This thesis titled

Determining the Effectiveness of Athletic Injury Rehabilitation: Pilot Study

by

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ABSTRACT

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Objective: To determine the effectiveness of care rendered by Athletic Trainers (ATs) on patient outcomes in relation to pain and function of high school athletes after sustaining an athletic injury. Participants: High school student athletes aged 14-19 years old recruited from 14 southeastern Ohio schools and 1 West Virginia school. Methods: A rehabilitation plan was designed and administered by the AT. After each week of rehabilitation, a specific functional outcome scale and Clinical Pain Assessment Tool were readministered to collect functional outcome progressions until discharged. Main Outcome Measures: Patient perceived functional and pain outcomes. Results: Twenty-one of the 23 athletic injuries reported an increase in function and reduction in pain. Lateral ankle sprains (26.1%) were the most common rehabilitated athletic injury. Conclusion: Athletic training services are effective in rehabilitating athletic related injuries and decreasing pain at the high school level. There was a noticeable difference in functional outcomes and decrease in pain from rehabilitation services provided by ATs at the high school setting. Key Words: High School, Athletic Trainers, Functional Outcomes, Rehabilitation.

Approved: ____________________________

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>3</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>4</td>
</tr>
<tr>
<td>List of Tables</td>
<td>8</td>
</tr>
<tr>
<td>Chapter 1: Introduction</td>
<td>9</td>
</tr>
<tr>
<td>Overview</td>
<td>9</td>
</tr>
<tr>
<td>Rehabilitation Outcomes</td>
<td>11</td>
</tr>
<tr>
<td>Patient-Based Questionnaires</td>
<td>12</td>
</tr>
<tr>
<td>Summary</td>
<td>13</td>
</tr>
<tr>
<td>Statement of Problem</td>
<td>14</td>
</tr>
<tr>
<td>Purpose of Study</td>
<td>15</td>
</tr>
<tr>
<td>Research Hypotheses</td>
<td>15</td>
</tr>
<tr>
<td>Null Hypotheses</td>
<td>15</td>
</tr>
<tr>
<td>Delimitations of the Study</td>
<td>16</td>
</tr>
<tr>
<td>Limitations of the Study</td>
<td>16</td>
</tr>
<tr>
<td>Assumptions</td>
<td>17</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>17</td>
</tr>
<tr>
<td>Athletic Trainer</td>
<td>17</td>
</tr>
<tr>
<td>Athletic Injury</td>
<td>17</td>
</tr>
<tr>
<td>Disability</td>
<td>17</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>18</td>
</tr>
<tr>
<td>Efficacy</td>
<td>18</td>
</tr>
<tr>
<td>Functional Outcome Scales</td>
<td>18</td>
</tr>
<tr>
<td>Minimal Clinical Important Difference</td>
<td>18</td>
</tr>
<tr>
<td>Minimum Detectable Change</td>
<td>18</td>
</tr>
<tr>
<td>Outcome Management</td>
<td>18</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>18</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>19</td>
</tr>
<tr>
<td>Return to Play</td>
<td>19</td>
</tr>
</tbody>
</table>
Chapter 2: Literature Review ............................................................................................ 20
  Purviews and Responsibilities of Athletic Trainers ................................................... 20
  Clinician-Based vs. Patient-Based Outcomes ......................................................... 22
  Clinician-Based Outcomes Data ............................................................................. 23
  Patient-Based Outcome Scales .............................................................................. 27
    Disability of the Arm, Shoulder and Hand (DASH) Questionnaire .................... 27
    Cincinnati Knee Rating System ......................................................................... 28
    Foot and Ankle Disability Index (FADI) Sport Questionnaire ............................ 31
    Quebec Back Pain Disability Scale ..................................................................... 32
  Studies Using Functional Outcomes Measures .................................................... 33
    Studies Using the Disability of the Arm, Shoulder and Hand (DASH) Questionnaire ....................................................................................................... 33
    Studies Using the Cincinnati Knee Rating System ............................................ 35
    Study Using the Foot and Ankle Disability Index (FADI) Sport Questionnaire 37
    Studies Using the Quebec Back Pain Disability Questionnaire .......................... 38
  Summary ................................................................................................................ 41
Chapter 3: Methods ..................................................................................................... 42
  Purpose of the Study ............................................................................................. 42
  Research Design .................................................................................................... 42
    Variables ........................................................................................................... 42
    Statistical Design ............................................................................................. 43
  Participants .......................................................................................................... 43
  Instrumentation .................................................................................................... 43
  Procedures .......................................................................................................... 45
  Statistical Analyses ............................................................................................. 48
Chapter 4: Results .................................................................................................... 49
  Results .................................................................................................................. 50
    Upper Extremity Injuries .................................................................................. 50
    Knee Injuries ................................................................................................... 52
    Foot and Ankle Injuries .................................................................................... 53
    Overall Change in Rehabilitation ..................................................................... 56
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Cincinnati Knee Rating System Criteria</td>
<td>30</td>
</tr>
<tr>
<td>Table 2</td>
<td>Distribution of Athletic Injuries</td>
<td>51</td>
</tr>
<tr>
<td>Table 3</td>
<td>Disability of the Arm, Shoulder and Hand (DASH) Questionnaire Scores and Pain Scores</td>
<td>52</td>
</tr>
<tr>
<td>Table 4</td>
<td>Cincinnati Knee Rating System Scores and Pain Scores</td>
<td>54</td>
</tr>
<tr>
<td>Table 5</td>
<td>Foot and Ankle Disability Index (FADI) Sport Questionnaire Scores and Pain Scores</td>
<td>55</td>
</tr>
<tr>
<td>Table 6</td>
<td>Mean Scores for Overall Change in Rehabilitation</td>
<td>57</td>
</tr>
<tr>
<td>Table 7</td>
<td>Mean Scores for Overall Change in Pain</td>
<td>57</td>
</tr>
</tbody>
</table>
CHAPTER 1: INTRODUCTION

Overview

Athletic trainers (ATs) provide the foundation of athletic health care for high schools, assuming duties that include prevention, clinical diagnosis, and rehabilitation of injuries and illnesses (National Athletic Trainers’ Association, 2010). In 2004-2005, approximately 4.5 million high school students participated in high school athletics. In 2008-2009, the number of high school students participating in athletics increased to approximately 7.5 million (National Federation of State High School Association, 2009). Although overall health benefits might be realized from interscholastic participation, these activities carry the risk of a sport-related injury (Lyznicki, Riggs, & Champion, 1999; Valovich McLeod, Bay, Parsons, Sauers, & Synder, 2009). Powell and Barber-Foss's 1999 study concluded that 6,000 injuries were sustained each year among high school athletes, approximately 26.5% of which resulted in more than 7 days time lost from activity. Of those sport-related injuries reported, approximately 70% to 75% tended to be minor sprains, strains, and contusions and most frequently involved the lower extremity (Lyznicki et al., 1999). In 2000-2001, 1.4 million individuals reported sustaining an injury while participating in basketball, baseball, softball, football, or soccer that required medical attention. Of the 1.4 million injuries reported, 994,000 (29%) were sport, recreational, and exercise related injuries sustained by adolescents and young adults under the age of 25 (Centers for Disease Control and Prevention, 2002). Despite the acknowledgement of the increasing number of students participating in interscholastic sports and the high rate of athletic injuries, issues regarding appropriate
medical care at the high school level has not been addressed (Wham, Saunders, & Mensch, 2010). ATs are needed to provide services at practices and games to provide early recognition, immediate treatment, and proper rehabilitation to shorten recovery time and decrease long-term disability (Lyznicki et al., 1999).

In 1998, the American Medical Association recommended that all high schools should provide athletic training services for their athletes (Lyznicki et al., 1999). Lindaman (1992) identified that 30% of certified ATs in the high school setting were volunteers due to budget constraints. By having ATs as volunteers and not as full-time employees limits medical services and sport coverage provided to athletes, consequently placing the responsibility on coaches to provide health care services to their athletes. According to the National Federation of State High School Association (2002), 39 states require coaches to participate in a course specifically related to sport-related first-aid and basic first-aid; 10 states require coaches to participate in basic first-aid; and, Hawaii does not require coaches to participate in a basic or sport-related first-aid course. In 2002, the “Appropriate Medical Care of Secondary School-Aged Athletes (AMCSSA) Consensus Statement” established guidelines for health coverage for high school sports (Wham, Saunders, & Mensch, 2010). Several studies over the past decade documented numerous of high school athletic injuries that support the need to provide athletic training services to enhance safety (Almquist et al., 2008; Lyznicki et al., 1999; Rechel, Yard, & Comstock, 2008). However, there has been a lack of research to determine whether providing athletic training services has an effect on recovery time for athletes after sustaining an athletic injury.


Rehabilitation Outcomes

Health care providers are being called on to provide evidence of the quality of care they provide based on patient satisfaction following rehabilitation. This type of evidence-based research can be obtained by providing patients with patient-based questionnaires related to their rehabilitation results (Williams, Gangel, Arciero, Uhorchak, & Taylor, 1999). Organizations such as the National Athletic Trainers’ Association, the American Academy of Orthopaedic Surgeons, and the American Orthopaedic Society for Sports Medicine emphasize the need for clinician- and patient-based outcome measures to determine effective treatments and interventions provided by ATs (Valovich McLeod et al., 2009).

