors, were considered to be: footwear, training programmes, advice on activity, other devices.
2 = care programmes clearly identical.
1 = clear but trivial differences.
0 = no care programmes or clear and important differences in care programmes.

D. Were the inclusion and exclusion criteria clearly defined?
2 = clearly defined.
1 = inadequately defined.
0 = not defined.

E. Were the outcome measures used clearly defined? (by outcome measure)
2 = clearly defined.
1 = inadequately defined.
0 = not defined.

F. Were testing procedures used clearly defined? (by outcome)
2 = clearly defined.
1 = inadequately defined.
0 = not defined.

G. Had the testing technique been validated?
2 = Validity described.
1 = Referred to previous validity.
0 = Not mentioned or had not been validated.

H. Was the testing technique reliable?
2 = Reliability described and high.
1 = Reliability described and moderate.
0 = Reliability was poor or not mentioned.

I. Was there clinical relevance of the intervention?
Eg would clinicians generally use this intervention for this condition.
2 = Used often and easily performed.
1 = Used rarely or difficult to perform.
0 = Not used in the clinical setting

Appendix D: Physiotherapy Information Sheet

Physiotherapist Information Sheet

AUCKLAND UNIVERSITY OF TECHNOLOGY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Project Title:

Ankle sprains: An investigation into the results of different outcome measures used before and after treatment.

Invitation

Physiotherapists from private practice physiotherapy clinics who treat patients with a sprained ankle are invited to be part of the study. If you fulfil the criteria for this study and complete an informed consent document, you can join this study.

What is the purpose of the study?

The aim of this study is to investigate the relationship between different outcome measures from a patient's perspective and clinician's perspective.

What happens in the study?

Patients complete several questionnaires on their initial consultation after agreeing to participate and completing a consent form. The physiotherapist will also complete a global assessment questionnaire. The completed questionnaires are then forwarded by the physiotherapist to the researcher. Upon discharge the physiotherapist will again complete a global assessment questionnaire and return by post. The physiotherapist will then notify the researcher that the patient has been discharged. After notification of discharge by the physiotherapist the patients are contacted by phone and the same questionnaires are either mailed out or delivered to the patient and again completed and returned in the stamped addressed envelope. Approximately six week later patients are asked to attend one testing session at the Physical Rehabilitation Research Centre at Akoranga Campus of Auckland University of Technology. Patients will undergo specific practical exercises as well as answer the previous questionnaires. The practical testing session should not be difficult. A selection of patients will also be asked to participate in a one on one interview with the researcher. Depending on the results a selected group of participating physiotherapists may join a focus group to discuss the results of the testing session.

What are the discomforts and risks?

There is minimal risk associated with this study. Participation in this study will not cost you anything, though you will be required to travel to the Physical Rehabilitation Research Centre once if you are asked to join the focus group. Petrol vouchers of $10 are provided to all participants.

What are the benefits?

This study seeks to determine if outcome questionnaires reflect what the patient actually feels.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, you will be covered by the Accident Compensation legislation with its limitations. If you have any questions about ACC please feel free to ask the researcher for more information.

How is my privacy and confidentiality protected?

Your information is collected and used in accordance with the Privacy Act 1993.

The following steps are also taken to protect your privacy and confidentiality:

- Questionnaire forms are prepared with unique number only
- Mail-out is packaged and posted
- All names and contact details are deleted from data – leaving only unique number and demographic information

Costs of Participating (including time)

Participation in the study is voluntary. There is no cost to participants apart from the cost to travel to the Physical Rehabilitation Research Centre once. Petrol vouchers of $10 will be provided to all participants. The entire duration of the focus group session will be approximately 120 minutes.

Opportunity to consider invitation

You are free to contact Peter Larmer, peter.larmer@aut.ac.nz phone 09 917 9999 ext 7322, and have your questions answered. You have the right to withdraw from the research at any time, or to ask for your information to be withdrawn.

Opportunity to receive feedback on results of research

The results of this study will be published in health related journals and presented at appropriate conferences. It is usual that a delay between the end of the data collection and the publication or presentation of results may occur. The outcomes of this study will be available to participants by discussion with the principal researcher if you wish.

Participant Concerns

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Dr Peter McNair, peter.mcnair@aut.ac.nz phone 09 917 9999 ext 7146, or Dr Liz Smythe, LSMYTHE@aut.ac.nz phone 09 917 9999 ext 7196. Concerns regarding the conduct of the researcher should be notified to the Executive Secretary, AUTEC, Madeline Banda, madeline.banda@aut.ac.nz phone 09 917 9999 ext 8044.

