

The effect of fear of pain on rehabilitation of acute musculoskeletal injury

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## ABSTRACT

The effect of fear of pain on rehabilitation of acute musculoskeletal injury

Laura A. Legge

The Fear-Avoidance Model (FAM) is a psychological theory that was created to explain why some patients develop chronic back pain while others do not. However, there is little research on the influence of the FAM and acute extremity injuries. Therefore, the aim of our study was to determine if the FAM is correlated to time to return to play from an acute injury.

Twenty six student athletes who had suffered an acute injury that required up to six weeks of rehabilitation volunteered for this study. The FAM, including fear of pain (FPQ-III), kinesiphobia (TSK), fear avoidance (FABQ), and catastrophizing (PCS) was assessed using self-report questionnaires. Physical measures recorded included range of motion (ROM), strength, pain, disability, and evoked tenderness. All measurements were taken within 24 hours of an athlete being injured and every two weeks until the athlete returned to play. Return to play (RTP) was defined as returning to competition or practice in days.

No significant correlations were discovered between RTP and the FABQ and the TSK. Moderate correlations were found between the medical pain subscale of the FPQ-III and the magnification subscale of the PCS and RTP  $-0.372$  ( $p = 0.061$ ) and  $0.370$  ( $p = 0.063$ ) respectively. The FABQ was significantly correlated with many of the physical measures, including disability, pain, and ROM.

Although we could not confirm the ability of the FAM to predict the length of rehabilitation following an acute injury, moderate trends were found signifying that the FAM provides an important indicator of physical signs.

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## Introduction

The fear-avoidance model (FAM) is a proposed theory of the pathways through which pain is either maintained or extinguished. The first FAM was developed in an attempt to understand why some acute pain patients develop chronic pain while other patients do not [1].

The FAM incorporates several psychological components: fear of pain, catastrophizing, fear of movement/(re)injury, and avoidance behaviour [2]. Fear of pain is an excessive and persistent fear of experiencing pain, and has been identified as a factor that influences pain perception [3]. Catastrophizing refers to an exaggerated negative orientation toward noxious stimuli [4]. Fear of movement/(re)injury, also termed kinesiophobia, describes a fear of movement or physical activity which is wrongfully believed to cause pain [2]. Fear-avoidance refers to the avoidance of a situation based on the fear of experiencing pain [1]. The FAM shows how each of these four components contributes to the maintenance of pain.

Consequences of these components include increased pain sensitivity, chronic loss of function and disability, and reduced physical performance [5]. A low correlation generally exists between pain severity and loss of function, indicating that other factors must be identified in order to fully understand chronic pain [6]. People with fear of pain tend to anticipate and overestimate the amount of pain that will be experienced. This excessive fear of pain may lead to avoidance behaviour in an effort to minimize the likelihood of pain [1, 5, 7]. Neither pain severity nor disability alone can explain avoidance behaviours [6, 8, 9]. Avoidance behaviour occurs due to the anticipation of pain rather than as a response to pain [6, 10]. A significant consequence of avoidance behaviour is that daily activities which are expected to produce pain cease to be performed, leading to increased disability [6].

The development and progression of chronic pain is not well-understood. While the recovery of patients with acute shoulder pain can be predicted by pain severity and disability,

psychological factors appear to have a stronger influence on patients with sub-acute and chronic shoulder pain [11]. It has even been suggested that 'pain-related fear is more disabling than pain itself' [6].

Although there has been extensive research on fear of pain and fear-avoidance, the focus has been primarily chronic pain conditions, and specifically those that affect the neck and back [6, 8-10, 12]. Acute pain conditions have received much less attention than chronic pain in research. The majority of research on the effects of the FAM on acute pain conditions has focused on the back, although there have been several studies focused on acute shoulder conditions and ACL reconstruction in the knee. More recently there has been increased attention on rehabilitation of chronic back pain, and how the components of the FAM may affect the transition from acute to sub-acute and chronic pain and the psychological factors that may influence this transition [9, 10, 12]. Although it has been found that patients are affected differently by psychological factors depending on anatomic area of injury, there is currently no research that has focused on the effects of the FAM on the rehabilitation of acute injury that does not involve the neck and back [13].

Chronic pain is defined as pain that persists for longer than three months; however pain conditions that that persist beyond three months are rare in the athletic population [11]. Six months is a very long RTP in an athletic population, and is generally only seen after surgical intervention. Although the duration of pain symptoms in the athletic population tends to be shorter in comparison with the general population, parallels may be drawn. For example, back pain in the general population may resolve in six weeks, or may persist for over one year. In an athletic population this would be similar to the pain due to an ankle sprain resolving in two weeks, or persisting for eight weeks.

The FAM, and more specifically the FABQ, has been shown to relate to physical measures as well as the length of rehabilitation. This research has used acute and chronic back pain, revealing that the FABQ is correlated to pain intensity [14-16] and disability [15, 16], as well as the change in pain and the change in disability [17-19]. The FABQ has been recommended as a useful tool to help predict pain and disability in clinical assessment [14, 15, 17, 19].

Therefore, the aims of this study are: (1) to observe patients with a variety of musculoskeletal injuries to determine the effects of fear of pain on the process of rehabilitation, (2) to determine if the FABQ is correlated to physical measures as seen in previous studies, and (3) to determine if the rate of recovery from injury is affected by the presence of psychological factors included in the FAM. We hypothesize that fear of pain will have a negative impact on the rehabilitation process, that the FABQ will be correlated with the physical measures, and that higher scores on the FAM will predict a longer RTP.

## **Review of Literature**

### ***The Fear-avoidance Model***

The fear-avoidance model (FAM) was first developed by Lethem et al. in an attempt to understand why some acute pain patients develop chronic pain while other patients do not [1]. Pain is classified by the length of symptoms: pain lasting less than six weeks is considered to be acute, pain lasting between six weeks and three months is considered to be subacute, and pain lasting more than three months is considered to be chronic [11]. The authors hypothesized that the development of chronic pain was due to an exaggerated perception of pain following injury

[1]. The authors identified chronic back pain as a significant problem in society, and developed the model on patients with chronic low-back and sciatic pain [1].

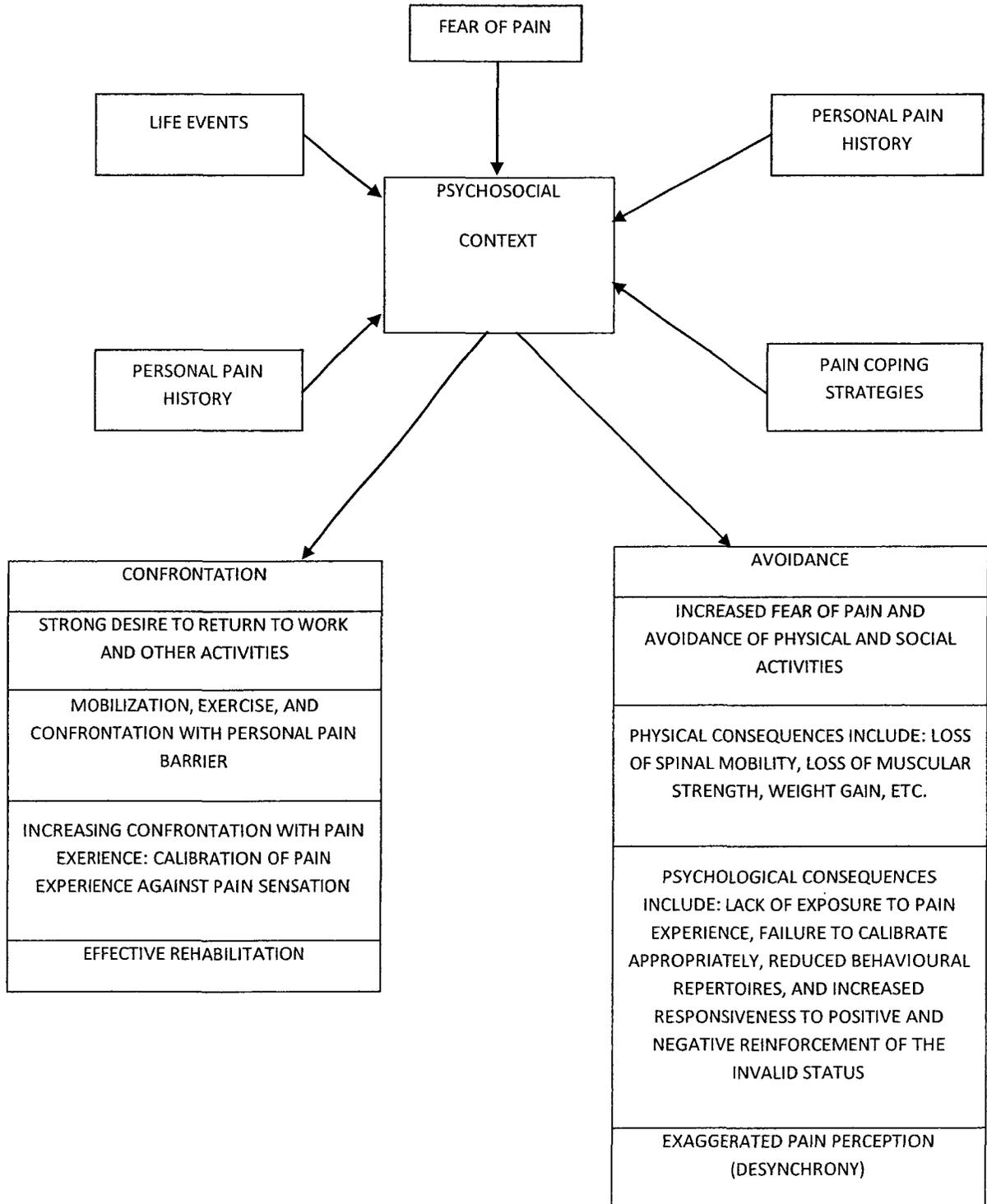


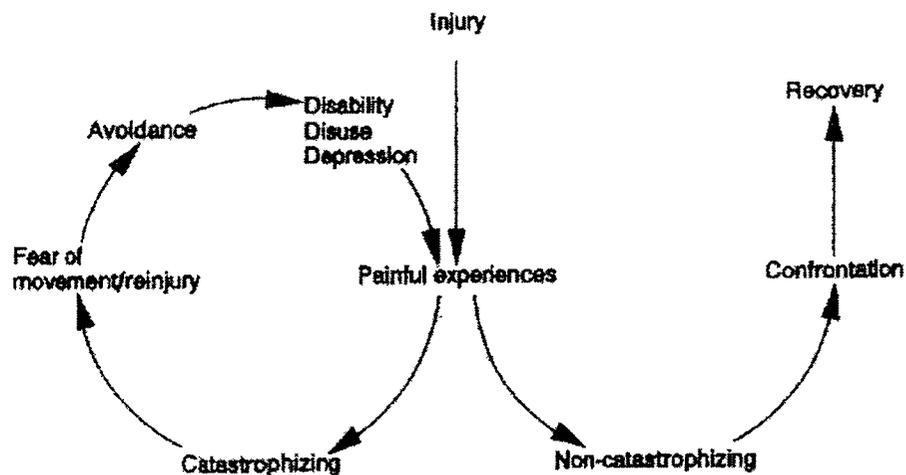
Fig. 1. The fear-avoidance model of exaggerated pain perception as presented by Lethem et al. [1].

Lethem et al. suggested that there are three components in the resolution of back pain: organic basis, a sensory component, and an emotional reaction component [1]. Organic basis refers to the lesion that occurs as result of injury. The sensory component refers to the pain experience [1]. The emotional reaction component is primarily psychological, and refers to behaviour [1]. Exaggerated perception of pain occurs when there is desynchrony between the pain sensation and the emotional reaction component [1]. Fear has been defined as the emotional reaction to an identifiable threat, specifically pain or injury in this case [20].

The FAM attempts to explain why some pain patients develop chronic pain, while others do not [1]. Fear of pain provides the starting point for the FAM, seen in Fig. 1 [1]. The next component of the model is the psychosocial context, which refers to the influence of social factors on behaviour [7]. The psychosocial context is influenced by four factors: life events, personal pain history, personal coping/response strategies, and characteristic behaviour patterns (personality) [1]. The model then shows a division brought on by the behaviour of the patient: confrontation or avoidance [1]. Avoidance has been described as the performance of a behaviour which postpones or averts the presentation of an aversive event [21]. A series of events occurs based on this behaviour, with confrontation ending in effective rehabilitation and elimination of pain and fear, and avoidance ending with an exaggerated perception of pain [1].