Clinician-based outcome research is defined as how the patient responded to a treatment or intervention assessed from the clinician’s perspective using measures such as range of motion, radiographs, strength, response to special tests, joint mobility, angles, and so on (Suk, Hanson, Norvell, & Helfert, 2005). Patient-based outcome research is obtained from the patient’s point of view using self-report questionnaires to identify important concerns of the patient that relate to symptoms, functional ability, and/or health related quality of life (Suk et al., 2005). Clinician-based outcome measures do not always correlate with a patient’s perception of function such as reduction in pain, improvement in activity and participation level, and health related quality of life (HRQOL) relative to the care provided (Dawes, Meterissian, Goldberg, & Mayo, 2008; Tomaino, Miller, & Burton, 1994). Therefore, it is imperative that functional outcomes data be obtained regarding HRQOL (Valovich McLeod et al., 2009). With the increasing number of
injuries over the years resulting from participation in athletics, HRQOL studies have been neglected in athletic training research among athletes (Valovich McLeod et al., 2009). A study reported that at the elite college level, injured athletes tended to have lower HRQOL scores (McAllister, Motamedi, Hame, Shapiro, & Dorey, 2001). However, it is unclear if this correlation of HRQOL and injury exists amongst the high school athletic population, because it has not yet been examined (Valovich McLeod et al., 2009).

To date, there is limited research on short- and long-term effects of rehabilitation amongst injuries in the high school athletic population (Valovich McLeod et al., 2009). Most research focuses on the outcomes of surgical procedures or other forms of interventions following an injury, not athletic related, via clinician-based outcome measures to establish which method would be most beneficial to the patient (Orchard, Massy, Brown, Cardon-Dunbar, & Hofmann, 2008; Paterno, Archdeacon, Ford, Galvin, & Hewett, 2006; Potter, Brukner, Makdissi, Crossley, & Kiss, 2006; Scarpone, Rabago, Zgierska, Arbogest, & Snell, 2008). Several authors have provided evidence that rehabilitation interventions reduce the length of time required to return to a sport and decrease the rate of symptoms from soccer and football related injuries. However, these results focused on clinician-based outcomes, particularly radiographs, special tests, muscular strength, and core stability (McCarthy & Vicenzino, 2003; Rodriguez, Miguel, Lima, & Heinrichs, 2001; Verrall, Slavotinek, Fon, & Barnes, 2007).

**Patient-Based Questionnaires**

Even though clinician-based outcome measures are frequently used to assess the effectiveness of rehabilitations, patient-based outcome questionnaires can be an efficient
method to determine rehabilitation effectiveness (Snyder et al., 2008). Four types of patient-based questionnaires included the Disability of the Arm, Shoulder, and Hand (DASH) Questionnaire, Cincinnati Knee Rating System, Foot and Ankle Disability Index (FADI) Sport Questionnaire, and Quebec Back Pain Disability Scale that are for body specific regions. Patient-based outcome questionnaires allow the patient to respond to various questions regarding their performance during sport specific tasks and activities of daily living using a numeric rating scale following rehabilitation services (Atroshi, Gummesson, Andersson, Dahlgren, & Johansson, 2008; Barber-Westin & Noyes, 1999; Davidson & Keating, 2002; Dixon, Johnston, McQueen, & Court-Brown, 2008; Fritz & Irrgang, 2001; Hale & Hertel, 2005). Patient-based outcome questionnaires can assess minimum detectable change (MDC) and minimal clinical important difference (MCID) by comparing the patient’s responses from initial injury and post rehabilitation (Beaton, Davis, Hudak, & McConnell, 2001; Eechaute, Vaes, Van Aerschot, Asman, & Duquet, 2007; Solway, Beaton, McConnell, & Bombardier, 2002). MCD and MCID values assist clinicians in determining if the rehabilitation services being provided are causing an increase in function based on the patient’s responses (Eechaute et al., 2007; Kovasc et al., 2008).

Summary

Clinicians and researchers should be attentive to prolonged pain and activity limitations, because such information will guide the selection of different management strategies and the design of outcomes-oriented research (Fritz & Clifford, 2010). Health care providers such as ATs would benefit from analyzing outcome management data to
determine which rehabilitation plan is more beneficial for the injured body part, because there is limited research on the effectiveness of rehabilitation provided by ATs (Williams et al., 1999). Therefore, the present study was motivated by the need to investigate outcomes of function and pain in relation to patient-based outcomes.

Statement of the Problem

There is limited research on the effectiveness of rehabilitation services provided by ATs based on patient perception, especially in the high school setting. Therefore, this study addressed the following questions:

1. Are the rehabilitation services offered by ATs effective at decreasing the amount of pain reported by injured athletes?
2. Are the rehabilitation services offered by ATs effective in improving functional outcomes for the arm, shoulder, and/or hand?
3. Are the rehabilitation services offered by ATs effective in improving functional outcomes for the knee?
4. Are the rehabilitation services offered by ATs effective in improving functional outcomes for the foot and/or ankle?
5. Are the rehabilitation services offered by ATs effective in improving functional outcomes for the low back?
6. Are the rehabilitation services offered by ATs effective at improving overall functional outcomes and decreasing overall pain for athletic injuries?
7. Does decreasing pain improve functional outcomes of an injured athlete?
Purpose of the Study

The purpose of this study was to determine the effectiveness of care rendered by ATs on patient-percieved outcomes in relation to pain and function in a selective population of high school athletes.

Research Hypotheses

1. Rehabilitation services offered by an AT will decrease pain of an injured athlete.
2. Rehabilitation services offered by an AT will improve functional outcomes for injuries to the arm, shoulder, and/or hand.
3. Rehabilitation services offered by an AT will improve functional outcomes for injuries to the knee.
4. Rehabilitation services offered by an AT will improve functional outcomes for injuries to the foot and/or ankle.
5. Rehabilitation services offered by an AT will improve functional outcomes for injuries to the low back.
6. Rehabilitation services offered by an AT are effective at improving overall functional outcomes and decreasing overall pain for athletic injuries.
7. Decreasing pain will improve functional outcomes of an injured athlete.

Null Hypotheses

$H_{01}$: Rehabilitation services offered by an AT will not decrease pain of an injured athlete.

$H_{02}$: Rehabilitation services offered by an AT will not improve functional outcomes for injuries to the arm, shoulder, and/or hand.
H₀₃: Rehabilitation services offered by an AT will not improve functional outcomes for injuries to the knee.

H₀₄: Rehabilitation services offered by an AT will not improve functional outcomes for injuries to the foot and/or ankle.

H₀₅: Rehabilitation services offered by an AT will not improve functional outcomes for injuries to the low back.

H₀₆: Rehabilitation services offered by ATs will not improve overall functional outcomes and decrease overall pain for athletic injuries.

H₀₇: Decreasing pain will have no effect on improving functional outcome of an injured athlete.

Delimitations of the Study

Delimitations of this study included:

1. Data was obtained from 14 southeastern Ohio high schools and 1 West Virginia high school.

2. Participants were between the ages of 14 and 19 and participated in sanctioned athletic practices, games, and scrimmages.

3. Participants must have sustained an athletic injury that withheld them from participation for at least one practice or game, and required the participant to perform a rehabilitation plan designed by the AT.

Limitations of the Study

1. Only standardized functional outcome scales were used; no analyses were performed on quantitative data, such as range of motion or strength.
2. Participants might not have remained in compliance with the designed rehabilitation plan, thereby producing inaccurate data.

3. Participants might have had co-morbidities, which could have impaired the duration of rehabilitation and/or return to play.

4. ATs at the participating high schools might not have recorded data accurately and/or might not have been compliant with standard procedures when collecting and reporting data.

Assumptions

1. Participants answered the functional outcomes scales and Clinical Pain Assessment Tool to the best of their abilities.

Definition of Terms

*Athletic trainer.* A health care professional who collaborates with physicians to optimize activity and participation of patients and clients through prevention, assessment, treatment, and rehabilitation of injuries and illnesses (National Athletic Trainers Association, 2010).

*Athletic injury.* An injury sustained by an individual during a regularly scheduled practice or game that affects the individual's participation or performance in sports, games, recreation, exercise, or other activity that requires physical strength, agility, flexibility, speed, stamina, or range of motion.

*Disability.* An observable mental or physical loss or impairment which is measurable and which might be permanent or temporary (Marcovitch, 2006).
Effectiveness. A measure of accuracy or success of a diagnostic or therapeutic treatment when delivered in an average clinical setting (Stedman, 2005).

Efficacy. The success or effectiveness of a treatment (Stedman, 2005).

Functional outcome scales (patient-perceived outcomes). Scales that were used to measure functional outcomes for the specific body part injured included:

1. The Disability of the Arm, Shoulder, and Hand Questionnaire (DASH Questionnaire).
2. Foot and Ankle Disability Index (FADI) Sport Questionnaire.
3. The Cincinnati Knee Rating System.
4. The Quebec Back Pain Disability Scale.

Minimal clinical important difference (MCID). The minimal amount of change in scores perceived by the patient and displays an alteration in the patient’s function (Eechaute et al., 2007).

Minimum detectable change (MDC). The minimal amount of change in improvement perceived by the patient and not due to measurement error (Kovasc et al., 2008).

Outcome management. Use of information collected through measurement of outcomes to improve effectiveness and value of treatments and services (Stedman, 2005).