Approved by the Auckland Ethics Committee on 24th February 2005 **Reference number** AKY/04/12/344

Appendix E: Consent to Participation in Research

Consent to Participation in Research

Participant Code:

Title of Project: Ankle sprains: An investigation into the results of different outcome measures used before and after treatment.

Project Supervisors: Dr Peter Mc Nair Position: Primary Supervisor
Dr Liz Smythe Position: Secondary Supervisor

Researcher: Peter Larmer Student of Doctor of Health Science of AUT

- I have read and understood the information provided about this research project.
- I have had an opportunity to ask questions and to have them answered.
- I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way. If I withdraw, I understand that all relevant information or parts thereof, will be destroyed.
- I agree to take part in this research.

Participant signature:.....Date:……

Confidential information:

Participant
name:……

Contact
Address:……

Contact Phone:……...

Researcher Contact Details:
Peter Larmer, peter.larmer@aut.ac.nz phone 09 917 9999 ext 7322

Project Supervisors Contact Details:
Dr Peter McNair, peter.mcnair@aut.ac.nz phone 09 917 9999 ext 7146
Dr Liz Smythe, LSMYTHE@aut.ac.nz phone 09 917 9999 ext 7196

Approved by the Auckland Ethics Committee on 24th February 2005 **Reference number** AKY/04/12/344

Appendix F: Physiotherapist Initial Global Assessment Questionnaire

Physiotherapist Initial
Global Assessment Questionnaire

Code: _____Date:_____

When answering these questions please reflect on your experience of treating ankle injuries and from the current patient's history.

Do not ask the patient these questions directly

Patient limitations

When comparing this sprained ankle injury to other ankle injuries you have seen, how do you rate the overall condition of this injury at the present time?

Please circle one number below.

1	2	3	4	5	6	7	8	9	10

ScaleDescription
2 – They have significant limitations that affect activities of daily living.
4 – They have moderate limitations that affect activities of daily living, e.g. no sports possible.
6 – They have some limitations e.g. with sports, but they can participate; they compensate.
10 – They are able to do whatever they wish with no problems.

_____

Patient prognosis

Please rate how well you think this patient is likely to recover.

Please circle one number below.

0	1	2	3	4

ScaleDescription
0 - Little or no change expected in impairment or function
1 - Some improvement expected in impairment and function
2 - Moderate change expected in impairment and function
3 - Good improvement expected in impairment and function
4 - Excellent improvement expected in impairment and function

Appendix G: Physiotherapist Discharge Global Assessment Questionnaire

Physiotherapist Discharge
Global Assessment Questionnaire

Code: _____Date:_____

When answering this question please reflect on your experience of treating ankle injuries and from the current patient's history.

Do not ask the patient this question directly

Patient's limitations

When comparing this sprained ankle injury to other ankle injuries you have seen, how do you rate the overall condition of this injury at the present time?

Please circle one number below.

1	2	3	4	5	6	7	8	9	10

ScaleDescription
2 – They have significant limitations that affect activities of daily living.
4 – They have moderate limitations that affect activities of daily living, no sports possible.
6 – They have some limitations e.g. with sports, but they can participate; they compensate.
10 – They are able to do whatever they wish with no problems.

Appendix H: Participant Information Sheet

Participant Information Sheet

AUT
AUCKLAND UNIVERSITY OF TECHNOLOGY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Project Title:

Ankle sprains: An investigation into the results of different outcome measures used before and after treatment.

Invitation

Patients from private practice physiotherapy clinics who present with a sprained ankle and are being treated for their sprained ankle are invited to be part of the study. If you fulfil the criteria for this study and complete an informed consent document, you can join this study.

What is the purpose of the study?

The aim of this study is to investigate the relationship between different evaluation forms from a patient's perspective and clinician's perspective.

What happens in the study?

Patients complete several questionnaires on their initial consultation after agreeing to participate and completing a consent form. The completed questionnaires are then forwarded by the physiotherapist to the researcher. After notification of discharge by the physiotherapist the patients are contacted by phone and the same questionnaires are either mailed out or delivered to the patient and again completed and returned in the stamped addressed envelope. Approximately six week later patients are asked to attend one testing session at the Physical Rehabilitation Research Centre at Akoranga Campus of Auckland University of Technology. Patients will undergo specific practical exercises as well as answer the previous questionnaires. The practical testing session should not be difficult. A selection of patients will also be asked to participate in a one-on-one interview with the researcher.

What are the discomforts and risks?