In 1995, a series of four studies were done which focused on fear of movement/(re)injury in chronic low-back pain (CLBP) and the effects on behavioural performance [2]. Based on the results from these four studies Vlaeyen et al. proposed an updated FAM, the cognitive behavioural model of fear-avoidance (fig. 2), which illustrates the possible mechanism for the contribution of fear of movement/(re)injury to the development and maintenance of CLBP [2]. Fear of pain is not named in this new FAM, and acute injury

provides the starting point for the model. Following acute injury the patient will encounter painful experiences. The manner with which the patient copes with these experiences is the dividing point of the model. Patients that do not catastrophize are directed to confrontation and recovery, while patients who catastrophize enter into a maladaptive loop. Catastrophizing leads to fear of movement/(re)injury, a concept not included in the original FAM. Fear of movement/(re)injury leads to increased avoidance, which in turn leads to disability, disuse, and depression [1, 2]. Depression and disuse are known to be associated with decreasing pain tolerance levels, which will promote further painful experiences [22, 23].



**Fig. 2.** The cognitive-behavioural model of fear avoidance. Vlaeyen et al. proposed this updated FAM to illustrate the importance of catastrophizing and fear of movement/(re)injury in the maintenance of chronic back pain [2].

Anxiety sensitivity (AS) is defined as the fear of anxiety-related bodily sensations, which arises from beliefs that these sensations have harmful somatic, psychological, or social consequences [24]. Many studies have been conducted by Asmundson et al. on this subject, and these authors have concluded that AS directly intensifies fear of pain even after controlling for pain severity,

and that AS indirectly promotes pain-related avoidance behaviour through its influence on fear of pain [25-29].

Based on these conclusions, Asmundson et al. presented an updated FAM in 2004, the fear-anxiety-avoidance model (fig. 3), which differentiates between fear and anxiety [26]. This new model has changed the 'fear of movement/(re)injury' label to 'fear of pain', and has added an anxiety pathway between fear and avoidance [26]. There is debate about the clinical distinctiveness of fear and anxiety, and whether this model adds value to the FAM by Vlaeyen et al. [30]. The majority of research continues to cite the FAM proposed by Vlaeyen et al. [30].

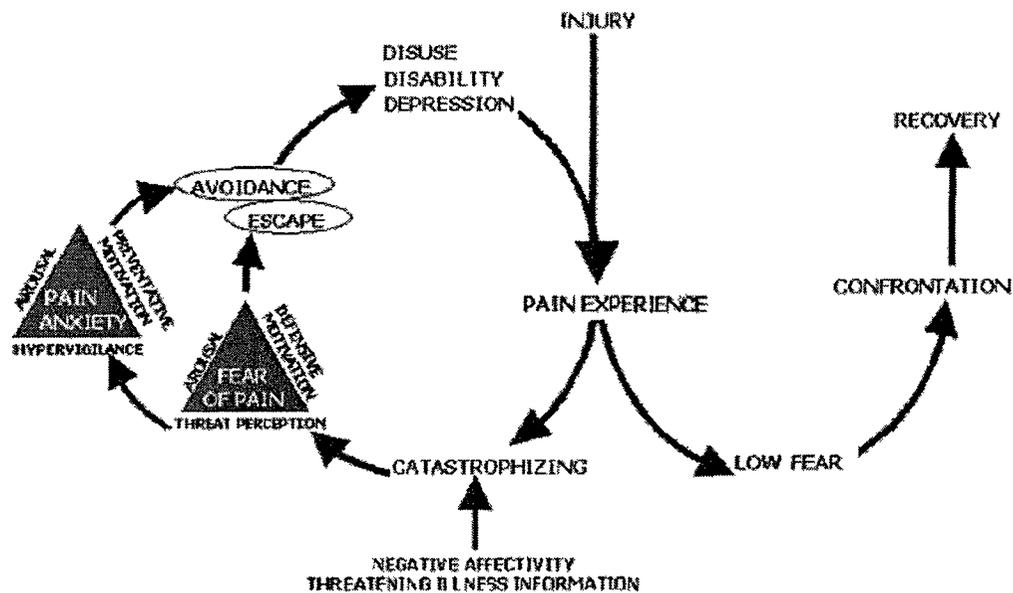


Fig. 3. The fear-anxiety-avoidance model aims to differentiate between fear and anxiety. A new pathway was added to indicate that some patients may experience fear alone, while others may also experience anxiety, a separate condition [30].

### ***Fear of Pain***

The concept of fear of pain was identified long ago, but did not receive focus in research until recently [3]. Aristotle was one of the first philosophers to discuss the relationship between fear and pain, saying in the 4<sup>th</sup> century BC 'let fear, then, be a kind of pain or disturbance resulting from the imagination of impending danger, either destructive or painful' [31]. In 1915-

16, fear was described as being not simply a sensation, but a sensation accompanied by emotion [32]. Injury was thought to be the origin of this fear of pain [33, 34]. However, not until 1957 was fear of pain or injury first considered to be a specific type of fear [35]. In 1983 Lethem et al. presented the FAM of exaggerated pain perception which highlighted fear of pain as a necessary factor in the development and maintenance of chronic back pain [1].

Also referred to as algophobia or odynophobia, fear of pain is defined as excessive fear of experiencing pain. This concept is measured with self-report questionnaires, such as the Pain Anxiety Symptoms Scale (PASS) [3]. The PASS was developed primarily on chronic back pain patients [36]. The PASS originally contained 62 statements developed to assess four subscales: somatic anxiety (“pain seems to cause my heart to pound or race”), cognitive anxiety (“I feel disoriented and confused when I hurt”), fear (“I think that if my pain gets too severe, it will never decrease”), and escape/avoidance behaviour (“I try to avoid activities which cause pain”) [36]. The scale was shortened to 53 statements, and then to 40 statements, eliminating items which did not correlate strongly with the subscales [36]. The frequency of occurrence of each statement is rated on a 6-point scale, with zero indicating never and five indicating always [36]. Construct validity was tested with Pearson product-moment correlations against questionnaires, and concurrent validity was tested with correlational & multiple regression analyses [36]. McCracken cautions that significance tests were included to determine validity, and that the results have an increased risk of being due to chance [36]. Further research provided preliminary evidence of the validity of the four-factor structure of the PASS [37, 38]. The PASS was shortened to 20 items in 2002, and was found to have good reliability (internal consistency, test–retest) and validity [39]. The four-factor model was maintained, with the subscale descriptions of fear of pain, escape/avoidance, physiological symptoms, and cognitive symptoms of anxiety providing the best fit for the data [39].

Another self-report questionnaire used to measure fear of pain is the Fear of Pain Questionnaire (FPQ). The FPQ was developed, refined, and tested in a series of four studies. The first three studies were aimed at refining the FPQ, and used university psychology students as subjects. The authors established groups by naming the top 5% of scores on the FPQ a 'high fear' group, and the lowest 20-30% the 'low fear' group [40]. The FPQ-I consisted of eight painful situations, such as dental work without anaesthetic, or receiving an electrical shock [40]. Each item is rated on a 5-point Likert-type scale, with higher numbers indicating more fear [40]. These individual scores are then added to obtain a total score for the FPQ. Total scores ranged from 8-40, with a higher score indicating increased fear of pain [40].

The questionnaire was expanded to include 57 items, known as the FPQ-II, before being refined to the current version, the FPQ-III [40]. The FPQ-III consists of three 10-item subscales: severe pain ("being in an automobile accident"), minor pain ("biting your tongue while eating"), and medical pain ("having a blood sample drawn with a hypodermic needle") [40]. Each item is rated on a 5-point Likert-type scale, with a higher score indicating increased fear of pain [40]. Using principal-components analysis, a three-factor solution was found to explain 51% of the variance in responses on the FPQ-III, and data suggests good internal consistency ( $\alpha = .92$ ) and test-retest reliability ( $r = .74$ ) [40].

A fourth study was done to determine if the FPQ-III is sensitive to chronic pain [40]. Only the severe pain subscale was effective in differentiating between the chronic pain patients and the students [40]. The authors also reported significant gender differences, with women scoring higher than men both overall, and on each of the three subscales [18]. Three studies by Osman et al. provide further evidence for the structure and reliability ( $\alpha = .91$ ) of the FPQ-III, as well as adequate concurrent validity ( $r = .42$ ) of the questionnaire in assessing a non-clinical population [41].

The PASS has not yet been translated to French, and will therefore not be used for the proposed research. The original FPQ has been translated into French and has been studied to determine factor structure in young adults (20-35 years old), middle-aged adults (36-55 years old), and an elderly population (56-80 years old) living in France [42]. At this time a French-Canadian translation is not available for either the original FPQ or the more current FPQ-III.

### ***Pain Catastrophizing***

Pain Catastrophizing is generally considered to be an exaggerated negative orientation toward noxious stimuli [4]. With pain catastrophizing, patients assume that in a given situation the worst possible outcome will occur, specifically pain [43]. Catastrophizing has been shown to affect distress reactions to painful stimuli, and is considered to be a precursor to pain-related fear [5]. This relationship is illustrated in the FAM by Vlaeyen et al.; catastrophizing leads to fear of movement/(re)injury [2].

Pain catastrophizing is primarily measured with a self-report questionnaire, the Pain Catastrophizing Scale (PCS). The PCS was developed to assess and compare catastrophizing in both clinical and non-clinical populations [4]. The questionnaire addresses components of catastrophizing, including the tendency to increase attentional focus on pain-related thoughts, to exaggerate the threat value of pain stimuli, and to adopt a helpless orientation to coping with painful situations [4, 44-46]. The 13 items included in the PCS can be grouped into three subscales, termed rumination, magnification, and helplessness [4]. Rumination includes four items related to worry and pain thoughts, such as 'I anxiously want the pain to go away' [4]. Magnification includes three items relating to magnification of painful situations, such as 'I become afraid that the pain may get worse' [4]. Helplessness includes six items relating to feelings of vulnerability and incapacity, such as 'there is nothing I can do to reduce the intensity

of the pain' [4]. Each item is rated on a 5-point scale, from zero ('not at all') to four ('all the time').

The structure, validity & reliability of the PCS has been assessed in a series of studies [47]. The first study used principal-components analysis to evaluate the factor structure of the PCS. The results indicated that the items associated with magnification & helplessness are related, and may be combined into one subscale [47]. However, the results of confirmatory factor analysis in the second study supported the three subscales previously described [47]. A third study was done to determine if the PCS could be used to differentiate between clinical and non-clinical populations [47]. The clinical group scored significantly higher on all three subscales and had higher scores overall on the PCS [47]. Reliability, concurrent validity, and discriminant validity were acceptable [47]. The PCS shows sufficient test-retest stability among chronic pain patients, and has also been used to assess acute pain conditions [48, 49]. A French-Canadian translation of the Pain Catastrophizing Scale (PCS-CF) has also been developed, and has been determined to be both a reliable and valid measure of pain catastrophizing that is psychometrically comparable to the original PCS [50].

### ***Fear of movement/(re)injury***

Fear of movement/(re)injury, also termed kinesiophobia, describes the fear of movement or physical activity which is wrongfully believed to cause pain[2]. The condition causes a feeling of vulnerability to painful injury or re-injury, which contributes to the development of an excessive, irrational, and debilitating fear of movement and physical activity [51]. This fear causes the avoidance of movements or activities that are believed to cause pain, and leads to a downward spiral of disuse, disability, and pain [5]. This is illustrated in the FAM presented by Vlaeyen et al., with fear of movement/(re)injury leading to avoidance behaviours [2].

Kinesiophobia is assessed with a self-report questionnaire, the Tampa Scale for Kinesiophobia (TSK). The TSK is a 17-item questionnaire that aims to assess fear of (re)injury due to movement [52]. Items are rated on a four-point Likert-type scale, ranging from 'strongly agree' to 'strongly disagree', and include statements such as 'my body is telling me I have something dangerously wrong,' and 'it's really not safe for a person with a condition like mine to be physically active' [52, 53]. The scale has been tested with four-factor and two-factor models; based on confirmatory factor analysis the two-factor model provides a better fit [53, 54]. The two factors have been labelled 'harm', which describes a focus on underlying and serious medical problems, and 'fear-avoidance', which reflects the fear that movement may result in (re)injury or increased pain [53]. The TSK has been determined to have good test-retest reliability, internal consistency and validity [2, 6, 52, 55].

The TSK has been shortened to 13 items, eliminating four items that had weak correlations with the total score of the TSK [53, 54, 56]. This shorter version is known as the adjusted version of the TSK (TSK-AV). The TSK has been further shortened to 11 items (TSK-11) and tested in a population of CLBP patients. This short version has been found to have good internal consistency, test-retest reliability, responsiveness, and concurrent and predictive validity [57]. The results of this study indicate that the psychometric properties of the TSK-11 are comparable to the original TSK [57]. There has been no further research on the psychometric properties to confirm this finding, although several studies have used this shortened form to measure fear of movement/(re)injury.