Rehabilitation. The spontaneous or therapeutic restoration to health and working capacity of a person incapacitated by disease, illness, or injury through the use of modalities, exercise, and/or manual therapy (Marcovitch, 2006; Stedman, 2005).
Responsiveness. Ability of a measurement tool to detect a meaningful change over time (Culp & Romani, 2006; Davidson & Keating, 2002; Fritz & Irrgang, 2001).

Return to play. When the athlete has demonstrated he/she is able to perform functional/sport specific tasks without any discomfort, shows no signs of a disability, and the athlete’s abilities are satisfactory to the AT and/or physician.
CHAPTER 2: LITERATURE REVIEW

A literature review was conducted using the following search engines; PubMed, Google, Google Scholar, and Sports Discus to identify previous research on the effectiveness of rehabilitation provided by athletic trainers (ATs). The search terms used were “athletic trainer,” “high school athletes,” “high school,” “secondary level,” “outcomes,” “athletic injuries,” “rehabilitation,” “outcome research,” and “importance of outcome research.” Reports of rehabilitation outcomes were mostly connected with studies conducted by physical therapists and other health care providers.

Purview and Responsibilities of Athletic Trainers

ATs are health care professionals who have a range of health care and medical knowledge including risk management and injury prevention, pathology of injuries and illnesses, orthopaedic clinical examination and diagnosis, and care of acute injury and illness. ATs are also educated in the areas of pharmacology, therapeutic modalities, conditioning and rehabilitative exercise, medical conditions and disabilities, nutritional aspects of injury and illness, psychosocial intervention and referral, health care administration, professional development, and responsibility (Commission on Accreditation of Athletic Training Education, 2008). Using this knowledge, ATs are on-site at various athletic events to provide athletes with immediate intervention of emergency, acute and chronic medical conditions, diagnosis, and rehabilitation (National Athletic Trainers’ Association, 2010).

As of November 2009, 7,420 (23%) National Athletic Trainers’ Association members were employed full time in high schools (National Athletic Trainers’
Association, 2010). The National Electronic Injury Surveillance System All Injury Program for July 2000-June 2001 estimated that 457,773 individuals aged 15-19 sustained an organized or unorganized sport-related injury (National Center for Injury Prevention and Control, 2002). A 2009 report stated that over 7.5 million high school students participated in athletics, potentially increasing the number of athletic injuries reported (National Federation of State High School Associations, 2009). The highest injury prevalence sports were football (42%), boys’ basketball (17.8%), girls’ basketball (10.3%), and wrestling (10%). The most frequently occurring injuries were sprains (32.3%) and strains (18.5%) commonly involving the ankle (24.2%) and knee (16.4%) (Claiborne, Hou, & Cappaert, 2007). Claiborne et al. (2007) reported the most frequently rendered rehabilitation plans by ATs included cold therapy (81%), flexibility training (70%), functional exercises (38%), and taping, bracing and padding (33%). The average duration of time from initial injury to return to play due to an athletic injury was 11.03 days. On average, severe injuries limited athletes from participation for 26.3 days and minor injuries for 5.4 days. Once an athlete completed the rehabilitation plan and was discharged by the AT, 83% of athletes returned to competition with no complaints, 14% returned with minor complaints, and 3% returned with moderate to severe complaints. Approximately 87% of injuries requiring no referral to a physician or specialist usually were rehabilitated by ATs. Therefore, Claiborne et al. (2007) suggested that ATs could reduce the number of unnecessary visits to the emergency room and physician referrals.
Clinician-Based vs. Patient-Based Outcomes

Clinician-based clinical trials are the “gold standard” in biomedical research because of the ability to document change over time for a specific treatment (Kang, Ragan, & Park, 2008). Clinician-based outcome research is defined by how the patient responded to a treatment or intervention assessed by range of motion, radiographs, strength, response to special tests, joint mobility, angles, and so on (Suk et al., 2005). The objective of measuring clinical findings from outcome management data was to enhance rehabilitation plans on clinician performance. However, clinician-based outcome data does not always mirror the perception of the patient’s outcome (Dawes et al., 2008; Tomaino et al., 1994) or determine whether an individual can participate in sports or perform activities of daily living (Valovich McLeod et al., 2008).

Patient-based outcome research is obtained from the patient’s point of view using self-report questionnaires to identify important concerns related to symptoms, functional ability, or HRQOL (Suk et al., 2005). Researching patient-based outcomes are vital to examining and refining various approaches to rehabilitating pathological conditions, allowing researchers and clinicians to focus rehabilitation plans on the importance of the patient’s HRQOL (Valovich McLeod et al., 2008). The majority of research conducted by ATs is clinician-based outcome research (Valovich McLeod et al., 2008). Koran (1975) stated that the reason for not using patient-based outcome measures to justify the effectiveness of a rehabilitation plan or intervention was because it might not have been credible. Clinicians had concerns that subjective measures did not form a sound basis for the measurement of health, even though clinician-based outcomes had been used for
decades. According to Koran (1975), clinician-based outcomes were poor indicators of the functional and psychological aspects of life.

ATs understand how a lateral ankle sprain can affect functional measures; however, ATs have minimal knowledge of how the injury affects the patients’ perception of their HRQOL (Snyder et al., 2008; Williams et al., 1999). Therefore, ATs must examine their rehabilitation strategies to build the scientific foundation for evidence-based practice (EBP). According to the EBP literature, patient-oriented evidence that matters (POEM) research is perceived to be more accurate in evaluating appropriate patient care that is consistent with patient-centered goals (Snyder et al., 2008). POEM measures are necessary to understand treatment results based on patients’ perceptions of improvement, long-term effects, efficacy, and effectiveness of treatment to enhance rehabilitation designs (Kang et al., 2008; Snyder et al., 2008; Williams et al., 1999). The first athletic training outcome study reported data collected from athletic training professionals from the mid-1990s (Albohm & Wilkinson, 1999). Since 1999, there has been an absence of patient-based outcomes research for ATs (Snyder et al., 2008). With the lack of POEM outcome studies in athletic training, ATs tend to use POEM measures from other professions to gauge the efficacy and effectiveness of rehabilitation. However, ATs needs to investigate their own clinical practices (Snyder et al., 2008).

Clinician-Based Outcomes Data

Research has examined the general effectiveness of rehabilitation as a whole. However, research is limited regarding which specific therapy intervention, medical procedure, patient education, or other activities improve functional impairments
The Spinal Cord Injury Rehabilitation (SCIRehab) project was designed to contribute to evidence-based guidelines for clinical treatments in patients with spinal cord injuries (SCI). The SCIRehab project database documented treatment interventions and patient management strategies. The database failed to document specific treatments used, providing inadequate information regarding rehabilitation outcomes. Due to the lack of information about treatment interventions, factors associated with functional improvement among SCI patients could not be discerned. Clinicians documented multiple treatments in one setting or did not document a specific treatment. Without regards to treatment, clinicians based functional improvement by observation of clinician-based outcomes data to determine functional improvement but not the patient’s perception of functional improvement (Whiteneck et al., 2009).

Studies focusing on clinician-based and patient-based outcomes were collected for muscle strength, functional performance, and self-reported outcomes after a partial meniscectomy. Subjects performed home exercise rehabilitation programs over 4 months designed by a physical therapist. Pre and post rehabilitation quadriceps isokinetic strength and functional performance were measured. Self-reported outcomes were measured using the Knee Injury and Osteoarthritis Outcome Score to determine patient improvement in pain, activities of daily living, function in sport and recreation, and knee-related quality of life. The researchers concluded that the rehabilitation program used did not increase the strength or functional performance of the operative leg compared to the nonoperative leg (Ericsson, Roos, & Dahlberg, 2006).
Short-term outcomes of active individual therapy were compared to a functional restoration program to determine the effectiveness of specific interventions for low back pain (LBP). Active individual therapy was described as a 5-week at-home program performed for 50 minutes a day. A physiotherapist instructed the patient about the types of exercises to perform within the categories of flexibility, pain management, stretching, cardiorespiratory exercises, and proprioception. The patient was expected to report the duration, type, and number of exercises performed at home. Functional restoration program was described as a supervised exercise program implemented by a physiotherapist. Each supervised session focused on muscular warm-up, stretching, flexibility, cardiorespiratory exercises, muscular strengthening exercises, proprioception, and coordination exercise. Each type of exercise’s intensity was increased based on the patient’s progress. Outcome measures included trunk flexibility, back flexor and extensor endurance. Patient-based outcomes such as pain intensity, activities of daily living, work ability, and resumption of sport and leisure activities were measured. The researchers focused on clinical-based outcomes, extensor strength, endurance, and psychological status, were used to determine optimal outcomes relative to pain and improvement in trunk flexibility, back flexor and extensor endurance, activities of daily living, resumption of sport and leisure activities, and work ability. The researchers concluded that a functional restoration program improved endurance relative to active individual therapy but neither intervention caused any other clinical based outcomes (Roche et al., 2007).
Researchers compared supervised exercise therapy to no exercise therapy in respect to recovery, pain, and function for patients with patellofemoral pain syndrome. No exercise therapy was defined as the patient performing his/her normal activities of daily living. Patients completed a Likert scale at baseline, 6 weeks, 3 months, 9 months, and 12 months (Linschoten et al., 2009). Patients undergoing supervised exercise therapy demonstrated statistically significant improvements compared to the no exercise therapy group, but this might not clearly reflect the patients’ self-reported recovery. Linschoten et al. (2009) documented a decrease in pain and an increase in the patient’s function, but could not determine whether or not supervised exercise therapy had an effect on the patients’ perceived recovery.