There is minimal risk associated with this study. Participation in this study will not cost you anything, though you will be required to travel to the Physical Rehabilitation Research Centre once. Petrol vouchers of $10 are provided to all participants.

How will these discomforts and risks be alleviated?

Testing procedures of the ankle will be under the control of the patient and patients will be freely able to communicate with the researcher at all times during the testing procedures and may cease participation in the study at any time.

What are the benefits?

This study seeks to determine if outcome questionnaires reflect what the patient actually feels.

What compensation is available for injury or negligence?

In the unlikely event of a physical injury as a result of your participation in this study, you will be covered by the Accident Compensation legislation with its limitations. If you have any questions about ACC please feel free to ask the researcher for more information.

How is my privacy and confidentiality protected?

Your information is collected and used in accordance with the Privacy Act 1993.

No materials which could personally identify you will be used in any reports on this study

The following steps are also taken to protect your privacy and confidentiality:

- Questionnaire forms are prepared with unique number only
- Mail-out is packaged and posted
- All names and contact details are deleted from data – leaving only unique number and demographic information

Costs of Participating (including time)

Participation in the study is voluntary. There is no cost to participants apart from the cost to travel to the Physical Rehabilitation Research Centre once. Petrol vouchers of $10 will be provided to all participants. The entire duration of the testing session will be approximately 120 minutes.

Opportunity to consider invitation

You are free to contact Peter Larmer, peter.larmer@aut.ac.nz phone 09 917 9999 ext 7322, and have your questions answered. You have the right to withdraw from the research at any time, or to ask for your information to be withdrawn.

Opportunity to receive feedback on results of research

The results of this study will be published in health related journals and presented at appropriate conferences. It is usual that a delay between the end of the data collection and the publication or presentation of results may occur. The outcomes of this study will be available to patients by discussion with the principal researcher if you wish.

Participant Concerns

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Dr Peter McNair, peter.mcnair@aut.ac.nz phone 09 917 9999 ext 7146, or Dr Liz Smythe, LSMYTHE@aut.ac.nz phone 09 917 9999 ext 7196. Concerns regarding the conduct of the researcher should be notified to the Executive Secretary, AUTEC, Madeline Banda, madeline.banda@aut.ac.nz phone 09 917 9999 ext 8044.

Approved by the Auckland Ethics Committee on 24th February 2005 **Reference number** AKY/04/12/344

Appendix I: Patient Initial Global Assessment Questionnaire

Patient Initial
Global Assessment Questionnaire

Code: _____Date:_____

Overall Condition scale:

Rate the **overall condition** of your ankle at the present time

Please circle one number below.

1	2	3	4	5	6	7	8	9	10

ScaleDescription
2 – I have significant limitations that affect activities of daily living.
4 – I have moderate limitations that affect activities of daily living, e.g. no sports possible.
6 – I have some limitations e.g. with sports, but I can participate; I compensate.
10 – I am able to do whatever I wish with no problems.

_____

Pain Scale:

Select the number that best describes **your pain** during the past 24 hours

Please circle one number below.

0	1	2	3	4	5	6	7	8	9	10

No Pain **Worst Pain Possible**

Appendix J: Lower Limb Tasks Questionnaire

LOWER LIMB TASKS QUESTIONNAIRE
ACTIVITIES OF DAILY LIVING SECTION

Patient: _____ **Date:**_____

INSTRUCTIONS
Please rate your ability to do the following activities in the **past 24 hours** by circling the number below the appropriate response.

If you did not have the opportunity to perform an activity in the **past 24 hours**, please make your *best estimate* on which response would be the most accurate.

Please also rate how important each task is to you in your daily life according to the following scale:

1. = Not important
2. = Mildly important
3. = Moderately important
4. = Very important

Please answer all questions.

		NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE	IMPORTANCE OF TASK
1.	Walk for 10 minutes	4	3	2	1	0	1 2 3 4
2.	Walk up or down 10 steps (1 flight)	4	3	2	1	0	1 2 3 4
3.	Stand for 10 minutes	4	3	2	1	0	1 2 3 4
4.	Stand for a typical work day	4	3	2	1	0	1 2 3 4
5.	Get on and off a bus	4	3	2	1	0	1 2 3 4
6.	Get up from a lounge chair	4	3	2	1	0	1 2 3 4
7.	Push or pull a heavy trolley	4	3	2	1	0	1 2 3 4
8.	Get in and out of a car	4	3	2	1	0	1 2 3 4
9.	Get out of bed in the morning	4	3	2	1	0	1 2 3 4
10.	Walk across a slope	4	3	2	1	0	1 2 3 4

TOTAL (/40):_____

Enquiries concerning this questionnaire: Peter J. McNair PhD, Health and Rehabilitation Research Centre, Auckland University of Technology, Private Bag 92006, Auckland; New Zealand. email: peter.mcnair@aut.ac.nz Phone: 921-9999 Ext 7143

LOWER LIMB TASKS QUESTIONNAIRE
RECREATIONAL ACTIVITIES SECTION

Patient: _____ **Date:**_____

INSTRUCTIONS
Please rate your ability to do the following activities in the **past 24 hours** by circling the number below the appropriate response.