Although the TSK was developed on CLBP patients, the questionnaire has also been determined to be valid and reliable in an acute LBP population [58]. The TSK has also been used to measure fear of movement/(re)injury in chronic neck pain [59], and as a prognostic tool for arm, neck, and shoulder pain [60-62]. The French-Canadian adaptation of the TSK, l'Échelle de

Kinésiophobie de Tampa (EKT-CF) has been studied, and internal consistency was determined to be acceptable [63]. Construct validity analyses revealed that higher levels of fear of movement/(re)injury were associated with a greater degree of perceived pain-related disability and increased levels of psychological distress, which is in line with the findings of the original TSK [63].

### ***Fear-Avoidance Beliefs***

Fear-avoidance refers to a coping response used to avoid a situation based on fear of the outcome [1, 64]. Pain patients will consciously or unconsciously alter their behaviour to avoid movements or activities that they believe will cause them pain. Although in theory avoidance behaviour seems to be adaptive, little evidence has been found to support the idea that avoidance reduces chronic pain [65]. Avoidance behaviours may actually increase or prolong pain, as they lead to altered movement patterns, disuse, and increasing disability [1, 5]. This is illustrated in the FAM presented by Vlaeyen et al., with avoidance leading to disability, disuse, and depression [2].

Avoidance behaviours temporarily reduce fear, but lead to maintenance and exacerbation of fear causing further withdrawal from activity long term [1, 30]. This decreasing activity level does not allow the patient an opportunity to correct their perception of pain, and reinforces the negative belief [66]. Psychological consequences may include depression and loss of self esteem, and development of phobias [2].

Beliefs about fear-avoidance are measured with a self-report questionnaire, the Fear Avoidance Beliefs Questionnaire (FABQ) developed by Waddell et al. in 1993. The scale was developed to measure fear-avoidance beliefs about physical activity and work that could be used clinically for patients with LBP [67]. In developing this questionnaire, the authors aimed to

determine the relationship between LBP, fear-avoidance beliefs and chronic disability in activities of daily living and work loss [67].

The questionnaire consists of 16 items relating to fear and avoidance, as well as disease conviction, which refers to the patient's beliefs about the seriousness of an injury or illness and the impact on daily life [67]. Each item is scored on a seven-point Likert scale, from 'strongly disagree' to 'strongly agree' [67]. The questionnaire is divided into two subscales relating to physical activity and work [67]. The physical activity subscale (FABQ-PA) consists of four items specific to fear-avoidance beliefs about physical activity ("I should not do physical activities which (might) make my pain worse") [67]. The work subscale (FABQ-W) consists of seven items specific to fear-avoidance beliefs about work ("I do not think that I will be back to my normal work within 3 months") [67].

Test-retest reliability of the FABQ was assessed prior to the main study, with patients completing the FABQ on the first visit, then completing the questionnaire again 48 hours later, with no active treatment between these visits [67]. All 16 items reached acceptable levels of test-retest reproducibility; 71% of individual answers were identical on retest [67]. Pearson product-moment correlation coefficients were high for both scales of the FABQ (FABQ-W, 0.95 and FABQ-PA, 0.88) [67]. Principal-component analysis suggested that the questionnaire could be divided into two subscales: 'work' and 'physical activity' [67]. The fear-avoidance beliefs about work subscale (FABQ-W) includes seven items, while the fear-avoidance beliefs about physical activity (FABQ-PA) subscale includes four items [67].

The main finding of the study was that there is little direct relationship between pain and disability [67]. Severity of pain only explained 14% of the variance of disability in activities of daily living, and all of the biomedical measures combined could only explain 5% of the variance

of work loss [67]. Although the physical activity subscale showed a weaker correlation, the FABQ-PA is stronger in predicting behavioural performance tests [6, 67].

Although the FABQ was developed specifically to assess chronic LBP, the questionnaire has also been determined to be a reliable measure of pain-related fear in an acute LBP population [19, 58]. As well, a French adaptation of the FABQ has been developed, which shows strong test-retest reliability (FABQ-W, ICC= 0.88 and FABQ-PA, ICC= 0.72)[68]. A French-Canadian adaptation has also been found to have acceptable test-retest reliability (FABQ-PA,  $r = 0.60$  and FABQ-W,  $r = 0.75$ ) [69].

### ***Other Measures***

Although there are many different methods for the assessment of pain, they depend on the accurate account of the patient, therefore providing subjective information. However, researchers have attempted to develop methods that quantify pain, providing a measure of objectivity. Presented here are two tools that are often used in an attempt to quantify pain.

### ***Visual Analog Scale***

The visual analog scale (VAS) is a common tool for measuring pain intensity [70-74]. The scale consists of a single 100 millimetre horizontal line with the ends of the line representing the extremes of pain, 'no pain' and 'worst pain ever experienced' [74, 75]. The subject is asked to indicate how much pain they are experiencing by making a mark through the line. A ruler is then used to measure the length between the start of the line and the pen mark. Accurate and consistent measurement is extremely important, as this number indicates the intensity of pain that the subject is experiencing. In general, measurements over 30mm indicate moderate pain

[73]. The minimum clinically significant difference on the VAS for change in acute pain intensity has been determined to be 13mm [72].

A significant benefit of the VAS over other methods of measuring pain is the continuous measure it provides, instead of a discrete value [74]. VASs are a simple and quick method of measuring pain intensity or pain relief, and are applicable in a variety of clinical settings [72]. The VAS has been determined to be valid and reliable in assessing chronic pain [76-79] as well as acute pain [72, 80-82].

#### *Fischer Algometer*

An algometer is a device used to measure sensitivity to pain or point-tenderness [83-85]. The device consists of a strain gauge and a metal arm ending in a round rubber footplate. The footplate is used to apply pressure to the soft tissues of the body while the gauge shows the current amount of pressure being applied. These measurements are useful for determining pain intensity, as well as efficacy of treatments [86, 87].

There are two different methods used to measure evoked tenderness, the pressure-pain threshold (PPT) method and the mechanical pain threshold (MPT) method. The PPT method involves the consistent and gradual application of pressure until the patient signals that the sensation has changed from 'pressure' to 'pain' [83, 85, 88]. Pressure is removed from the patient immediately, and the value is recorded. The MPT method involves the gradual application of pressure up to a preset limit. At the moment that the pressure limit is obtained, the patient is signalled to record pain intensity on a visual analog scale. The MPT method may not always cause the subject pain, and should be used if a pain threshold is not needed.

The algometer has been determined to be a valid and reliable measure of pain [83, 84, 86, 88, 89]. Research has shown the algometer to have good intrarater (ICC > 0.92) and

interrater (ICC > 0.80) reliability, providing the application rate is the same for each trial [90, 91]. High within-session reliability has been found (ICC > 0.91), as well as high between-session reliability (ICC > 0.87) [86]. The experimenter controls the rate of pressure application; caution must be used to be consistent as higher PPT values have been obtained with faster application rates [92]. Fischer recommended an application rate of 1 kg/cm<sup>2</sup> [84].

### *Disability*

The last component in the FAM, disability, is measured with self-report questionnaires. Although there have been many questionnaires developed to measure disability, only two will be used in this study. Disability of the upper extremity will be measured with the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, and disability of the lower extremity will be measured with the Lower Extremity Functional Scale (LEFS).

The DASH was developed to assess symptoms and physical function in patients with upper extremity musculoskeletal conditions [93]. Thirteen previously developed scales were reviewed, and 821 items identified [93]. These items were then reviewed by the Upper Extremity Collaborative Group, who reduced the number of items to 75 items based on judgement of validity [93]. Each item is scored on a five- or seven-point Likert scale [93]. Pilot testing on 20 patients with upper extremity musculoskeletal conditions results in a final list of 78 items [93]. After further testing, the questionnaire was reduced to 30 items that assess the patient's ability to perform certain tasks ("open a tight or new jar", "push open a heavy door", "place an object on a shelf above your head") [93]. The scoring was also standardized to a five-point Likert-type scale [94]. These individual scores are then used to calculate a total score for the scale, ranging from 0 (no disability) to 100 (severe disability) [94]. The DASH has been determined to be valid, reliable, and responsive to both small and large changes in disability in

both proximal and distal upper extremity musculoskeletal disorders [94, 95]. The minimum important change on the DASH has been found to be 10 scales points, or 10% change [94]. The DASH has been translated into 27 languages, including Parisian French and French-Canadian translations [96].

The LEFS was developed in an effort to find a valid and reliable measure of self-reported disability that could be applied to a variety of lower extremity musculoskeletal conditions in both research and clinical settings [97]. The scale was tested on 107 physical therapy patients who suffered from any lower extremity musculoskeletal condition, including sprains, strains, fractures, dislocations, and osteoarthritis [97]. Seventy-seven functional limitation items were identified from other disability questionnaires, and by surveying patients and clinicians [97]. These items were reduced to 22 by grouping similar activities [97]. After factor analysis two items were eliminated, leaving 20 items in the final questionnaire [97]. Patients are instructed to rate the ease or difficulty of performing specific tasks (“squatting”, “walking 2 blocks”, “sitting for 1 hour”) [97]. Each item is rated on a five-point scale from zero to four, with zero indicating extreme difficulty and four indicating no difficulty [97]. Each item is added for a total score which indicates the level of function the patient is experiencing [97]. The LEFS has been determined to be a valid and reliable measure of lower-extremity function, and has been found to be more sensitive to change than previous measures [97-99]. The minimal clinically important difference is nine scale points, or 11.25% change [97].

### ***Clinical Application Studies***

Back pain is both physically debilitating for the patient, and financially debilitating for society [100-102]. Low-back pain (LBP) is the largest category of workers' compensation claims, and 7% of LBP claims represent approximately 70% of all compensation costs [103, 104]. In the

Netherlands in 2000 alone, the direct costs associated with LBP were €337 million [105]. When factoring in costs due to work loss, the indirect costs reached €1.7 billion [105]. There is also a high prevalence of LBP, as 90% of all adults will experience LBP at some point in their lives [106-108].

Due to the overwhelming problems associated with LBP, researchers have focused on identifying factors that contribute to the development and maintenance of back pain. The majority of research on the components of the FAM has been on subjects with back pain. Although this focus is understandable, there is little research to suggest that the components of the FAM may be applicable to musculoskeletal pain conditions of the extremities.

### **Chronic Back Pain**

‘Pain-related fear is more disabling than pain itself’ [6]. This statement encompasses the idea that psychological factors may be more damaging to a pain patient than the actual pain. Three studies were done in 1998 to help support this theory.

Study 1 investigated the role of pain severity, pain-related fear, and general negative affect in predicting self-reported disability [6]. Thirty-five patients (24 females and 11 males) with chronic back pain were recruited from a pain clinic and from a psychosomatic rehabilitation clinic [6]. The average duration since onset of pain was 6.7 years (SD = 7.8) [6]. Participants completed a VAS to measure pain intensity, the TSK to measure fear of movement/(re)injury, the FABQ to measure beliefs about how work and physical activity will affect pain, the Negative Emotionality Scale (NEM-scale) to measure negative affect, and the Roland Disability Questionnaire (RDQ) to measure disability [6]. The results showed that the TSK and the FABQ were better predictors of disability than pain intensity and the measure of general negative affect [6].

Study 2 investigated the role of pain intensity, pain-related fear, pain anticipation, and general negative affect in predicting behavioural performance [6]. Thirty-eight chronic back pain (CBP) patients (25 females, 13 males) were enrolled in this study. Mean duration of pain was 6.35 years (SD = 7.68) [6]. Physical examinations were done to ensure that there was minimal risk for (re)injury for any of the participants. Participants completed the TSK, FABQ, and the NEM prior to the behavioural test [6]. Participants then sat on a Trunk Extension-Flexion machine and were instructed to maximally flex and then maximally extend the back three times, as hard and as fast as they could [6]. The TEF measured the torque produced in flexion and extension [6]. Prior to the behavioural test, participants reported the intensity of pain that they were experiencing, and the intensity of pain they expected to experience during the test [6]. After the test, participants reported the intensity of pain they had experienced during the test [6]. The results showed that the most consistent predictors of torque were the FABQ-PA and the TSK [6]. The authors also found that an increase in expected pain, not the actual pain experienced, predicted poor behavioural performance [6].