Boling, Bolgla, Mattacola, Uhl, and Hosey (2006) conducted a study on a home-supervised weight-bearing rehabilitation program on quadriceps and gluteus medius electromyographic (EMG) activity, pain, and function in subjects with patellofemoral pain syndrome. After 6 weeks, the researchers documented a difference in onset firing timing in the quadriceps muscle group through EMG testing, decreased pain, and increased function. Although the home-supervised rehabilitation program was proven to be successful in decreasing pain and increasing function, no specific exercises were identified as being associated with these positive results. Therefore, further research is necessary to identify specific quadriceps and gluteus medius exercises responsible in quadriceps firing time that decrease pain in patients with patellofemoral pain (Boling et al., 2006).
Patient-Based Outcome Scales

ATs should incorporate patient-based outcomes into their evaluation process to determine the values and needs of the patient in order to provide the most effective care to patients. Patient-based outcome measures assist ATs with examining the efficacy and effectiveness of their clinical interventions necessary to meet patient goals identified by self-reported information. By having patients report their level of impairment, functional loss, disability, and societal limitations, the clinician and patient will be able to determine whether the rehabilitation program is effectively meeting the patient’s goal (Snyder et al., 2008).

Disability of the Arm, Shoulder and Hand (DASH) Questionnaire

The DASH Questionnaire was developed by the American Academy of Orthopaedic Surgeons as a self-administered region-specific outcome instrument designed to measure upper extremity disability and symptoms (Atroshi et al., 2008; Dixon et al., 2008). The DASH Questionnaire is a 30-item disability scale that focuses on six specific domains including daily activities, symptoms, social function, work function, sleep, and confidence (Atroshi et al., 2008; Dixon et al., 2008; Bialocerkowski, 2007). From the 30 items, 21 items address the degree of difficulty in performing various physical activities; 5 items address pain severity, activity related to pain, tingling, weakness, and stiffness; and, 4 items address social activities, work, sleep, and psychological impact. There are two optional sections each consisting of 4 items assessing the patient’s ability to perform sports/or play a musical instrument (sport/music scale) and the ability to work (work scale). Each item has 5 responses to select from.
ranging from no difficulty/ or no symptom (1 point) to unable to perform activity/ or very severe symptom (5 points) (Atroshi et al., 2008).

The DASH score was calculated as:

\[
\text{DASH} = \{(\text{sum of } n \text{ responses}/n) - 1\} \times 25
\]

\(n = \text{total number of questions answered}\)

The minimum detectable change (MDC) identifies a shift of 12.7 points from the initial score to the next score as a statistically significant improvement of function at the 95% confidence interval (Solway, Beaton, McConnell, & Bombardier, 2002). The minimum clinical important difference (MCID) identifies a shift of 15 points from initial score to final score as a clinically significant improvement of function (Beaton et al., 2001).

The DASH Questionnaire has a better reliability and responsiveness than any other joint specific instrument for the upper extremity (Culp & Romani, 2006). Culp and Romani (2006) found that the DASH Questionnaire demonstrated high test-retest instrument reliability (ICC = 0.96) relative to the American Shoulder and Elbow Surgeons Standardize Shoulder Assessment Form (ASES) which had a test-retest instrument reliability of ICC = 0.84 (Michener, McClure, & Sennett, 2002). The Rowe questionnaire was compared to the ASES form and was shown to be similar in reliability with an ICC = 0.77 (Williams et al., 1999).

**Cincinnati Knee Rating System**

The Cincinnati Knee Rating System was designed to quantify the amount of disability following a knee injury based on a functional assessment of six abilities that are
essential to sport participation. The Cincinnati Knee Rating System assessed the athlete’s ability to walk, use stairs, squatting and kneeling, straight running, jumping, landing, hard twists, cuts, and pivots (see Table 1).

The overall score is calculated as:

Functional Assessment score = SUM (points for all six activities of the questionnaire)

Minimum points = 120

Maximum points = 420

No MDC or MCID values have been calculated for this scale. To show improvement from the rehabilitation, the final score was compared to the results of the initial score (Barber-Westin & Noyes, 1999).

The Cincinnati Knee Rating System was compared to three other knee rating scales for reliability and validity: the Lysholm Scale, the American Academy of Orthopaedic Surgeons Sports Knee-Rating Scale, and the Activities of Daily Living Scale of the Knee Outcome Survey (Marx et al., 2001). All four scales were found to have excellent reliability, validity, and responsive (Marx et al., 2001). The Cincinnati Knee Rating System has a reliability score of 71.6; the Lysholm Scale, 84.1; the American Academy of Orthopaedic Surgeons Sports Knee-Rating Scale, 85.1; and, the Activities of Daily Living Scale of the Knee Outcome Survey, 84.1. The Cincinnati Knee Rating System had an intraclass correlation coefficient of 0.88 (Marx et al., 2001). The Cincinnati Knee Rating System showed a validity of 0.68; the Lysholm Scale, 0.68; the American Academy of Orthopaedic Surgeons Sports Knee-Rating Scale validity, 0.67;
### Table 1

**Cincinnati Knee Rating System Criteria**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Ability</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>normal unlimited</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>some limitations</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>only 3-4 blocks</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>less than 1 block</td>
<td>0</td>
</tr>
<tr>
<td>Stairs</td>
<td>normal unlimited</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>some limitations</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>only 11-30 steps possible</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>only 1-10 steps possible</td>
<td>0</td>
</tr>
<tr>
<td>Squatting and kneeling</td>
<td>normal unlimited</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>some limitations</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>only 6-10 possible</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>only 0-5 possible</td>
<td>0</td>
</tr>
<tr>
<td>Straight running</td>
<td>full competitive</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>some limitations guarding</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>half-speed definite limitations</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>not able</td>
<td>40</td>
</tr>
<tr>
<td>Jumping and landing</td>
<td>fully competitive</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>some limitations guarding</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>half-speed definite limitations</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>not able</td>
<td>40</td>
</tr>
<tr>
<td>Hard twists, cuts, and pivots</td>
<td>fully competitive</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>some limitations guarding</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>half-speed definite limitations</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>not able</td>
<td>40</td>
</tr>
</tbody>
</table>

*Note.* Adapted from “A rationale for assessing sports activity levels and limitations in knee disorders,” by F. R. Noyes, S. D. Barber, & L. A. Mooar, 1989, *Clinical Orthopaedics and Related Research, 246*, 238-249; “Assessment of sport participation...

and, the Activities of Daily Living Scale of the Knee Outcome Survey validity, 0.77, with a statistically significant correlation coefficient (p<0.01) (Marx et al., 2001).

**Foot and Ankle Disability Index (FADI) Sport Questionnaire**

The FADI Sport Questionnaire assesses functional limitations related to foot and ankle conditions (Hale & Hertel, 2005). The FADI Sport Questionnaire is a region-specific self-report of function with two components: FADI includes 26 items assessing activities of daily living and the FADI Sport includes 8 items assessing more difficult tasks that are essential to sport. Each item was scored from 0 (unable to do) to 4 (no difficulty at all).

Scores for this instrument are recorded as follows:

1) The FADI score was recorded as a percentage of 104 points.

2) The FADI Sport score was recorded as a percentage of 32 points.

No MDC or MCID values have been calculated for this scale. To show improvement from the rehabilitation, the final score was compared to the results of the initial score (Carcia, Martin, & Drouin, 2008; Eechaute et al., 2007). The FADI Sport Questionnaire was tested for reliability, validity, and sensitivity against other foot and ankle outcome questionnaires: the Foot Function Index, the Ankle Osteoarthritis Scale, and the American Orthopedic Foot and Ankle Scale (Hale & Hertel, 2005).
The FADI Sport Questionnaire has an ICC = 0.89 when administered 1 week following the injury and 0.84 at week 7, therefore making this instrument a reliable source for collecting outcomes data (Hale & Hertel, 2005). The FADI Sport Questionnaire is sensitive in detecting deficits amongst high-functioning individuals after injury compared the Foot Function Index, the Ankle Osteoarthritis Scale, and the American Orthopedic Foot and Ankle Scale. The Foot Function Index is most reliable, valid, and sensitive in detecting deficits amongst individuals with rheumatoid arthritis. The Ankle Osteoarthritis Scale, modified version of the Foot Function Index, is valid and reliable amongst individuals who suffer from osteoarthritis of the foot and ankle. The American Orthopedic Foot and Ankle Scale is mainly used involving foot and ankle dysfunctions, especially in studies of foot and ankle surgical outcomes (Hale & Hertel, 2005).

Quebec Back Pain Disability Scale

The Quebec Back Pain Disability Scale is a condition specific scale that assesses how back pain affected the patient’s ADLs (Davidson & Keating, 2002; Fritz & Irrgang, 2001). The Quebec Back Pain Disability Scale contains 20 specific items related to difficulty in performing ADLs (Fritz & Irrgang, 2001). Each item asks the patient to rate the degree of difficulty in performing each activity from 0 (not difficult at all) to 5 (unable to do) (Fritz & Irrgang, 2001). Scores were assessed by summing all points from each of the responses.