If you did not have the opportunity to perform an activity in the **past 24 hours**, please make your *best estimate* on which response would be the most accurate.

Please also rate how important each task is to you in your daily life according to the following scale:

1. = Not important
2. = Mildly important
3. = Moderately important
4. = Very important

Please answer all questions.

		NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE	IMPORTANCE OF TASK
1.	Jog of 10 minutes	4	3	2	1	0	1 2 3 4
2.	Pivot or twist quickly while walking	4	3	2	1	0	1 2 3 4
3.	Jump for distance	4	3	2	1	0	1 2 3 4
4.	Run fast/sprint	4	3	2	1	0	1 2 3 4
5.	Stop and start moving quickly	4	3	2	1	0	1 2 3 4
6.	Jump upwards and land	4	3	2	1	0	1 2 3 4
7.	Kick a ball hard	4	3	2	1	0	1 2 3 4
8.	Pivot or twist quickly while running	4	3	2	1	0	1 2 3 4
9.	Kneel on both knees for 5 minutes	4	3	2	1	0	1 2 3 4
10.	Squat to the ground/floor	4	3	2	1	0	1 2 3 4

TOTAL (/40):_____

Enquiries concerning this questionnaire: Peter J. McNair PhD, Health and Rehabilitation Research Centre, Auckland University of Technology, Private Bag 92006, Auckland; New Zealand. email: peter.mcnair@aut.ac.nz Phone: 921-9999 Ext 7143

Your Health and Well-Being

This questionnaire asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. ***Thank you for completing this questionnaire!***

For each of the following questions, please mark an ☒ in the one box that best describes your answer.

1. In general, would you say your health is:

Excellent	Very good	Good	Fair	Poor
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

2. <u>Compared to one year ago</u>, how would you rate your health in general <u>now</u>?

Much better now than one year ago	Somewhat better now than one year ago	About the same as one year ago	Somewhat worse now than one year ago	Much worse now than one year ago
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

3. The following questions are about activities you might do during a typical day. Does <u>your health now limit you</u> in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all
a Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	☐ 1	☐ 2	☐ 3
b Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	☐ 1	☐ 2	☐ 3
c Lifting or carrying groceries	☐ 1	☐ 2	☐ 3
d Climbing several flights of stairs	☐ 1	☐ 2	☐ 3
e Climbing one flight of stairs	☐ 1	☐ 2	☐ 3
f Bending, kneeling, or stooping	☐ 1	☐ 2	☐ 3
g Walking more than a kilometre	☐ 1	☐ 2	☐ 3
h Walking several hundred metres	☐ 1	☐ 2	☐ 3
i Walking one hundred metres	☐ 1	☐ 2	☐ 3
j Bathing or dressing yourself	☐ 1	☐ 2	☐ 3

4. During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of your physical health</u>?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Cut down on the <u>amount of time</u> you spent on work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b <u>Accomplished less</u> than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Were limited in the <u>kind</u> of work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d Had <u>difficulty</u> performing the the work or other activities (for example, it took extra effort)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

5. During the <u>past 4 weeks</u>, how much of the time have you had any of the following problems with your work or other regular daily activities <u>as a result of any emotional problems</u> (such as feeling depressed or anxious)?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Cut down on the <u>amount of time</u> you spent on work or other activities	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b <u>Accomplished less</u> than you would like	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Did work or other activities <u>less carefully than usual</u>	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

6. During the <u>past 4 weeks</u>, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

Not at all	Slightly	Moderately	Quite a bit	Extremely
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

7. How much <u>bodily</u> pain have you had during the <u>past 4 weeks</u>?

None	Very mild	Mild	Moderate	Severe	Very severe
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

8. During the <u>past 4 weeks</u>, how much did <u>pain</u> interfere with your normal work (including both work outside the home and housework)?