Study 3 examined the role of pain severity, pain-related fear, and catastrophizing in predicting self-reported disability and behavioural performance [6]. Thirty-one CBP patients (16 females, 15 males) were enrolled in this study [6]. The mean duration of pain was 10.1 years (SD=8.9) for these patients, and the patients were grouped based on type of onset (sudden or gradual) [6]. Participants completed the TSK, PASS, PCS, RDQ, NEM, and reported current pain intensity on a VAS prior to the behavioural test [6]. The behavioural test consisted of the participant being asked to stand up and lift and hold a 5.5-kg bag with their dominant arm for as long as possible [6]. The test ended when the participant could no longer hold the bag due to pain, or after 300 seconds [6]. Analysis revealed a significant association between both the TSK and the RDQ with pain onset [6]. Participants who had experienced a sudden onset of pain

scored significantly higher on the TSK than participants who had experienced a gradual onset of pain [6]. The opposite association was found with the RDQ: participants who had experienced a gradual onset of pain scored significantly higher on the RDQ than participants who had experienced a sudden onset of pain [6]. The results also indicated that the TSK was a strong predictor of self-reported disability and performance – better than the PASS or the PCS [6].

In conclusion, the authors state that the strongest associations were found between the measures of pain-related fear and self-reported disability and behavioural performance, indicating that the FABQ-PA and the TSK may be used to identify patients whose disability is determined by pain-related fear [6]. Early identification will allow for education and rehabilitation of back pain before chronicity develops [6]. If the administration of these questionnaires becomes a standard part of baseline testing of musculoskeletal pain conditions, healthcare providers may be able to reduce the length of symptoms for patients, as well as reduce the financial burden these conditions place on our healthcare system.

### *Fear of Pain*

Fear of pain is considered to be one of the most important factors in predicting avoidance behaviours and self-reported disability [1, 7]. A study in 1993 examined how predictions of pain in low back pain patients related to a behavioural test [8]. Forty-three patients (29 males, 14 females) who had reported to a multidisciplinary clinic with low back pain participated in this study [8]. Mean pain duration was 19 months (range 3-324 months) [8]. Participants completed the PASS, and then underwent a physical examination. Patients who agreed to participate in the study completed informed consent following this examination [8]. Each participant then completed six trials of the passive straight leg raise (SLR) test, three trials with each leg [8]. Each trial ended when the subject indicated that they could not tolerate

further movement into hip flexion [8]. Prior to each trial the participant was asked to predict the maximum intensity of pain that they expected to experience, and after each trial they were asked to report how much pain they actually experienced [8]. These pain ratings were reported on separate numerical pain scales ranging from zero ('no pain') to 100 ('worst pain imaginable') [8].

The authors concluded that (1) patients who reported greater pain-related anxiety showed a tendency to over-predict new pain events, but corrected their predictions in the next trial, (2) patients who reported less pain-related anxiety tended to consistently under-predict pain, and (3) higher predictions of pain related to less range of motion during the SLR, regardless of actual pain reports [8]. This study shows that predictions of the pain a movement will cause, especially over-predictions, will affect physical performance tests. If only one repetition of the movement is performed, the patient is not given an opportunity to correct their prediction of pain. This suggestion should be considered when designing testing and rehabilitation procedures to allow the patient to correct their beliefs, and help to limit avoidance behaviour.

### *Catastrophizing*

Catastrophizing is believed to be a pre-cursor to pain-related fear, which includes fear of pain and fear of movement/(re)injury [2, 55]. A study in 2007 aimed to investigate whether fear of movement/(re)injury intercedes the relationship between catastrophizing and functional disability. All participants for this study were respondents to a national survey about the prevalence and course of musculoskeletal complaints in the Netherlands [109]. Data from 152 people (94 females and 58 males) who reported that they had LBP was analyzed for the current study [109]. Of these 152 people, 131 reported that their pain was chronic [109]. The initial questionnaire assessed the area of musculoskeletal pain complaints, pain catastrophizing,

functional disability, pain intensity, and fear of movement/(re)injury in general [109]. A follow-up questionnaire, sent six months later, addressed the same areas, with the addition of questions specific to fear of movement/(re)injury in LBP [109].

The study had mixed results. The results indicated that catastrophizing was not related to functional disability when fear of movement/(re)injury was excluded from analysis. However, pain catastrophizing was significantly related to fear of movement/(re)injury at the six months follow-up, more so than fear of movement/(re)injury already present at baseline.

### *Fear of movement/(re)injury*

The landmark studies that focused on fear of movement/(re)injury were done by Vlaeyen et al., who used these results to develop the current FAM. The first study was a correlational study designed to determine how fear of movement/(re)injury related to biographical, pain-related, and distress-related variables [2]. The sample included 103 patients (58 women and 45 men) with CLBP [2]. Participants had a mean pain duration of 3.7 years (SD=4.7) but had minimal organic basis, or reported pain that was in excess of that expected for their organic pathology [2]. All participants completed self-reported measures that focused on pain intensity, fear of pain, catastrophizing, fear of movement/(re)injury, avoidance behaviour, coping, and depression [2]. The results indicated that fear of movement/(re)injury can be measured reliably with a self-report questionnaire, and that fear of movement/(re)injury is related to catastrophizing [2, 52]. Pain intensity was not predictive of fear of movement/(re)injury, indicating that this type of fear occurs independently from current pain intensity [2].

The second study was an experimental study designed to determine whether fear of movement/(re)injury is related to behavioural performance [2]. Thirty-three CLBP patients (25

women and 8 men) were included in this study [2]. Participants completed measures of fear of movement/(re)injury (TSK), anxiety (State-Trait Anxiety Inventory: STAI), and fear (VAS) prior to the behavioural test [2]. Participants were then asked to stand, lift, and hold a 5.5 kilogram weight [2]. The test was terminated when pain or discomfort made continuing impossible, or after a maximum time of 300 seconds [2]. The median score on the questionnaire measuring kinesiophobia was used to divide the subjects into high responders and low responders [2]. The results indicated that there were no significant differences between the high responders and low responders with respect to age or gender [2]. High responders reported a longer duration of pain, and showed decreased performance in the lifting task [2]. No correlations were found between HR or SCL and kinesiophobia [2].

The third study examined the factor structure of the TSK. The sample of participants included 129 CLBP patients (79 women and 50 men) with a duration of pain complaints of 9.9 years (SD=8.8) [55]. All patients had minimal organic basis, or reported pain that was in excess of that expected for their organic pathology [55]. Participants completed questionnaires to measure pain intensity, pain cognitions (PCL), fear of movement/(re)injury (TSK), fear, and pain control [55]. Analysis revealed that the questionnaire contained four subscales: harm, fear of (re)injury, importance of exercise, and avoidance of activity [55]. The authors conclude that these subscales may be used independently to measure a specific construct, or together to obtain a more complete picture of fear of movement/(re)injury [55].

The fourth study had two aims, (1) to examine whether fear of movement/(re)injury is a major predictor of disability, as compared with pain intensity, catastrophizing, and impairment, and (2) to examine whether catastrophizing, rather than pain intensity and impairment, is predictive of fear of movement/(re)injury [55]. Thirty-three CLBP patients (17 women and 16 men) were included in this study [55]. The mean duration of pain was 7.6 years (SD=8.2), and all

patients had minimal organic basis [55]. Participants completed questionnaires to assess impairment (The Medical Evaluation and Diagnostic Information Coding system: MEDICS), pain intensity (VAS), pain cognitions (PCL), fear of movement/(re)injury (TSK), and disability (RDQ) [55]. Participants were then asked to complete seven activities designed to assess behavioural performance [55]. The results indicated that fear of movement/(re)injury is the best predictor for self-reported disability levels, more so than biomedical status, pain intensity, and catastrophizing [55]. Analysis also revealed that catastrophizing is predictive of fear of movement/(re)injury [55].

A high degree of fear of movement/(re)injury as measured with the TSK has been found to be associated with poor performance on a number of physical tests, including weight lifting, isokinetic tests, or lumbar extension tests, and reaching tests [2, 6, 110, 111]. As well, the TSK has been demonstrated as being superior in predicting self-reported disability and poor behavioural performance [6, 55, 112]. This questionnaire has the potential to identify back pain patients whose level of disability is mainly determined by pain-related fear, and not by pain intensity or biomedical status [6, 55, 112].

#### *Fear-avoidance*

Pain-related fear is associated with avoidance behaviours in chronic back pain patients. Poor behavioural performance [2, 6, 110, 111] and self-reported disability [6, 36, 55] have been found to be more strongly associated with pain-related fear than with pain severity or biomedical findings.

A study done in 2000 aimed to determine how anticipation and fear of pain affect avoidance behaviour in CLBP patients [113]. Sixty-three CLBP patients in Kuwait city (34 males and 29 females) volunteered for this study [113]. The average duration of pain was 10.33

months (SD=7.24) [113]. Participants completed Arabic translations of the FABQ and Disability Belief Questionnaire (DBQ), and were then strapped into a MedX lumbar extension machine to test isometric strength [113]. Participants completed MVICs at 0, 12, 24, 26, 48, 60, and 72° of lumbar flexion [113]. After each MVIC there was a 10-second rest period. After all trials had been completed, participants were instructed to report the pain intensity experienced on a VAS [113]. Analysis revealed that anticipation of pain and fear-avoidance beliefs were the strongest predictors of poor performance [113]. The authors also note that the intensity of pain reported after the test and self-reported disability were not related to strength deficits [113].

Strong interrelationships have been found between pain, catastrophizing, depression, fear, and avoidance beliefs [114]. These factors are related to the onset of pain, as well as the transition from acute pain to subacute and chronic pain [115]. Fear-avoidance beliefs about work are strongly related to disability in daily living and work lost in the past year, more so than pain variables such as duration of pain, and pain severity [67]. The psychological factors included in the FAM should be considered as risk factors for developing chronic pain and disability [6, 115].

### **Acute Back Pain**

In comparison with the focus that chronic back pain has received, there has been little focus on acute back pain in research to date. However, the research that has been done on acute back pain tends to focus on identifying factors that may be used in the prediction of chronic pain.

One such study aimed to determine if chronicity could be predicted from an acute back pain in the general population. Three hundred acute LBP patients (151 males, 149 females) were enrolled in the study [116]. All participants met two criteria for inclusion in the study, (1) the

pain had begun no more than one week before they consulted their general practitioner (GP), and (2) the GP had determined that the patient was suffering from benign musculoskeletal LBP [116]. Participants completed several questionnaires at baseline, including assessments of stressful life events, personality, previous pain history, and coping strategies [116]. These questionnaires were re-administered at 2-month and 12-months follow-ups, in addition to measures of depression, disability, inappropriate signs and symptoms, pain drawing, and a physical exam [116]. The results indicated that patients with acute LBP will either improve significantly within two months, or will become chronic sufferers [116]. The FAM appears to be the best predictor of the course of LBP within the first two months [116]. The authors conclude that assessment of fear of pain needs to occur early in the course of acute LBP, and that rehabilitation should focus on confrontation of feared activities [116].

A study of patients with acute work-related back pain aimed to identify psychosocial factors that could predict return to work [117]. The sample included 78 acute LBP patients with a mean pain duration of 5.5 days (SD= 4.6) [117]. Participants completed questionnaires to measure impairment, disability, pain intensity, depression, anxiety, and fear-avoidance beliefs [117]. These measures were repeated at a follow-up done at four weeks, in addition to an assessment of work status [117]. Participants were assigned to one of two therapy intervention groups: a general therapy group, or a therapy group that specified activity based on the patient's symptoms [117]. The results indicate that the FABQ-W was the strongest predictor of work status, and that this subscale of the FABQ may be used to predict return to work in patients with acute work-related low back pain [117].

The role of fear-avoidance beliefs in patients with acute LBP has also received significant attention. Patients with acute LBP report high levels of fear-avoidance beliefs soon after pain onset, as measured with the FABQ [118]. These levels are similar to those reported by patients

with subacute and chronic LBP, indicating that fear-avoidance beliefs may greatly contribute to the continuation of pain [119, 120]. Fear-avoidance beliefs have been shown to be a strong indicator of disability and work status four weeks after onset of acute LBP, even after controlling for initial pain intensity, disability, and therapy [19]. Rising levels of disability appear to correspond with increases in pain-related fear, even when patients initially report low levels of disability. However, rehabilitation targeted to reduce fear-avoidance beliefs has been shown to help reduce disability, as well as reducing fear-avoidance beliefs in patients suffering from acute LBP [121].

Researchers have also found that pain-related fear is associated with decreased involvement in activities of daily living (ADLs) [122], greater perceived disability [16, 123-126], increased work loss [16, 127], and decreased performance of simple physical tasks [124] in patients with acute LBP.

### **Temporomandibular Joint Pain**

Two studies by Turner et al. have focused on determining whether catastrophizing is associated with outcome measures in patients suffering from disorders involving the temporomandibular joint of the skull, known as temporomandibular disorders (TMD) [128, 129]. The first study included 118 patients (95 females and 23 males) with TMD, with a mean pain duration of 6.23 years (SD=7.43) [128]. Participants completed questionnaires to measure pain, beliefs, catastrophizing, coping, pain-related activity interference, jaw activity limitations, and depression [128]. A physical exam was also done to measure jaw opening impairment [128]. Analysis revealed that significant associations exist between pain beliefs and activity interference, depression, and non-masticatory jaw activity limitations [128]. These same

associations are seen with catastrophizing [128]. The authors conclude that pain beliefs and catastrophizing significantly affect physical and psychological functioning [128].