The Quebec Back Pain Disability Scale is highly reliable (ICC = 0.80) (Davidson & Keating). When this scale was compared to other back pain scales to determine its
responsiveness, the Quebec Back Pain Disability Scale was no more or less responsive compared to the Roland-Morris Disability Questionnaire, the Waddle Disability Index, or the Oswestry Disability Questionnaire (Davidson & Keating, 2002).

Studies Using Functional Outcomes Measures

Functional outcome scales such as the DASH Questionnaire, the Cincinnati Knee Rating Scale, FADI Sport Questionnaire, and Quebec Back Pain Disability Questionnaire were used to determine patient-perceived functional outcomes following rehabilitation, treatment, and/or interventions.

Studies Using the Disability of the Arm, Shoulder, and Hand (DASH) Questionnaire

The DASH Questionnaire was used in studies to assess the functional outcomes in the thumb, wrist, and shoulder injuries. Khan, Waseem, Raza, and Derham (2009) used the DASH Questionnaire to assess functional improvement and pain in patients with carpometacarpal (CMC) joint osteoarthritis of the thumb. Patients received a single intra-articular corticosteroid injection of 10mg of Kenalog. The DASH Questionnaire was administered prior to the injection, 6 weeks, 3 months, and 6 months following injection to assess function and pain of the hand. A comparison of DASH scores from pre injection and 6 weeks post injection showed 26 patients had an overall improvement of 10 points and four patients showed an improvement less than 10 points. Based on the DASH pre and post scores, Khan et al. (2009) concluded that a single injection of Kenlog caused significant improvement in pain and function in patients with osteoarthritis of the thumb CMC joint. The DASH Questionnaire was determined reliable and valid in measuring functional improvement of the hand.
Johnston, Durand, and Hildebrand (2009) studied functional outcomes in patients with a volar distal radioulnar joint instability following a repair of the volar and dorsal capsule and radioulnar ligament of the wrist. Patients presented with signs of ulnar-side wrist pain, loss of forearm rotation, and “clunking” or “popping” with forearm rotation in the supinated position. Patients performed rehabilitation exercises addressing forearm rotation at the elbow and wrist, hand dexterity, and strengthening exercises following 10 weeks of casting. The DASH was administered at follow-up (approximately 16.5 months post surgery) to assess the surgical outcome from the patient’s perspective. Johnston et al. (2009) concluded improvement of functional outcomes despite loss in grip strength and mild loss of supination.

Lim, Chan, and Low (2008) used the DASH Questionnaire in their study to assess outcomes of patients with superior labral anterior and posterior (SLAP) lesions and associated lesions that underwent arthroscopic surgery. The DASH Questionnaire was administered prior to surgery as a baseline measurement. Patients performed physical therapy exercises such as pendulum shoulder flexion with a progression to forward flexion and strengthening exercises post surgery. Following physical therapy, patients were re-evaluated using the DASH Questionnaire. Lim et al. (2008) stated that a 10-point difference between pre and post scores would classify as minimal improvement. Pre and post scores showed 10 patients (63%) with isolated SLAP lesions had a 10-point difference indicating improvement. DASH scores showed an overall improvement in 67% of the patients who underwent arthroscopic repair for SLAP and associated lesions in the shoulder. Lim et al. (2008) concluded that the DASH Questionnaire could detect
and differentiate changes in function in patients with upper extremity musculoskeletal disorders.

Bron, Wensing, Franssen, and Oostendorp (2007) investigated if inactivation of myofasical trigger point (MTrP) therapy could improve function in common shoulder muscle disorders in a population of chronic atraumatic shoulder patients. Patients attended 1 physical therapy session per week for 12 weeks. The DASH Questionnaire was administered to each patient during initial physical therapy visit, 12 weeks, 6 months, and 12 months post physical therapy. Bron et al. (2007) determined that the results of whether intervention of inactive MTrP caused functional improvement as inconclusive based on a wide range of DASH pre and post scores.

Kennedy et al. (2006) used the DASH Questionnaire to identify predictors of change in disability and level of disability following physical therapy treatment. The DASH Questionnaire was used as a patient perception health outcome tool in patients with soft tissue disorders of the shoulder. Data for this study was collected at initial visit and at discharge (12 weeks). DASH pre and post scores were analyzed after 12 weeks and showed an overall mean score of improvement of 17.9 points compared to the mean pre score of 40.1 points. DASH scores displayed a greater improvement in patients who had a shorter duration of shoulder symptoms.

Studies Using the Cincinnati Knee Rating System

The Cincinnati Knee Rating System is a functional outcome scale used in studies to assess knee injuries. The Cincinnati Knee Rating System was used primarily in studies involving anterior cruciate ligament (ACL) injuries. The Cincinnati Knee Rating System
was used in three studies where the focus was to investigate if strengthening the hamstrings and quadriceps through physiotherapy, neuromuscular training, or a strength training program would improve knee function in ACL reconstruction patients (Feller, Webster, Taylor, Payne, & Pizzari, 2004; Li, Maffulli, Hsu, & Chan, 1996; Risberg, Holm, Mylebust, & Engebresten, 2007). Li et al. (1996) administered the Cincinnati Knee Rating System to 46 recreational athletes before and after the completion of their individualized strength training program. Patients who attended physiotherapy were only assessed 12 months post ACL reconstruction (Feller et al., 2004). Patients who performed a neuromuscular or strength training program were administered the Cincinnati Knee Rating System at initial visit, 3 months, and 6 months post reconstruction and post neuromuscular training (Risberg et al., 2007). Within these studies, the Cincinnati Knee Rating System scores showed a significant increase in knee function regardless of the type of rehabilitation protocol performed by ACL reconstructive patients (Feller et al., 2004; Li et al., 1996; Risberg et al., 2007).

Studies involving autologous chondrocyte implantation (ACI) have used the Cincinnati Knee Rating System to assess knee function. Amin et al. (2006) used the Cincinnati Knee Rating System to investigate the preliminary findings of ACI following and combined with ACL reconstruction. Patients either had a successful ACL reconstruction prior to ACI treatment (Group 1) or had both ACL reconstruction and ACI treatment performed (Group 2). The Cincinnati Knee Rating System was administered to each patient in each group prior to and after ACI treatment. Based on pre and post scores, Group 1 had a difference of 27 points and Group 2 had a difference of 11. Amin et al.
(2006) concluded that ACL reconstruction and ACI treatment provided excellent outcomes in most patients.

Mandelbaum et al. (2007) investigated the use of ACI to determine the efficacy and safety of ACI in patients with full thickness articular cartilage defects of the trochlea. Mandelbaum et al. (2007) administered the Cincinnati Knee Rating System at initial visit and at 2 or more years follow-up to assess function, pain, and swelling. Based on the pre and post scores, the results showed ACI appeared to improve function and reduce symptoms in young and middle aged patients. Ossendorf et al. (2007) used the Cincinnati Knee Rating System to determine if ACI was effective in treating posttraumatic and focal osteoarthritic cartilage defects of the knee. The Cincinnati Knee Rating System was administered to patient’s pre ACI, 3, 6, 12, and 24 months post ACI. The scores displayed statistically significant improvement as early as 6 months post ACI. Based on clinical outcome scores, Ossendorf et al. (2007) concluded that ACI was an effective treatment for those with posttraumatic and mild degenerative defects as well as for focal osteoarthritic defects of the knee.

Study Using the Foot and Ankle Disability Index (FADI) Sport Questionnaire

To date, one study used the FADI Sport Questionnaire. McKeon et al. (2008) used the FADI Sport Questionnaire to test the effects of a 4-week balance training program on static and dynamic postural control and self-reported functional outcomes in those with chronic ankle instability (CAI). Thirty-one physically active individuals with CAI were randomly assigned to either a balance training group or a control group. The balance training group underwent 12 sessions of supervised training for a 4-week period. The
control group maintained the activity level they had prior to the study for the 4-week period. Outcome measures were obtained before and after the intervention. FADI Sport scores were significantly greater following balance training compared to pre test scores and significantly greater than the control group’s post test scores. McKeon et al. (2008) concluded that 4 weeks of balance training resulted in increases in self-reported function and static postural control.

Studies Using the Quebec Back Pain Disability Questionnaire

The Quebec Back Pain Disability Questionnaire was used in various studies pertaining to low back pain (LBP) and the spine. Sanchez et al. (2009) used the Quebec Back Pain Disability Questionnaire to identify more defined treatment goals for patients with disabling chronic LBP. Patients were excluded if they were under the age of 18. Patients were administered the McMaster-Toronto Arthritis Patient Preference Disability (MACTAR) Questionnaire to assess patient priorities and the Quebec Back Pain Disability Questionnaire to assess chronic low back disability. Based on the MACTAR, the researchers found that the most important priorities for patients with chronic LBP were mobility, social life, and domestic life. After patients’ priorities were determined and the baseline Quebec Back Pain Disability scores were obtained, treatment plans were designed and implemented specifically for each patient. Once the treatment plan was completed, post Quebec Back Pain Disability scores were measured. Sanchez et al. (2009) analyzed the results from the Quebec Back Pain Disability and the MACTAR Questionnaire concerning improving patient-perceived disability based on patient priorities and treatment plans. Sanchez et al. (2009) discovered that being able to
understand patients’ priorities might guide more appropriate treatment plans for the patient’s overall satisfaction of treatment.