Not at all	A little bit	Moderately	Quite a bit	Extremely
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

9. These questions are about how you feel and how things have been with you <u>during the past 4 weeks</u>. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the <u>past 4 weeks</u>…

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
a Did you feel full of life?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b Have you been very nervous?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c Have you felt so down in the dumps that nothing could cheer you up?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d Have you felt calm and peaceful?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
e Did you have a lot of energy?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
f Have you felt downhearted and depressed?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
g Did you feel worn out?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
h Have you been happy?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
i Did you feel tired?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

10. During the <u>past 4 weeks</u>, how much of the time has your <u>physical health or emotional problems</u> interfered with your social activities (like visiting with friends, relatives, etc.)?

All of the time	Most of the time	Some of the time	A little of the time	None of the time
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

11. How TRUE or FALSE is <u>each</u> of the following statements for you?

	Definitely true	Mostly true	Don't know	Mostly false	Definitely false
a	I seem to get sick a little easier than other people	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b	I am as healthy as anybody I know	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c	I expect my health to get worse	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d	My health is excellent	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Thank you for completing these questions!

Appendix L: Patient discharge letter

Date

Dear

Thank you for agreeing to be part of my ankle research.

I have received notification that you have been discharged from physiotherapy treatment for your ankle injury.

The next stage of the research involves you completing the enclosed questionnaires and returning them in the postage paid envelope. Please complete **all** sections of the questionnaires.

On receipt of these questionnaires either my research assistant or I will be in contact with you to set up a time that is convenient for you to attend the Physical Rehabilitation Research Centre, AUT, Akoranga Drive, Northcote. This will be in approximately six weeks. When you attend you will be provided with a $10 petrol voucher and also go in the draw to win a pair of Asics shoes.

A detailed map along with a parking permit and instructions will be mailed to you once a suitable time has been arranged.

If you have any concerns please do not hesitate to contact me at:
Peter Larmer, peter.larmer@aut.ac.nz phone 09 917 9999 ext 7322

Once again many thanks for participating in this research.

Peter Larmer
Encl: 3 questionnaires and postage paid envelope.

Approved by the Auckland Ethics Committee on 24th February 2005 **Reference number** AKY/04/12/344

Appendix M: Patient Discharge Global Assessment Questionnaire

Patient Discharge
Global Assessment Questionnaire

Code: _____Date:_____

Overall Condition scale:

Rate the **overall condition** of your ankle at the present time. Please circle one number below.

1	2	3	4	5	6	7	8	9	10

ScaleDescription
2 – I have significant limitations that affect activities of daily living.
4 – I have moderate limitations that affect activities of daily living, e.g. no sports possible.
6 – I have some limitations e.g. with sports, but I can participate; I compensate.
10 – I am able to do whatever I wish with no problems.

_____

Overall Status:

Since I started treatment my overall status now is:

Please circle one number below.

0	1	2	3	4	5	6

ScaleDescription

0 - Very much improved4 - Minimally worse
1 - Much improved5 - Much Worse
2 - Minimally improved6 - Very much worse.
3 - No Change

_____

Pain Scale:

Select the number that best describes **your pain** during the past 24 hours

Please circle one number below.

0	1	2	3	4	5	6	7	8	9	10

No Pain **Worst Pain Possible**

Appendix N: Participants appointment confirmation letter

Date

Dear

Re: Confirmation of Ankle testing appointment.

Your appointment has been scheduled for: **Date**

At the Physical Rehabilitation Research Centre
Akoranga Drive

A map is enclosed with directions for parking along with a parking notice.
Enter at **Gate 2 on Akoranga Drive** and proceed to the bottom parking area marked on the map. Please place the parking notice on the dashboard of your car while you are parked at the AUT.

Please **wear comfortable clothing** such as a track suit or loose fitting trousers. Some of the tests require bare feet.

The testing should take approximately two hours. You are welcome to bring a **support person** with you. They may like to bring along a book to read while you are being tested.

In recognition of your participation you will receive a $10 petrol voucher and your name will be placed in the draw for one of two pair of Asics running shoes at the completion of the research project.

If you have any concerns please do not hesitate to contact me at
921 9999 ext 7322

Thanking you for your continued support
Kind regards

Peter Larmer

Encl: 2

Appendix O: Semi-structured interview questions

- “How did you hurt your ankle?”
- “What did you do then?”
- “Who did you see?”
- “Tell me how you ankle is feeling now?”
- “Tell me about how hurting your ankle has affected your lifestyle?”
- “Would you say you have made a full recovery?”
- “How did you find the questionnaires?”
- “Did the questionnaires adequately describe how you felt about your ankle?”
- “Were there important questions that the questionnaire did not ask?”
- “How did you feel about doing the tasks at the end?”
- “How did you feel about putting a scoring or number to your pain or feelings?”