The second study aimed to determine if catastrophizing is associated with clinical examination findings, pain-related activity interference, and health care use of patients with TMD [129]. The sample included 338 patients (294 females, 44 males) with TMD [129]. Participants completed questionnaires to measure catastrophizing, pain, pain-related activity interference, health care use, and depression [129]. A clinical examination was almost completed by an oral medicine specialist [129]. Analysis revealed that catastrophizing was not significantly associated with the more objective clinical examination measures but was significantly associated with the more subjective examination measures, as well as increased TMD-related activity interference and number of health care visits [129]. The authors conclude that TMD patients who catastrophize report higher pain intensity and more widely dispersed pain upon palpation, as well as greater TMD-related activity interference and health care use [129]. The authors suggest that clinicians consider screening patients with moderate or greater TMD pain and activity interference for catastrophizing, and that by identifying these patients education can be made available [129].

### **Neck Pain**

The majority of research on neck pain has focused on whiplash syndrome in an attempt to determine why pain persists long after the lesion site has healed. There is much debate about the mechanism of transition from acute to chronic pain after a whiplash injury. Several studies have hypothesized that pain after a whiplash injury is due to muscular or cerebral injury but results have been inconsistent [130-133]. Researchers are endeavouring to identify factors that contribute to the continuation of pain and disability in an attempt to predict chronicity.

Psychological factors have been suggested to contribute, and the FAM may explain the transition from acute to chronic pain after whiplash injury [115, 134-136].

One such study determined that fear of movement/(re)injury may help to predict chronic disability. Eighty-two patients (47 women and 25 men) who had experienced a motor vehicle accident (MVA) and developed pain within 48 hours of the incident were included in this study [137]. Participants completed measures of disability (Neck Disability Index: NDI), pain intensity (VAS), fear of movement/(re)injury (TSK), and catastrophizing (Pain Cognition List: PCL) [137]. Isometric muscle activity using electromyography was also assessed [137]. Analysis indicated that chronic disability may be predicted using the NDI and TSK at baseline with a probability of 54.3% [137]. The authors conclude that these measures are quick and easy to administer, and with their predictive ability may help to reduce chronic disability through education [137].

Catastrophizing has also been identified as a predictor of chronic disability following acute whiplash [138]. A study of acute whiplash patients included a sample of 147 patients who had experienced a MVA in the past three months [138]. Participants completed measures of catastrophizing (PCS), fear of movement/(re)injury (TSK), disability (Neck Disability Index: NDI), depression (Beck Depression Inventory: BDI), and pain intensity [138]. Analysis indicated that catastrophizing and fear of movement/(re)injury were predictors of both disability and depression, and that pain intensity was also a predictor of disability [138]. The authors conclude that these findings are in line with the current FAM: catastrophizing and fear of movement/(re)injury lead to disability, which in turns promotes chronicity [138].

Catastrophizing has also been shown to be predictive of exercise intolerance in MVA pain patients [139]. Eighty-six participants (59 women and 27 men) with a mean duration of pain of 2.7 years were included in the study [139]. Participants completed questionnaires to measure

catastrophizing (PCS), depression (BDI), anxiety (STAI), pain (McGill Pain Questionnaire: MPQ), and disability (Pain Disability Index: PDI) [139]. Analysis of the data revealed that catastrophizing was significantly correlated with reported pain intensity, disability, and employment status. Catastrophizing was also found to be a better predictor of disability than pain intensity [139].

If catastrophizing and fear of movement/(re)injury are addressed early in rehabilitation, disability and depression may be reduced [138, 140]. Patients who catastrophize, or display fear of movement and avoidance behaviours should be encouraged to participate in physical activity [137]. Graded exposure to feared activities will allow the patient to correct their inaccurate beliefs that activity will cause pain [137]. This confrontation, as described by the FAM, will direct the patient toward effective rehabilitation.

### **Chronic Shoulder Pain**

The majority of research regarding the upper extremity has focused on shoulder pain, due to the volume of non-recovery. Almost half of patients with non-traumatic shoulder injuries do not recover within 6 months, and only 60% of these patients recover within 12 months post-injury [12, 141, 142]. While the recovery of patients with acute shoulder pain can be predicted by pain severity and disability, psychological factors have a stronger influence on patients with sub-acute and chronic shoulder pain [11]. Research on the effects of psychological factors on chronic shoulder pain have shown similar results to those found in chronic back and chronic neck pain studies.

Based on the current FAM, Huis in 't Veld et al. studied females with neck and shoulder pain related to computer work in an attempt to apply the FAM to these types of pain [143]. Subjects completed a battery of questionnaires related to the FAM as well as a behavioural avoidance test (BAT), which was one maximal voluntary contraction (MVC) of the trapezius

muscle [143]. Subjects that had reported more pain also had more neck disability and less strength than the control group [143]. All relationships in the FAM were significant, except the relationship between the catastrophizing subscale of the Coping Strategies Questionnaire and pain-related fear [143]. The authors concluded that the results of the study were in line with the FAM, and identified the importance of pain-related fear in neck and shoulder pain related to computer work [143].

The FAM has been shown to be applicable to shoulder pain, and pain-related fear in neck and shoulder pain related to computer work [143]. Subjects that had reported more pain also had more disability and less strength than the control group [143]. Patients with chronic shoulder pain seem to maintain anxiety, depression, and psychological distress over time [144]. This indicates that psychological health is not solely dependent on pain, and that a measure of disability is also necessary [144]. Psychosocial factors, specifically kinesiophobia and catastrophizing, seem to be more important in the persistence of complaints than physical factors [62].

### **Acute Shoulder Pain**

As with back pain, there has been very little research dedicated to the effects of the FAM on acute shoulder pain. One notable study examined the effect of fear of pain after delayed-onset muscle soreness (DOMS) in the shoulder. The sample included 42 participants, 23 females and 19 males [145]. Participants completed questionnaires to assess negative affect from anxiety (STAI), fear of pain (FPQ-III), fear of movement/(re)injury (TSK), catastrophizing (Coping Strategies Questionnaire: CSQ), and disability (Disability of Arm, Shoulder, and Hand Questionnaire: DASH) [145]. Five trials were performed to determine MVIC of the shoulder external rotators using an isokinetic dynamometer [145]. Participants then underwent a

concentric/eccentric exercise protocol for the external rotators until fatigue [145]. Fatigue was determined to have been reached when the participant could only generate the force equal to 50% of their MVIC [145]. Evoked tenderness levels were assessed using the MPT with a Fischer algometer and VAS after 48 hours [145]. Analysis revealed that fear of pain was consistently associated with pain, disability, and fear of movement/(re)injury [145].

### **Lower Extremity Pain**

Few studies have focused on the effects of the FAM with respect to lower extremity injury. Research seems to focus on the knee, and specifically anterior cruciate ligament (ACL) reconstruction. A study in 2005 was done to determine if fear of re-injury has a significant influence on the return to previous level of activity in ACL-reconstructed patients [146]. The sample included 62 patients (34 men and 28 women), all of which had undergone ACL-reconstruction surgery. Subjects were asked about past and current physical activity, including whether they were involved in contact or non-contact activity, whether they had returned to their previous activity, and if they were at the same level of competition [146]. The authors found that only half of the patients with ACL reconstruction returned to their previous level of activity, and that the patients that did not return to their previous level of activity had higher fear of movement/(re)injury than those who had returned to their previous level of activity [146, 147]. The authors concluded that kinesiophobia is a psychological factor that should be considered in the rehabilitation after ACL reconstruction [146, 147].

Another study of ACL-reconstruction patients investigated the association between fear of movement/(re)injury on function [148]. The study included 97 ACL-reconstruction patients (61 males and 36 females), divided into three groups based on time since surgery [148].

Participants completed questionnaires designed to measure functional disability (International

Knee Documentation Committee: IKDC), fear of movement/(re)injury (TSK), and quality of life (Medical Outcomes Study 8-Item Short-Form Health Survey: SF-8) [148]. The results indicate that fear of movement/(re)injury appears to decrease during ACL reconstruction rehabilitation, and corresponds with an increase in function [148].

### **Other Pain Conditions**

Pain-related fear has been studied in other conditions, such as chronic headache [28, 149-152], fibromyalgia [53, 153-156], chronic fatigue syndrome [157, 158], burn pain [159], and neuropathic pain [160-163]. The FAM has been determined to be applicable to these conditions, and in a study of Post Herpetic Neuralgia (PHN) patients and Reflex Sympathetic Dystrophy (RSD) patients, recovery or chronicity was correctly predicted with an accuracy of 82%, regardless of pathology [161].

In 2008, an editorial suggested that healthcare providers (HCPs) may contribute to the likelihood of a patient following the FAM [164]. The author suggests that some HCPs may themselves be fear-avoidant, and their treatment advice may influence their patients to become so [164-167]. Ostelo suggests that HCPs may unknowingly influence patients with their own fear-avoidance beliefs, and that the FAM may be expanded to include the influence of fearful observers [164].

Although there have been relatively few studies done on the effects of the FAM on acute musculoskeletal pain conditions, these studies have shown results that appear in line with the multitude of chronic musculoskeletal pain condition studies. Fear of pain has been shown to be consistently associated with pain, disability, and fear of movement/(re)injury [145]. Fear of movement/(re)injury has been found to be a strong predictor of future activity level following rehabilitation, with patients who report higher scores on the TSK being much less likely to return

to their pre-injury level of activity [146]. Catastrophizing has also been determined to predict performance on physical tests, and has been found to be a better predictor of disability than pain intensity [139]. These conclusions indicate that these psychological factors affect physical performance following musculoskeletal injury, and are important to address in rehabilitation before the condition becomes a chronic problem.

### **Rehabilitation of Chronic Conditions**

Recently there has been an increased focus on identifying and understanding the progression and resolution of symptoms associated with musculoskeletal pain. Research has tended to focus on back pain, and specifically back pain related to work-loss. A study done in 2005 investigated the effects of anticipation of fear and fear-avoidance beliefs on the outcome of CLBP following a rehabilitation intervention [14]. The sample included forty-two CLBP patients (22 men and 20 women) who had been cleared by a physician for participation in this study [14]. Mean pain duration was 4.8 months (SD=2.2) [14]. Participants completed questionnaires to assess fear-avoidance beliefs (FABQ), pain intensity (VAS), and disability (RDQ) [14]. Participants also completed three timed physical performance tests: sit to stand, lumbar forward bending, and fast walking [14]. In addition, isometric lumbar extension strength (ILES) was tested before and after the exercise intervention using a MedX machine [14].

The exercise intervention focused on strengthening the lumbar extensor muscles [14]. Participants would begin each session with a five-minute warm-up, followed by one set of lumbar extension exercises through the available range of motion (0-72°) [14]. Initially the workload was set for 50% of the ILES measurement, a load that allowed the participants to complete 6 to 12 repetitions before fatigue [14]. The load was increased by 5% when the participant could complete 12 repetitions to ensure progressive resistance training [14]. Training

sessions occurred once per week for 10 weeks [14]. The subjects were instructed not to alter normal daily activities, life-style, or diet during the treatment [14].

The results of this study indicate that despite significant improvements in all variables following intervention, anticipated pain remained significantly higher than reported pain during physical performance testing for subjects with very high scores on the FABQ. The authors suggest that high scores on the FABQ-PA prior to rehabilitation may be a significant indication of non-recovery in patients [14]. This trend was not seen with the FABQ-W scale, which conflicts with previous research. The authors suggest that this may show that the scales of the FABQ are population-sensitive [14]. Further research should be done comparing workers who are receiving compensation with workers who are not receiving compensation to test this theory.

Another study of fear-avoidant CLBP patients aimed to determine if a targeted exercise-based rehabilitation program would improve outcomes at six- and 12-months [168]. The sample of participants included 187 CLBP patients (106 women and 81 men) [168]. The duration of pain ranged from six weeks to six months, and all patients had been cleared by their GP for participation in this study [168]. Participants completed questionnaires to measure disability (RDQ), fear-avoidance beliefs about physical activity (FABQ-PA), and the DRAM, which was used as a predictor of outcome, and combines the Modified Somatic Perceptions Questionnaire and the modified Zung questionnaire [168]. The RDQ and the FABQ-PA were re-administered at six weeks, and the RDQ was re-administered at six- and 12-months [168]. The FABQ-PA was used to divide the participants into high fear-avoidance and low fear-avoidance groups using a cutoff score of 14, which was the median score at baseline [168]. Participants were randomly divided into a usual care group and an exercise intervention group [168].