Poiraudeau, Rannou, Baron et al. (2006) used the Quebec Back Pain Disability Questionnaire to assess fear avoidance belief in patients with subacute LBP. Pre and post scores were measured using the Quebec Back Pain Disability Questionnaire and the Fear-Avoidance Belief Questionnaire. Data analysis showed a correlation in patients with subacute LBP. Those that had a high fear avoidance belief also had a high perceived level of disability.

Poiraudeau, Rannou, Le Henanff et al. (2006) studied patient characteristics related to outcome of subacute LBP related to physical and occupational activity. Patients who complained of LBP were administered the Quebec Back Pain Disability Questionnaire during the initial visit. Patients then participated in a physical therapy program for 3 months. Following the 3 months, patients were given the questionnaire for re-evaluation. Poiraudeau, Rannou, Le Henanff et al. (2006) concluded from this study that age and pain were strong predictors of outcome in subacute LBP. The older patient population still felt they had a disability after 3 months of physical therapy.

Van der Roer, Ostelo, Bekkering, Van Tulder, and De Vet (2006) used the Quebec Back Pain Disability Questionnaire and a numerical rating scale to estimate minimal change of pain intensity in patients with nonspecific LBP. Patients were required to attend physiotherapy. Following physiotherapy, post scores were obtained to analyze functional status. From the data analysis, Van der Roer et al. (2006) discovered that
41.2% of the patients showed improvement and 47.0% of the patients showed no change after physiotherapy.

Al-Herz, Snip, Clark, and Esdaile (2007) used the Quebec Back Pain Disability Questionnaire to evaluate the effect of exercise therapy on back pain, spinal range of motion, and disability in patients with diffuse idiopathic skeletal hyperostosis. Patients were instructed to attend physiotherapy in the clinic for 14 visits over 8 weeks for an hour. Each session was supervised. After 8 weeks of supervised physiotherapy, patients were required to continue the same exercise program at home for 16 weeks on a daily basis. Scores were obtained at baseline, after 8 weeks, and after 24 weeks. At the conclusion of 24 weeks, 8 patients (53%) showed a decrease of impairment of the low back.

Almeida et al. (2008) conducted a study to identify a correlation between fibrosis and new or residual symptoms of patients who were to undergo low lumbar disc surgery for the first time. Patients were involved in physical therapy immediately following surgery. The focus of physical therapy was mobilization and posture orientation. Physical therapy concluded after 3 months, and pre and post scores were analyzed. Almeida et al. (2008) found no statistically significant correlation between degree of fibrosis and clinical outcomes.

Wallbom et al. (2009) used the Quebec Back Pain Disability Questionnaire to determine whether the flexion-relaxation phenomenon improves as pain decreases in patients recovering from lumbar disc surgery. Patients were administered the questionnaire prior to surgery and 30 days following surgery. Data analysis showed no
Sign of significant improvement of flexion-relaxation phenomenon or range of motion after surgery despite improvement in measures of pain, perceived function, and general health.

Summary

Evidence-based clinical outcomes research along with patient-based outcomes research in the field of athletic training is needed to enhance the athletic training profession (Valovich McLeod et al., 2008). It is essential for athletic training researchers to conduct and interpret patient-based outcomes data from various techniques in order to determine which rehabilitation plan would ultimately improve the quality of health care being provided to patients (Kang et al., 2008). Patient-based outcome assessments are necessary for ATs to demonstrate the effectiveness of therapies and interventions, the importance of patient-centered care, and the development of evidence-based practice guidelines (Valovich McLeod et al., 2008).
CHAPTER 3: METHODS

This chapter is divided into the following sections: purpose of study, research design, variables, statistical design, participants, instrumentation, procedures, and statistical analyses.

Purpose of the Study

The purpose of this study is to determine the effectiveness of care rendered by ATs on patient-perceived outcomes in relation to pain and function in a selective population of high school athletes.

Research Design

Variables

The variables for this study were the specific body parts injured. The independent variables include: the arm, hand, shoulder, foot, ankle, knee, and/or low back. The dependent variables were the functional outcome scores and pain scores. The dependent variables were collected using the Clinical Pain Assessment scores collected pre and post rehabilitation and the functional outcome scores collected pre and post rehabilitation. Functional outcome scores were based on injury evaluation using the Disability of the Arm, Shoulder, and Hand (DASH) Questionnaire, Cincinnati Knee Rating System, Foot and Ankle Disability Index (FADI) Sport Questionnaire, and/or Quebec Back Pain Disability Scale based on body part injured.
**Statistical Design**

The mean pre and post scores of the Clinical Pain Assessment Tool and the pre and post scores of the functional outcome scales means and standard deviations were calculated for analysis.

**Participants**

Participants were high school student athletes aged 14 to 19 years old recruited from 14 southeastern Ohio local high schools and 1 West Virginia high school. The participants were selected from these 15 high schools because these schools provided athletic training services via Ohio University’s Master of Science in Athletic Training Program. All participants were members of sanctioned high school sports such as soccer, football, basketball, track and field, tennis, wrestling, volleyball, baseball, and/or softball.

Participants had to meet both of the following inclusionary criteria: (a) sustained an athletic related injury that required rehabilitation, and (b) the injury had to restrict the participant from athletic participation determined by the AT or team physician for at least one day beyond the date of injury. Participants were excluded from the study if the student athlete sustained his/her injury outside of his/her sanctioned sport or in the off-season.

**Instrumentation**

The ATs that were assigned to each of the 15 participating high schools were provided and instructed on how to properly administer the functional outcome scales and pain scale that were used in this study: Clinical Pain Assessment Tool, FADI Sport Questionnaire, Cincinnati Knee Rating System, DASH Questionnaire, and Quebec Back
Pain Disability Scale. The Clinical Pain Assessment Tool, administered for each injury, was used to collect outcome data on the athlete’s perception of pain. Each functional outcome scale was body region specific. The functional outcome scales for each area of the body (ankle, knee, hand, shoulder, arm, and low back) were:

1. The Clinical Pain Assessment Tool is a two-part assessment tool. Part one is the McGill pain scale where the participant is able to mark on the body diagram the location of pain. Part two of this assessment tool asked the participant to circle a numerical value on a 10-point Likert scale for two pain related questions: (a) how much does it hurt and (b) how unpleasant is the pain?

2. The Foot and Ankle Disability Index (FADI) Sport Questionnaire is a 5-point Likert rating scale which rates various functional activities such as walking, standing, running, squatting, and other activities of daily living. A number 4 rating corresponds to no difficulty; 3, slight difficulty; 2, moderate difficulty; 1, extreme difficulty; and, not applicable indicates an inability to perform the specific task.

3. The Cincinnati Knee Rating System is a questionnaire that measures functional activities such as walking, using stairs, squatting/kneeling, straight running, jumping/landing, hard twists, cuts, and pivoting. Each of the functional categories ranged from no limitations to severe limitations and are based on a point system depending on how much of a limitation the participant was experiencing. All the movements listed for this questionnaire stress the knee
and the lower extremity; however, it is different from the FADI Sport Questionnaire because it assesses more difficult functional movements.

4. The Disability of the Arm, Shoulder, and Hand (DASH) Questionnaire is a 5-point Likert scale that measured activities of daily living, pain/abnormal feelings throughout the hand/arm, and sport specific tasks, e.g., any difficulty using your usual technique to perform your sport, any difficulty playing your sport due to arm, shoulder, and/or hand pain, any difficulty playing your sport as well as you would like, and any difficulty spending your usual amount of time practicing your sport.

5. The Quebec Back Pain Disability Scale was used to assess all low back injuries. This 6-point Likert scale allows participants to rate how well they can perform certain tasks/activities. Some activities include personal living activities, walking, lifting, pain intensity, standing, sleeping, social life, sitting, and traveling.

These four region-specific questionnaires and Clinical Pain Assessment Tool were chosen because they were used in previous studies examining functional outcomes based on the patient’s perception of functional improvement.

Procedures

Copies of the consent and assent forms approved by Ohio University’s Institutional Review Board were provided to each of the ATs at the 15 participating high schools. When a participant sustained an injury during a sanctioned sport activity, the AT performed a full examination appropriate for the condition. If the AT determined the
participant met the inclusionary criteria, copies of the assent form were given to the participant to read and sign to determine if the participant would participate in the study. The assent form informed the participant of the purpose, risk(s) and benefit(s) of the study. In the event the participant was a minor, the parent(s) were given a consent form to read and sign before his/her child participated in the study. The consent form informed the parent(s) of the purpose, risk(s), and benefit(s) of the study to determine if he/she would allow his/her child to participate. For the participant to be considered for the study, both consent and assent forms (if necessary) had to be returned to the AT at the participating high school. If the participant was over the age of 18, he/she read and signed the consent form and returned it to the AT during initial injury evaluation. All consent and assent forms were kept in a secure area known only to the researcher.