The exercise-based program, 'Back to Fitness,' uses a cognitive-behavioural approach designed to increase confidence with normal spinal motion [168]. The exercise protocol consisted of a one-hour session, twice per week for four weeks [168]. The program incorporates low-impact aerobic exercise with stretching and strengthening for the major muscle groups [168].

The results of this study indicate that there was no significant difference in function for patients with low fear-avoidance, regardless of the group [168]. In contrast, patients with high fear-avoidance beliefs had a better recovery when enrolled in an exercise-based rehabilitation program at six- and 12-month follow-ups than patients who received usual care from their GP [168]. At one year, patients with high fear-avoidance beliefs who completed the exercise program were over 3 times more likely to be functional than those who had received usual care [168]. This trend was not observed in patients with low fear-avoidance beliefs [168].

A study of the effects of educational booklets in patients with acute LBP showed that education is a critical part of the rehabilitation process [169]. Patients received either a standard care educational booklet about back pain, or a new booklet which focuses on physical activity and restoring daily activities [169]. Patients completed questionnaires to measure fear-avoidance beliefs (FABQ-PA), disability (RDQ), beliefs about the consequences of back pain (Back Beliefs Questionnaire: BBQ), and pain intensity (VAS) [169]. These same questionnaires were used as outcome measures at follow-up which was collected at two weeks, 3 months, and one year after baseline testing [169]. The results showed that Patients who had received the experimental booklet showed a significant early improvement as compared to patients who had received the standard care booklet [169]. Patients with high fear-avoidance who received the experimental booklet had a clinically significant improvement in fear-avoidance beliefs at two weeks and a clinically significant improvement in disability at three months [169]. Both

improvements in fear-avoidance beliefs and disability were maintained at one year [169]. The authors conclude that the content of information presented to pain patients can have a significant impact on the beliefs and outcomes of the rehabilitation process [169].

Several studies focused specifically on neck and upper extremity pain, although these studies focused on the course of symptoms, not on rehabilitation specifically [10-12]. These studies all use mailed self-report questionnaires for follow-up, ranging from three months to six months after baseline testing. Results indicate that catastrophizing is less influential for patients with shoulder pain than low-back pain [12]. Only catastrophizing in patients who had longer duration of shoulder pain at baseline was a significant predictor of persisting symptoms at follow-up [12]. This indicates that the influence of psychological factors may vary with different types of pain [12]. Acute pain patients showed the best course over the six-month period, with the greatest pain reduction and least functional disability [11]. Chronic pain patients showed the poorest results, with increased catastrophizing showing an association with smaller reductions in pain [11]. Acute pain was determined to be the presence of symptoms for less than six weeks, subacute pain was determined to be the presence of symptoms for 6-12 weeks, and chronic pain was determined to be the presence of symptoms for more than 3 months [11]. Kinesiophobia, as measured with the TSK, remained unchanged over the course of 12 months in non-recovered patients [10]. The strongest associations with kinesiophobia were catastrophizing and disability [10].

The components of the FAM have been shown to affect the rehabilitation of chronic pain patients. Fear-avoidance beliefs have been shown to be a significant indication of non-recovery in chronic back pain patients [14]. This non-recovery may be prevented however; education and specific rehabilitation programs have been shown to increase the rate of recovery of patients with high fear-avoidance beliefs as compared with usual care rehabilitation

programs [168, 169]. Kinesiophobia levels have been shown to remain steady over the course of 12 months in non-recovered patients, indicating that this fear of movement/(re)injury may be interfering with the rehabilitation process [10]. Catastrophizing has also been shown to predict persistence of symptoms, specifically in patients who had longer duration of shoulder pain at baseline testing [12]. This indicates that the influence of psychological factors may vary with different types of pain [12].

### **Rehabilitation of Acute Injury**

To date, there is no research that has focused on the effects of fear of pain, catastrophizing, fear of movement/(re)injury, or fear-avoidance beliefs on the rehabilitation of acute musculoskeletal injury.

### ***Aim & Hypothesis***

Based on the current body of knowledge, the aim of the current study was to determine if the rate of recovery from acute musculoskeletal injury is affected by the psychological factors included in the FAM. We hypothesized that fear of pain will have a negative impact on the rehabilitation process, that the FABQ will be correlated with the physical measures, and that higher scores on the FAM will predict a longer RTP.

## Methods

### *Participants*

Participants were recruited from Concordia University's varsity athletic teams, as well as athletic teams from Dawson College. Two certified athletic therapists are employed by each of these institutions to assess and provide rehabilitation for all athletes. Following any injury, it is the role of these athletic therapists to determine the type and severity of the injury. These athletic therapists were contacted, informed of the details of the current investigation, and were consistently in contact with the primary investigator. All athletic therapists from Concordia University and Dawson College were given four specific inclusion criteria, which were used in their post-injury assessment. These criteria include:

1. Injury must be an acute musculoskeletal injury of the upper or lower extremity, and any previous injury to the area must have been fully healed
2. Athlete must not require surgery
3. Anticipated rehabilitation lasting up to six weeks\*
4. Athlete must not be able to participate in practice or games for up to six weeks\*

If an athlete met these four inclusion criteria, the primary investigator was contacted to meet with the athlete within 24 hours of injury to confirm these criteria. The rehabilitation treatments were performed by or supervised by a certified athletic therapist. Participants who failed to adhere to treatment schedules were excluded from the study.

\*One of the initial criteria for entrance into the study – an injury with an expected rehabilitation of at least two weeks – was eliminated midway through data collection. We discovered that disability at baseline, which we used to judge whether the athlete would be in rehabilitation for between two- and six-weeks, did not correlate to RTP ( $-0.331, p = 0.099$ ), baselinepain ( $0.168, p = 0.413$ ), or change in strength ( $0.168, p = 0.412$ ). These numbers mean

that athletes with high levels of disability may not report high levels of pain, show a greater change in strength, and may return to play quickly, while athletes with low levels of disability may report high levels of pain, show a large change in strength, and take much longer to RTP. Based on these initial results, we eliminated the two-week minimum rehabilitation criteria.

### ***Assessment of the Fear-Avoidance Model***

Self-report questionnaires were used to measure four components of the FAM. The questionnaires used are the FPQ-III, the PCS, the TSK, and the FABQ. The FPQ-III is a 30-item questionnaire found to be a valid and reliable measure of fears about painful situations [40-42]. The PCS is a 13-item questionnaire found to be a valid and reliable measure of the three subscales of catastrophizing: rumination, magnification, and helplessness [4, 47, 50]. The TSK is a 17-item questionnaire found to be a valid and reliable measure of beliefs about (re)injury during physical activity and work [2, 52, 53, 55, 63]. The FABQ is a 16-item questionnaire found to be a valid and reliable measure of fear-avoidance beliefs about physical activity and work [67-69]. These questionnaires were available in English and French translations for each athlete. These questionnaires were administered only at the baseline assessment, not at each follow-up assessment.

### ***Outcome Measures***

#### ***Return to Play***

Recovery time was measured from the day of initial injury to the day the athlete was able to return to full practice or competition, termed return to play (RTP). Athletic therapists at each institution determined the ability of the athlete to return safely to their sport. This time was measured in days.

### *Range of Motion*

Range of motion of the joints surrounding the lesion site of the athlete was measured with a universal plastic goniometer [170, 171]. The specific joints that were assessed were different for each athlete based on their injury, and included the joint or joints closest to the lesion site. The participant was asked to move through the joint range of motion while the plastic arms of the goniometer were aligned along the long axis of the body. When the patient signalled that they could not move further into the range, the active range of motion (AROM) measurement was recorded in degrees. As an example, to test the ROM available in knee flexion the plastic arms of the goniometer would be aligned with the femur and fibula, and the athlete asked to bend their knee as much as possible.

The number of ROMs measured depended on the site of the injury, and ranged from two ROMs to eight ROMs. To normalize the ROM between joints, percent change in ROM was used. These ROM measurements were recorded at baseline assessment, and each follow-up assessment until the athlete returned to play.

### *Strength*

Manual Muscle Testing (MMT) was used to test the strength of the muscles surrounding the lesion site. As with the ROM measures, the specific muscles that were assessed varied between athletes based on their injury. A maximal voluntary isometric contraction (MVIC) was performed, which involved the participant pushing as hard as they could against resistance without movement for a period of five seconds[75]. As an example, to test the strength of knee flexion the patient was supine with their knee bent to 90 degrees. The athlete was then asked to bend their knee further while the investigator applied a counter force. Strength was graded on a

6-point scale, with zero indicating no contraction of the involved musculature and five indicating a maximal contraction against gravity with maximal resistance [172]. Only one repetition was performed for each muscle, as it has been shown in previous studies that repeated trials might cause an improvement in performance for fear-avoidant patients [8, 9, 143]. These strength measurements were recorded at baseline assessment, and each follow-up assessment until the athlete returned to play.

Although isokinetic dynamometers are considered to be the gold standard in stretch measurement, they are expensive and therefore less accessible for most clinicians. We chose to use MMT to measure strength in our subjects as this method is the most commonly used technique in clinics. This method is certainly less accurate than isokinetic testing, but makes our results more applicable to the average clinician.

#### *Pain Intensity*

The VAS used for this study consists of a 100-mm horizontal line with the left end labelled “no pain” and the right end labelled “worst pain” [74, 75]. Participants were instructed to make a single pen slash through the line that indicates on average how much pain they were experiencing that day [75]. The line was then measured between the left end and the pen slash to the nearest millimetre, giving scores that range from 0 to 100 [75]. This measurement was recorded at baseline assessment, and each follow-up assessment until the athlete returned to play.

#### *Evoked Tenderness*

Evoked tenderness was assessed with a Fischer algometer (Pain Diagnostics and Thermography Inc., Great Neck, NY), which has been determined to be a valid and reliable

measure of pain [83, 84, 86, 88, 89]. We used both methods of application of the hand-held algometer, first the MPT method then the PPT method. The MPT method is applied first as this method may not evoke pain in the athlete, and is less likely to affect the PPT reading. These measurements were recorded at baseline assessment, and each follow-up assessment until the athlete returned to play.

The MPT for each patient was measured by applying the rubber footplate of the algometer against the skin at the point that each athlete indicated was the most painful point. The primary investigator applied  $9 \text{ kg/cm}^2$  at a rate of approximately  $1 \text{ kg/s}$  [75]. A test point was performed on an uninjured area so that the participant understood the amount of pressure that was to be applied. When a pressure of  $9 \text{ kg/cm}^2$  was reached, the participant was asked to rate their pain intensity on a VAS [75]. The pressure was removed immediately after this recording.

The PPT for each patient was measured by applying the rubber footplate of the algometer against the skin at the point that each athlete indicated was the most painful point. Pressure was applied at a rate of approximately  $1 \text{ kg/s}$  until the patient signalled that the sensation has changed from 'pressure' to 'pain' [75]. The pressure was removed immediately, and the amount of pressure that was applied was recorded.

### *Disability*

The disability of each athlete was measured with one of two self-report questionnaires that are specifically designed to assess disabilities of either the upper extremity or the lower extremity. The DASH is a 30-item questionnaire that was used to assess symptoms and disability in the upper extremity [93]. The LEFS is a 20-item questionnaire that was used to assess disability in the lower extremity [97]. The questionnaire that is applicable to the injured area

was administered at baseline assessment, and each follow-up assessment until the athlete returned to play.

### ***Procedure***

After confirmation that the athlete met the four inclusion criteria, study information was provided and each participant signed the informed consent form. A baseline assessment occurred within 24 hours of injury. This baseline assessment included the collection of demographic information and completion of four questionnaires to measure the components of the FAM. In addition, the baseline assessment included measurement of range of motion, strength, pain intensity, evoked tenderness, and disability. This baseline assessment took place before the athlete was given pain medications, which may alter the results of the physical assessment due to the reduction in pain symptoms.

Follow-up sessions occurred every two weeks until the athlete has been deemed able to RTP. Return to play is a term that is used to indicate that an athlete has been deemed able to return to full practice or competition by the athlete's athletic therapist. These follow-up sessions involved the collection of repeat measures of ROM, strength, pain intensity, evoked tenderness, and disability. The athletic therapists in our study were blind to the data being collected.

Once the athletic therapists had determined that the athlete is able to return to play, the primary investigator was contacted to complete a final assessment, during which final measurements of range of motion, strength, pain intensity, evoked tenderness, and disability were collected. The length of rehabilitation was recorded as the number of days from injury to RTP. The number of treatment sessions that each athlete completed were recorded, as well as whether the treatment was provided by a student or a certified athletic therapist.

### ***Data Analysis***

A sample of 29 athletes was collected from Concordia University and Dawson College. Demographic data is presented in Table 1. The data from three subjects were eliminated from analysis in accordance with previously outlined exclusion criteria. One athlete was pushed to return to competition before fully healed, one athlete's injury did not cause them to miss practice, and one athlete was out of season and was not motivated to return to off-season training. This left data from 26 athletes for our analysis.

Two self-report questionnaires were used to measure disability, the DASH and the LEFS. The LEFS is a scale from zero to 80 that measures the ability to perform activities using the lower extremity, with a lower score representing greater disability. The DASH measures the ability to perform activities with the upper extremity and provides a percentage score, with a higher score representing greater disability. We converted the LEFS to a percentage score and reversed the direction of the DASH in order to normalize these scales to provide a single disability score. The final calculated disability score is presented as a percentage, where 100% indicates no disability. Athletes completed either the DASH or the LEFS, depending on the location of their injury.

Pearson correlations between each of the four components of the FAM and RTP were calculated to determine if there was a relationship between fear of pain, catastrophizing, fear of movement/(re)injury, or fear-avoidance and time to RTP. There are several studies that state that the FABQ is able to predict change in disability [18, 168, 169, 173, 174]. Correlations between the FABQ and the physical measures were also calculated to test this theory. All data was analyzed using SPSS for Windows, Version 15.0 (SPSS, Inc., Chicago, IL), with type I error rate of 0.05.

## Results

### Sample Characteristics

The final sample of 26 was comprised of 17 males and 9 females. The mean age was 20.8 years, with a standard deviation of 2.1 years (males: 21.5 years, SD=1.8 years, females: 19.6 years, SD=2.1 years). At the time of entry into the study, 10 subjects were currently participating in a training camp for the upcoming season, 13 subjects were currently in season, and 3 subjects were out of season. The average disability score was 45.1% (SD=22.9); the average time to RTP was 19.1 days (SD=11.4), with a range from 5-50 days. Demographics are presented in table 1. Means and standard deviations are presented for all questionnaires and physical measures in table 2.

	Total	Male	Female
	n=26	n=17	n=9
Age (years)	20.8 (2.1)	21.5 (1.8)	19.6 (2.1)
Height (cm)	181.7 (9.9)	187.1 (6.5)	171.6 (6.6)
Weight (kg)	79.9 (16.0)	88.4 (12.2)	63.8 (7.8)
Right Hand Dominant	19	12	7
Left Hand Dominant	7	5	2
Football	12	12	0
Rugby	3	2	1
Hockey	3	1	2
Basketball	5	2	3
Soccer	2	0	2
Volleyball	1	0	1
Upper Extremity Injury	3	2	1
Shoulder	3	2	1
Lower Extremity Injury	23	15	8
Foot	1	0	1
Ankle	9	5	4
Knee	4	1	3
Thigh	6	6	0
Hip	3	3	0
Training Camp	10	10	0
In Season	13	4	9
Out of Season	3	3	0

Table 1. Description of 26 athletes including sport and injury.

	Average (n=26)	Standard Deviation
Return to Play (RTP)	19.12	11.44
FPQ-III Total score	74.46	19.76
FPQ-III Severe Pain score	30.96	8.82
FPQ-III Minor Pain score	19.31	6.81
FPQ-III Medical Pain score	24.19	7.55
PCS Total score	19.00	10.21
PCS Rumination score	8.42	4.07
PCS Magnification score	3.15	2.33
PCS Helplessness score	7.42	5.22
TSK score	39.58	6.46
FABQ Total score	42.69	19.92
FABQ Physical Activity score	17.81	5.10
FABQ Work score	12.19	12.44
Baseline Disability %	45.12	22.91
Final Disability %	91.60	7.72
Change in Disability %	46.48	25.76
Baseline Overall Pain	54.00	24.56
Final Overall Pain	10.37	12.90
Change in Overall Pain	-42.91	22.92
Baseline MPT	50.88	37.73
Final Evoked MPT	20.21	28.03
Change in Evoked MPT	-29.43	40.40
Baseline PPT	6.72	4.85
Final PPT	9.36	4.31
Change in PPT	2.58	6.24
Baseline Average ROM %	72.28	29.23
Change in Average ROM %	27.72	29.23
Baseline Peak-low ROM %	58.48	27.88
Change in Peak-low ROM %	41.52	27.88
Baseline Strength	3.78	0.52
Final Average Strength	4.89	0.25
Change in Average Strength	1.10	0.52

Table 2. Means and standard deviations of FAM questionnaire and physical measure scores.

### Correlations of the Fear-Avoidance Model to Return to Play

No significant correlations between the FABQ and the TSK and RTP were found. A trend was identified between the FPQ-III and the PCS and RTP. The medical subscale of the FPQ-III showed a correlation of  $-0.372$  ( $p = 0.061$ ) with RTP (chart 1), and the Magnification subscale of the PCS showed a correlation of  $0.370$  ( $p = 0.063$ ) with RTP (chart 2). Correlations between the FAM and RTP, disability, and overall pain are presented in table 3.

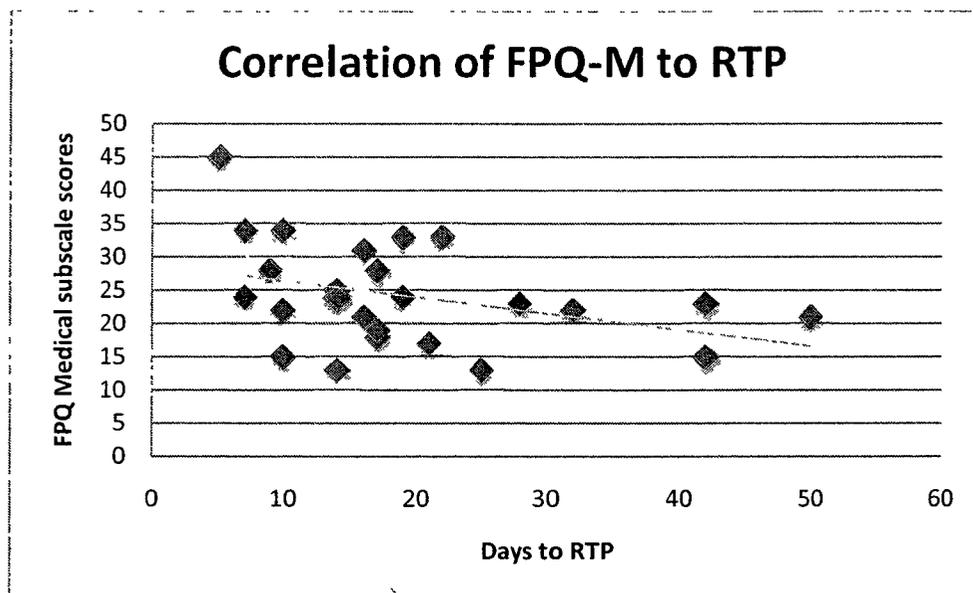


Chart 1. Plot showing the relationship between the medical subscale of the FPQ-III and RTP. Note the negative correlation, which goes against previous research. A possible explanation for this finding is that athletes who have higher levels of fear of medical pain are less likely to come to athletic therapists for rehabilitation, and push themselves to return to play to avoid possible medical pain.

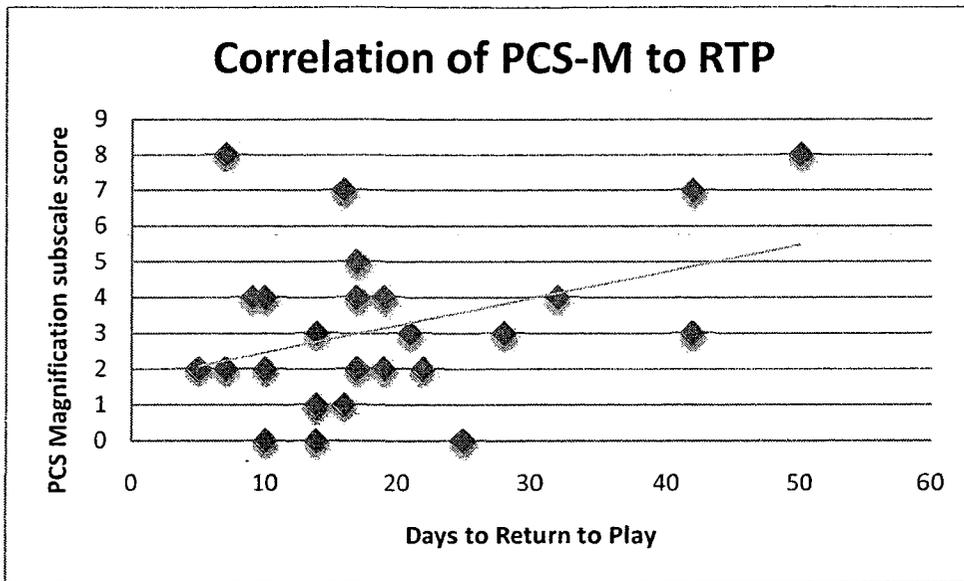


Chart 2. Plot showing the relationship between the magnification subscale of the PCS and RTP.

	RTP	Baseline Disability	Baseline Pain
<b>FPQ-III Total</b>	-0.203 (0.321)	-0.052 (0.800)	-0.052 (0.799)
Severe Pain subscale	-0.011 (0.957)	-0.217 (0.287)	-0.059 (0.744)
Minor Pain subscale	-0.161 (0.433)	0.028 (0.893)	-0.112 (0.585)
Medical Pain subscale	-0.372 (0.061) <sup>^</sup>	0.092 (0.654)	0.033 (0.872)
<b>PCS Total</b>	0.257 (0.205)	-0.235 (0.248)	0.389 (0.049)*
Rumination subscale	0.117 (0.568)	-0.151 (0.462)	0.412 (0.036)*
Magnification subscale	0.370 (0.063) <sup>^</sup>	-0.361 (0.071)	0.224 (0.271)
Helplessness subscale	0.246 (0.226)	-0.181 (0.376)	0.340 (0.089)
<b>TSK</b>	0.300 (0.137)	-0.218 (0.284)	0.128 (0.533)
<b>FABQ Total</b>	0.239 (0.239)	-0.442 (0.024)*	0.414 (0.035)*
Physical Activity subscale	0.046 (0.822)	-0.432 (0.028)*	0.308 (0.126)
Work subscale	0.253 (0.212)	-0.328 (0.102)	0.354 (0.076)

Table 3. Correlations among the four components of the fear avoidance model and rehabilitation variables at baseline (p values). \* indicates significance, ^ denotes a trend which approaches significance.

Although the FABQ was not significantly correlated to RTP, it was significantly correlated with many of the physical measures, both at the time of injury, and the overall change in scores from baseline to RTP. Significant correlations with the FABQ at time of injury include: disability ( $r = -0.442, p = 0.024$ ), average ROM ( $r = -0.450, p = 0.021$ ), peak-low ROM ( $r = -0.389, p = 0.050$ ), overall pain ( $r = .414, p = 0.035$ ), evoked tenderness ( $r = 0.425, p = 0.030$ ), and PPT ( $r = -0.512, p = 0.007$ ). Our finding that the FABQ was significantly correlated with overall pain is very similar to the correlation of  $r = 0.31$  between the FABQ and overall pain found in a sample of 42 chronic LBP patients [14]. The FABQ was significantly correlated with the change in: disability ( $r = 0.450, p = 0.021$ ), average ROM ( $r = 0.450, p = 0.021$ ), peak-low ROM ( $r = 0.389, p = 0.050$ ), overall pain ( $r = 0.539, p = 0.004$ ). The FABQ-PA and FABQ-W subscale correlations are presented in table 4.

	FABQ-T	FABQ-PA	FABQ-W	RTP
Baseline Pain	0.41* (0.035)	0.31	0.35	0.17
Final Pain	-0.10	-0.22	-0.04	-0.28
Change in Pain	0.54** (0.004)	0.44* (0.024)	0.45* (0.022)	0.33
Baseline Disability	0.45* (0.024)	-0.43* (0.028)	-0.33	-0.33
Final Disability	0.19	0.45* (0.021)	0.06	.17
Change in Disability	0.45* (0.021)	0.52** (0.007)	0.31	0.35

Table 4. Correlations between scores on the FABQ-PA and FABQ-W and pain and disability scores. \*\* denotes significance at  $p < 0.001$ , \* denotes significance at  $p < 0.05$ .

### Discussion

Although there were no significant correlations between four components of the FAM, trends were identified between two aspects of the FAM and RTP. The medical pain subscale of

the FPQ-III was correlated with RTP ( $r = -0.372, p = 0.061$ ), while the Magnification subscale of the PCS had a correlation of  $r = 0.370$  ( $p = 0.063$ ) with RTP.