When the participant sustained an injury and had been evaluated by the AT and the AT verified that both assent (if necessary) and consent forms had been signed then the functional outcome scale, chosen based on body part injured, and Clinical Pain Assessment Tool were given to the participant. This initial evaluation process served as a pre score measure of pain and patient-based functional limitations. Once the functional outcome scale and Clinical Pain Assessment Tool scores were obtained, the AT determined and implemented a rehabilitation plan for the participant’s injury. The AT at each high school determined the duration of the rehabilitation plan. After a week (including weekdays only) of completing the specified rehabilitation plan, the AT readministered the functional outcome scale and Clinical Pain Assessment Tool that were given at the initial evaluation session to re-evaluate the participant’s prognosis. The Clinical Pain
Assessment Tool and functional outcome scale were readministered each week until the participant was discharged. Data were collected weekly because previous research documented that the average time from initial injury to return to play for minor injuries was 5 days. Once the final patient-based functional outcome scale and Clinical Pain Assessment Tool scores were obtained, those scores served as the post score for the rehabilitation plan. If the participant was discharged earlier than a week (e.g., after 3 days of rehabilitation), the AT administered the same functional outcome scale and Clinical Pain Assessment Tool to re-evaluate the participant’s prognosis. Rehabilitation duration was determined by the date on the initial functional outcome questionnaire and the date on the final functional outcome scale. Rehabilitation plans were not reported to the researcher. These assessment tools were used within this study to collect functional outcomes of functional improvement, but could also be administered to determine return to play of the participant.

All functional outcome scales, Clinical Pain Assessment Tool, consent and assent forms were collected by the AT from each participating high school and returned to the researcher at the end of every athletic season.

To protect participants’ confidentiality, the data from the functional outcome scales and Clinical Pain Assessment Tool were recorded using a pre determined six-digit code number assigned to the athlete at the beginning of their athletic career (refer to Protocol # 06X187). The AT used the pre assigned code number from the approved protocol.
Statistical Analyses

Data was processed using Microsoft Excel 2007 and Statistical Package for the Social Sciences (SPSS, version 17.0, Chicago, IL). Descriptive statistics were calculated from the pre and post scores of each of the functional outcome scales and pre and post scores from the Clinical Pain Assessment tool to test for improvement of functional outcomes and pain outcomes due to rehabilitation provided by an AT. Pre and post functional outcome scores were analyzed using a dependent $t$-test. Pre and post pain scores were analyzed using a dependent $t$-test. Dependent $t$-tests were used to evaluate whether the mean of the difference between the pre and post scores were statistically different from zero. Pearson Product Correlation analysis was used to determine if there was a relationship between pain and functional outcomes.
CHAPTER 4: RESULTS

The population for this study was high school student athletes recruited from 14 southeastern Ohio high schools and 1 West Virginia high school. Of the 15 high schools, 6 southeastern Ohio high schools reported cases that met the inclusionary criteria. Of the injuries reported during the 2008-2010 academic year, 5 were related to the arm, shoulder, or hand, 6 related to the knee, and 12 related to the foot or ankle. No low back injuries were reported (see Table 2).

Statistical analyses was performed for each of the instruments used in this study, the Disability of the Arm, Shoulder, and Hand (DASH) Questionnaire, Foot and Ankle Disability Index (FADI) Sport Questionnaire, and the Cincinnati Knee Rating System. Mean scores for each injured body area were calculated using the pre and post scores for the indicated body part to determine improvement of functional outcomes. Outcome scores for the Clinical Pain Assessment Tool were calculated by subtracting the pre and post pain scores to determine if there was a change in the level of pain.

Clinical improvement was determined by percent change using pre score to post score. Percent change for Cincinnati Knee Rating System and FADI Sport Questionnaire was calculated by subtracting post score from pre score and dividing by post score. Percent change for the DASH Questionnaire was calculated by subtracting pre score from post score and dividing by pre score. A dependent $t$-test was used to determine the significance of rehabilitation services rendered by ATs on overall improvement on function and pain for each individual body part injured. Pearson Product Correlation
analysis was performed to determine if there was a correlation between pain and functional outcomes.

Results

*Upper Extremity Injuries*

Five injuries occurred to the arm, shoulder, and/or hand and were assessed using the DASH Questionnaire and the Clinical Pain Assessment Tool to collect pre and post functional outcome scores and pain scores. The mean DASH pre score was $47.6 \pm 21.9$ (range from 25.7 to 83.8) and the mean post score was $16.6 \pm 12.3$ (range from 0 to 33.1), yielding a mean difference in improvement of $31.0 \pm 24.9$. The MDC in function for the DASH is 12.7 points (Solway et al., 2002; Beaton et al., 2001). The MCID change in function for the DASH scores is 15 points (Solway et al., 2002; Beaton et al., 2001). Four of the five cases reported with MCD values as followed for function: elbow subluxtion was 381.1%; AC sprain, 112.6%; triceps strain, 197.6%; and, thumb dislocation, 187.4%. MCID values as followed for function: elbow subluxtion was 307.1%; AC sprain, 80%; triceps strain, 153%; and, thumb dislocation, 143.3%. A case involving lateral epicondylitis did not meet the criteria for MDC or MCID for function. MCD and MCID value for the lateral epicondylitis was 7.4. The Clinical Pain Assessment Tool mean pre score was $16.3 \pm 3.6$ (range from 12.0 to 20.0) and the mean post score was $7.9 \pm 5.6$ (range from 0 to 12.0), an average improvement of $8.4 \pm 9.0$. There was a mean percent increase of 56.7% in function and 44% decrease in pain for injuries sustained in the upper extremity (see Table 3).
### Table 2

**Distribution of Athletic Injuries**

<table>
<thead>
<tr>
<th>Injury</th>
<th>N (%)</th>
<th>Days of Rehabilitation (Mean/SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral Ankle Sprain</td>
<td>6 (26.1%)</td>
<td>38 (6.3±2.4)</td>
</tr>
<tr>
<td>ATF/CF Ankle Sprain</td>
<td>2 (8.7%)</td>
<td>12 (6±0.0)</td>
</tr>
<tr>
<td>MCL Knee Sprain</td>
<td>2 (8.7%)</td>
<td>27 (13.5±10.6)</td>
</tr>
<tr>
<td>Elbow Subluxtion</td>
<td>1 (4.3%)</td>
<td>6 (---)</td>
</tr>
<tr>
<td>Lateral Epicondylitis of the Elbow</td>
<td>1 (4.3%)</td>
<td>22 (---)</td>
</tr>
<tr>
<td>AC Shoulder Sprain</td>
<td>1 (4.3%)</td>
<td>6 (---)</td>
</tr>
<tr>
<td>Triceps Strain</td>
<td>1 (4.3%)</td>
<td>8 (---)</td>
</tr>
<tr>
<td>Thumb Dislocation</td>
<td>1 (4.3%)</td>
<td>6 (---)</td>
</tr>
<tr>
<td>Patella Subluxtion</td>
<td>1 (4.3%)</td>
<td>5 (---)</td>
</tr>
<tr>
<td>Subcondral Fracture of the Knee</td>
<td>1 (4.3%)</td>
<td>11 (---)</td>
</tr>
<tr>
<td>Bursitis of the Knee</td>
<td>1 (4.3%)</td>
<td>6 (---)</td>
</tr>
<tr>
<td>LCL Knee Sprain</td>
<td>1 (4.3%)</td>
<td>4 (---)</td>
</tr>
<tr>
<td>Medial Ankle Sprain</td>
<td>1 (4.3%)</td>
<td>6 (---)</td>
</tr>
<tr>
<td>ATF Ankle Sprain</td>
<td>1 (4.3%)</td>
<td>6 (---)</td>
</tr>
<tr>
<td>Syndesmosis Ankle Sprain</td>
<td>1 (4.3%)</td>
<td>8 (---)</td>
</tr>
<tr>
<td>Peroneal Sprain</td>
<td>1 (4.3%)</td>
<td>4 (---)</td>
</tr>
</tbody>
</table>

*Note.* ATF = anterior talofibular ligament; CF = calcaneofibular ligament; AC = acromioclavicular; MCL = medial collateral ligament; LCL = lateral collateral ligament. (---) = No Mean and/or Standard Deviation.
Table 3

Disability of the Arm, Shoulder and Hand (DASH) Questionnaire Scores and Pain Scores

<table>
<thead>
<tr>
<th>Injury</th>
<th>Functional Outcome</th>
<th>Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Score</td>
<td>Post Score</td>
</tr>
<tr>
<td>Elbow Subluxation</td>
<td>83.8</td>
<td>22.7</td>
</tr>
<tr>
<td>Lateral Epicondylitis</td>
<td>25.7</td>
<td>33.1</td>
</tr>
<tr>
<td>AC Sprain</td>
<td>41.9</td>
<td>14.9</td>
</tr>
<tr>
<td>Triceps Strain</td>
<td>37.8</td>
<td>0</td>
</tr>
<tr>
<td>Thumb Dislocation</td>
<td>48.7</td>
<td>12.2</td>
</tr>
<tr>
<td>Mean</td>
<td>47.6</td>
<td>16.6</td>
</tr>
</tbody>
</table>

*Note. Injuries that have meet the criteria for MCD and MCID.