There are several possible reasons that significant correlations between the components of the FAM and RTP were not found. One explanation is that there simply is no relationship between the FAM and the length of rehabilitation, however the trends found between RTP and the PCS-M and FPQ-M do not support this. Another possible explanation is that perhaps athletes do not respond to pain-related fear in the same manner as the general population. The FAM questionnaires were developed using the general population – it is possible that the questionnaires are not as valid and reliable when testing athletes. A third explanation is that there is a true relationship between the FAM and RTP in athletes, but that our sample was not large enough to be able to identify this trend. An increase in sample size is necessary to identify whether there is truly a relationship or not.

The negative correlation found between the medical pain subscale of the FPQ-III and RTP goes against what we had expected to find: that as fear of pain increased so would RTP. A possible explanation for this finding is that previous research had been done on the general population, not specifically athletes. Athletes may be more sensitive than the general population to medical pain, as it is medical personnel who keep them from returning to competition. These athletes may push themselves to return to play faster to avoid contact with medical personnel, thereby avoiding medical pain.

Several of the mean scores reported on the FPQ-III in our study are similar with previous studies. The Fear of Pain questionnaire was developed to assess fear of pain, and was tested on groups of undergraduate students, medical patients, and chronic pain patients [40]. The undergraduate students were used to represent a healthy control group, while the general medical outpatient group was used as a second control group that represented a similarity of

the function to that of the chronic pain patients. Forty chronic patients were included, all with symptoms occurring for longer than six-weeks. The majority of the sample (n=21) suffered from neck and/or back pain. A separate study to confirm the reliability and validity of the FPQ-III in non-clinical samples focused specifically on undergraduate students [41]. The scores reported by the athletes in our study closely match the reported scores of the medical outpatients and chronic pain patients on the minor pain subscale and medical pain subscale. In contrast, the scores reported by athletes on the severe pain subscale and the overall questionnaire scores are lower than the undergraduate students, medical patients, or chronic pain patients, indicating that student-athletes may be a distinctive group.

Table 5 presents mean scores and standard deviations on the FPQ-III from Osman et al. and McNeil & Rainwater for comparison with the scores from our study.

	<b>Undergraduate Students</b>	<b>Medical Outpatients</b>	<b>Chronic Pain Patients</b>	<b>Athletes with Acute Injury</b>
	<i>Osman et al., 2002</i>	<i>McNeil &amp; Rainwater, 1998</i>	<i>McNeil &amp; Rainwater, 1998</i>	<i>McNeil &amp; Rainwater, 1998</i>
				<i>Legge &amp; Dover, 2010</i>
<b>Severe Pain Subscale</b>	34.9 (8.1)	33.5 (8.7)	33.8 (11.0)	37.1 (7.4)
				<b><u>31.0 (8.8)</u></b>
<b>Minor Pain Subscale</b>	18.7 (5.7)	18.4 (6.0)	19.6 (8.3)	19.2 (6.1)
				<b><u>19.3 (6.8)</u></b>
<b>Medical Pain Subscale</b>	26.7 (8.1)	27.0 (8.5)	24.7 (9.3)	23.4 (6.3)
				<b><u>24.2 (7.6)</u></b>
<b>Total Score</b>	80.2 (18.5)	79.0 (19.0)	78.1 (25.1)	79.7 (16.2)
				<b><u>74.5 (19.8)</u></b>

Table 5. Mean scores and (Standard Deviations) of the FPQ-III for undergraduate students, medical outpatients, chronic pain patients, and athletes with acute musculoskeletal injuries.

The mean scores reported by the athletes in our study do not closely follow previously reported scores by undergraduate students or patients seeking medical care. The PCS was developed to assess catastrophizing related to pain, and has been tested on undergraduate psychology students, as well as patients seeking medical care for various pain-related conditions [47]. Our sample was a student population as well as a population seeking medical care, so we expected our scores to be in line with Osman et al. The scores from our sample do appear to better match the scores of the patients seeking medical care - of note would be the scores on the Helplessness subscale in males ( $7.82 \pm 5.14$ ) in our study compared to males seeking medical care ( $7.03 \pm 4.78$ ), as well as the total score on the PCS in males in our study ( $19.12 \pm 9.97$ ) compared to males seeking medical care ( $18.41 \pm 9.64$ ). Overall the scores reported by athletes appear higher than scores reported by undergraduate students and patients seeking medical care, indicating that student-athletes may be a distinctive group.

Table 6 presents mean scores and standard deviations on the PCS from Osman et al. for comparison with our results.

	Undergraduate		Patients seeking		Athletes with Acute	
	Students		Medical Care		Injury	
	<i>Osman et al., 1997</i>		<i>Osman et al., 1997</i>		<i>Legge &amp; Dover, 2010</i>	
	<i>Males</i>	<i>Females</i>	<i>Males</i>	<i>Females</i>	<i>Males</i>	<i>Females</i>
<b>Rumination Subscale</b>	5.58 (3.81)	6.57 (4.04)	7.54 (3.88)	5.52 (3.76)	<b>8.59</b> <b>(3.87)</b>	<b>8.11</b> <b>(4.65)</b>
<b>Magnification Subscale</b>	2.29 (1.98)	2.81 (2.44)	3.83 (2.69)	2.47 (2.34)	<b>2.71</b> <b>(2.26)</b>	<b>4.00</b> <b>(2.35)</b>
<b>Helplessness Subscale</b>	4.01 (3.39)	5.20 (4.06)	7.03 (4.78)	3.76 (3.24)	<b>7.82</b> <b>(5.14)</b>	<b>6.67</b> <b>(5.61)</b>
<b>Total Score</b>	11.88 (8.02)	14.28 (9.55)	18.41 (9.64)	11.74 (8.40)	<b>19.12</b> <b>(9.97)</b>	<b>18.78</b> <b>(11.26)</b>

Table 6. Mean scores and (Standard Deviations) of the PCS for undergraduate students, patients seeking medical care, and athletes with acute musculoskeletal injuries.

A study of LBP patients showed that a medium to high score on the PCS led to a seven times increased odds ratio for low physical activity compared to a score indicating no pain catastrophizing ( $OR = 1.0$ ) [175]. Although we did not measure physical activity directly in our study, RTP does provide a similar measure, as RTP does indicate full physical activity.

Although the FABQ was not significantly correlated to RTP, we found that scores on the FABQ did significantly correlate with many of the physical measures at the time of the baseline assessment, as well as the overall change in these physical measures. While we could not confirm that the FABQ is directly related to time to RTP, it is related to the physical measures that athletic therapists use to assess the athlete's ability to return to their sport. This relationship between the FABQ and measures of disability, pain intensity, and ROM indicates that these physical measures are affected by the psychological health of the athlete.

A study of LBP patients examined relationships between the subscales of the FABQ and pain and disability, relationships that were also examined in our study. These correlations are presented for comparison with our results in table 7. One of the most notable differences between studies is that while the FABQ-W was significantly correlated with final pain, change in pain, final disability, and change in disability in the study by Cleland, we found significance only between the FABQ-W and change in pain. In addition, the strongest correlation in both studies is between change in disability and the FABQ (-0.50 and 0.52), although the subscale differs between studies. A possible explanation for this difference is that our study was done on an undergraduate-athletic population who strongly identify with the questions presented on the FABQ-PA subscale, but may not identify with the questions presented on the FABQ-W as many students do not have jobs while going to school. In contrast, the study of by Cleland et al.

focused on workers with LBP, who strongly identify with the questions presented on the FABQ-W subscale, but may not identify with the questions presented on the FABQ-PA.

	<i>Cleland et al., 2008</i>		<i>Legge &amp; Dover, 2010</i>	
	FABQ-PA	FABQ-W	FABQ-PA	FABQ-W
<b>Baseline Pain</b>	-0.055	-0.11	0.31	0.35
<b>Final Pain</b>	0.25*	0.35**	-0.22	-0.04
<b>Change in Pain</b>	-0.26*	-0.39**	0.44*	0.45*
<b>Baseline Disability</b>	-0.048	-0.17	-0.43*	-0.33
<b>Final Disability</b>	0.30**	0.44**	0.45*	0.06
<b>Change in Disability</b>	-0.32*	-0.50**	0.52**	0.31

Table 7. Comparison of correlations between scores on the FABQ-PA and FABQ-W and pain and disability scores. \*\* denotes significance at  $p < 0.001$ , \* denotes significance at  $p < 0.05$ . Note that the disability scale in the Cleland et al. study ran in the opposite direction from the current study.

Return to play was chosen as the end-point of our study due to our focus in the field of athletic therapy. It would certainly have been easier to schedule assessments if a concrete deadline (6 weeks, 6 months, 1 year) was used, however each injury is different, and each athlete responds differently to both injury and rehabilitation; having a set deadline for each injury was just not plausible. In addition, because RTP is a moving deadline, we were able to determine whether an athlete took longer to RTP than expected for a particular injury, and compare this with their scores on the FAM. Although there has been little research in the area of the FAM and its impact on acute injury, several studies of ACL reconstruction use RTP as the cut-off point [146, 148].

There is support for the theory that the FAM may change over time, that patients who receive education may decrease their levels of pain-related fear both in chronic pain [169, 176] and acute back pain [18, 121]. We chose not to re-evaluate the FAM, as determining the ability of the FAM to change in an acute time-period was not one of our main objectives. It may be of value for future studies to re-evaluate the FAM during the course of rehabilitation from acute injury to determine if the FAM can change with various acute injuries and if so, when this change occurs.

Range of motion was difficult to compare across injuries. The number of ROMs affected varied, so that some athletes only had two ranges, while others had eight. We dealt with this difficulty by converting the ROM to a percentage. For the purpose of the analysis, the RTP ROM was considered to be 100% for each athlete. Each ROM score at baseline was divided by the ROM at RTP and multiplied by 100 to give the percentage of ROM available at baseline. Using this method we were able to compare ROM between subjects at baseline, as well as compare the change in ROM between subjects.

Two different methods were used to report ROM, both with strengths and weaknesses. Overall average ROM was reported, which averages all of the ranges of motion measured for each subject. This average value gives an overall evaluation of ROM, but if only one ROM is diminished the magnitude of the loss of ROM will not be apparent. This average score is best for an overall assessment of a joint when more than one ROM is affected. Peak-low ROM was also reported, which is the one ROM which was most affected. This score represents how much range has been lost for each subject, but only accounts for one range, and does not give a complete assessment of the ROM available at the joint. This score is best to assess the magnitude of loss of ROM in a joint when only one ROM is affected. Both values are presented as percentage scores, where 100% indicates full range of motion.

One of the major limitations of this study was the inability to isolate a homogeneous group. While all subjects were athletes, age, experience, sport, injury type and injury severity were not controlled. The location, type, and severity of injury also could not be controlled, although the FAM has been shown to be applicable to all manners of chronic back pain, regardless of age, cause, severity, or length of symptoms. In addition, the rehabilitation of these athletes was performed at two separate venues by a team of six certified therapists, which does not guarantee the same type of rehabilitation program. This lack of homogeneity can also be seen as a benefit however; the aim of this research was to be applicable to rehabilitation in all clinics that treat athletes.

Another major limitation of this study was the heterogeneity of data collection period. Data was collected throughout the year, which included athletes being injured at varying times during their athletic season. Whether the athlete was in training camp, in-season, or in the off-season is likely to have played a factor in the motivation of the athlete to return to play. A study of the ability of the FABQ to predict the outcome of low-back pain showed that the patients' insurance affected the outcome of rehabilitation [17]. Poor outcome could be predicted by both the FABQ-PA and FABQ-W in patients who were receiving workers' compensation [17]. Neither subscale could predict outcome in patients with private insurance [17]. This illustrates that if the motivation to work is removed, the patient is less likely to return to work quickly. It can be theorized that the same is true for the athlete, whose "work" is rehabilitation and training in preparation for competition. If the athlete is out of season, a time when there is not competition, the motivation to return to play is removed. Without this motivation, athletes may be less likely to train as hard and confront rehabilitation as they would during their competitive season.

### ***Future Considerations***

Relationships between the area of injury and RTP, and possible differences between males and females with respect to the FAM scores, physical measures, and RTP may be interesting to examine with future research. A further suggestion for future research would be to obtain more information about athletes' previous experience with athletic therapy. Athletes who have no previous experience with athletic therapists may have higher levels of pain-related fear than athletes who have previous experience.

### ***Conclusion***

Although we could not confirm the ability of the FAM to predict the length of rehabilitation following an acute injury, strong trends were found. We believe that these trends indicate that the FAM provides an important element in the rehabilitation of acute injury as well as chronic injury, and that self-report questionnaires to assess the components of the FAM, specifically the FABQ, may provide a useful tool for the prediction of the length of rehabilitation in athletes.

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