Knee Injuries

Six injuries occurred to the knee and were assessed using the Cincinnati Knee Rating System and Clinical Pain Assessment Tool to collect pre and post functional outcome scores and pain scores. The mean Cincinnati Knee Rating System pre score was 178.3 ± 59.8 points (range from 120 to 250) and the mean post score was 318.3 ± 109.4 (range from 120 to 400), yielding a mean difference in improvement of 140.0 ± 105.8. MCD and MCID values were not established for the Cincinnati Knee Rating System. Significant clinical increase in function was documented by showing a 50% difference
between pre and post functional scores. The Clinical Pain Assessment Tool mean pre
score was $13.5 \pm 3.72$ (range from 9.0 to 18.0) and the mean post score $7.2 \pm 3.9$ (range
from 2.0 to 12.0), an average improvement of $6.3 \pm 7.3$. There was a mean $33.4\%$
increase in function, and a mean $38.9\%$ decrease in pain (see Table 4).

*Foot and Ankle Injuries*

Twelve injuries occurred to the foot and/or ankle and were assessed using the
FADI Sport Questionnaire and Clinical Pain Assessment Tool to collect pre and post
functional outcome scores and pain scores. The mean FADI Sport Questionnaire pre
score was $72.3 \pm 14.1$ (range from 34 to 89) and the mean post score was $123.6 \pm 10.2$
(range from 97 to 136), yielding a mean difference in improvement of $51.3 \pm 12.1$. MCD
and MCID values were not established for the FADI Sport Questionnaire. Significant
clinical increase in function was documented by showing a 50% difference between pre
and post functional scores. The Clinical Pain Assessment Tool mean pre score was $14.7 \pm
3.0$ (range from 11.0 to 20.0) and the mean post score was $3.6 \pm 1.7$ (range from 1.0 to
6.0), an average improvement of $11.1 \pm 3.3$. There was a mean percent increase of $41.8\%$
in function and $74.7\%$ decrease in pain (see Table 5).
Table 4

*Cincinnati Knee Rating System Scores and Pain Scores*

<table>
<thead>
<tr>
<th>Injury</th>
<th>Pre Score</th>
<th>Post Score</th>
<th>Change</th>
<th>% Change</th>
<th>Pre Score</th>
<th>Post Score</th>
<th>Change</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patella Subluxtion</td>
<td>120</td>
<td>400</td>
<td>280</td>
<td>70.0%</td>
<td>18.0</td>
<td>5.0</td>
<td>13.0</td>
<td>72.2%</td>
</tr>
<tr>
<td>Subcondral Fracture</td>
<td>120</td>
<td>120</td>
<td>0</td>
<td>0.0%</td>
<td>9.0</td>
<td>12.0</td>
<td>-3.0</td>
<td>-25.0%</td>
</tr>
<tr>
<td>Bursitis</td>
<td>180</td>
<td>420</td>
<td>240</td>
<td>57.1%</td>
<td>18.0</td>
<td>2.0</td>
<td>16.0</td>
<td>88.9%</td>
</tr>
<tr>
<td>MCL Sprain&lt;sub&gt;1&lt;/sub&gt;</td>
<td>150</td>
<td>290</td>
<td>140</td>
<td>48.3%</td>
<td>12.0</td>
<td>11.5</td>
<td>0.5</td>
<td>4.2%</td>
</tr>
<tr>
<td>MCL Sprain&lt;sub&gt;2&lt;/sub&gt;</td>
<td>250</td>
<td>310</td>
<td>60</td>
<td>19.4%</td>
<td>11.0</td>
<td>7.5</td>
<td>3.5</td>
<td>31.8%</td>
</tr>
<tr>
<td>LCL Sprain</td>
<td>250</td>
<td>370</td>
<td>120</td>
<td>32.4%</td>
<td>13.0</td>
<td>5.0</td>
<td>8.0</td>
<td>61.5%</td>
</tr>
<tr>
<td>Mean</td>
<td>178.3</td>
<td>318.8</td>
<td>140</td>
<td>33.4%</td>
<td>13.5</td>
<td>7.2</td>
<td>6.3</td>
<td>38.9%</td>
</tr>
</tbody>
</table>

*Note.* Subscript following an injury denotes the case number when multiple cases were reported for that particular injury.
Table 5

*Foot and Ankle Disability Index (FADI) Sport Questionnaire Scores and Pain Scores*

<table>
<thead>
<tr>
<th>Injury</th>
<th>Functional Outcome</th>
<th>Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Score</td>
<td>Post Score</td>
</tr>
<tr>
<td>Lateral Ankle Sprain₁</td>
<td>77</td>
<td>131</td>
</tr>
<tr>
<td>Lateral Ankle Sprain₂</td>
<td>71</td>
<td>123</td>
</tr>
<tr>
<td>Lateral Ankle Sprain₃</td>
<td>34</td>
<td>97</td>
</tr>
<tr>
<td>Lateral Ankle Sprain₄</td>
<td>89</td>
<td>120</td>
</tr>
<tr>
<td>Lateral Ankle Sprain₅</td>
<td>76</td>
<td>133</td>
</tr>
<tr>
<td>Lateral Ankle Sprain₆</td>
<td>73</td>
<td>126</td>
</tr>
<tr>
<td>Medial Ankle Sprain</td>
<td>78</td>
<td>127</td>
</tr>
<tr>
<td>ATF Sprain</td>
<td>87</td>
<td>120</td>
</tr>
<tr>
<td>ATF/CF Sprain₁</td>
<td>70</td>
<td>117</td>
</tr>
</tbody>
</table>
Table 5 (continued)

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>n</th>
<th>Count</th>
<th>No.</th>
<th>%</th>
<th>Pre</th>
<th>Post</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATF/CF Sprain_2</td>
<td>68</td>
<td>131</td>
<td>63</td>
<td>48.1%</td>
<td>15.0</td>
<td>2.0</td>
<td>13</td>
</tr>
<tr>
<td>Syndesmosis Sprain</td>
<td>80</td>
<td>122</td>
<td>42</td>
<td>34.4%</td>
<td>11.0</td>
<td>5.0</td>
<td>6</td>
</tr>
<tr>
<td>Peroneal Sprain</td>
<td>64</td>
<td>136</td>
<td>72</td>
<td>52.9%</td>
<td>18.0</td>
<td>2.0</td>
<td>16</td>
</tr>
<tr>
<td>Mean</td>
<td>72.3</td>
<td>123.6</td>
<td>51.3</td>
<td>41.8%</td>
<td>14.7</td>
<td>3.6</td>
<td>11.1</td>
</tr>
</tbody>
</table>

*Note.* Subscript following an injury denotes the case number when multiple cases were reported for that particular injury.

*Overall Change in Rehabilitation*

Overall rehabilitation was defined as combining pre and post scores from the functional outcome questionnaires for all types of specific athletic injuries. The overall mean rehabilitation for the pre score was 99.4 ± 60.7 and the mean post score was 152.8 ± 122.0, yielding a mean difference in improvement of 53.4 ± 79.5 in function (see Table 6).

*Overall Change in Pain*

Overall pain was defined as combining all the pre and post scores of all the specific athletic injuries. The overall mean pre score for pain was 14.8 ± 3.3 and the mean post score was 6.2 ± 3.8, yielding a mean difference in improvement of 8.6 ± 6.1 (see Table 7).
### Table 6

*Mean Scores for Overall Change in Rehabilitation*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Pre Score</th>
<th>Post Score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASH Questionnaire</td>
<td>47.6</td>
<td>16.6</td>
<td>0.044*</td>
</tr>
<tr>
<td>Cincinnati Knee Rating Scale</td>
<td>178.3</td>
<td>318.3</td>
<td>0.023*</td>
</tr>
<tr>
<td>Table 6 (continued)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FADI &amp; FADI Sport</td>
<td>72.3</td>
<td>123.6</td>
<td>0.000*</td>
</tr>
<tr>
<td>Mean</td>
<td>99.4</td>
<td>152.8</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05

### Table 7

*Mean Scores for Overall Change in Pain*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Pre Score</th>
<th>Post Score</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASH Questionnaire</td>
<td>16.3</td>
<td>7.9</td>
<td>0.105</td>
</tr>
<tr>
<td>Cincinnati Knee Rating Scale</td>
<td>13.5</td>
<td>7.2</td>
<td>0.088</td>
</tr>
<tr>
<td>FADI &amp; FADI Sport</td>
<td>14.7</td>
<td>3.6</td>
<td>0.000*</td>
</tr>
<tr>
<td>Mean</td>
<td>14.8</td>
<td>6.2</td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05
Analysis of Research Hypotheses

Research Hypothesis 1: Rehabilitation Services Offered by an AT Will Decrease Pain of an Injured Athlete

A dependent $t$-test was used to analyze the difference between pre and post scores for pain to determine if AT services caused a decrease in pain through rehabilitation based on the participant’s perception. There was a significant difference shown between pre and post scores demonstrating that rehabilitation services offered by ATs are effective in decreasing pain based on participants’ perceptions, $t(22) = 7.324, p<0.05$. Therefore, these results reject $H_{01}$ demonstrating rehabilitation services offered by ATs can cause a decrease in pain.

Research Hypothesis 2: Rehabilitation Services Offered by an AT Will Improve Functional Outcomes for Injuries to the Arm, Shoulder, and/or Hand

A dependent $t$-test was used to analyze the difference between pre and post scores for athletic injuries to the arm, shoulder and/or hand to determine if there was improvement from rehabilitation services on function based on participants' perceptions. There was a statistically significant difference shown between pre and post scores demonstrating that rehabilitation services offered by ATs can cause an increase in function of the arm, shoulder, and/or hand based on participants’ perceptions, $t(4) = 2.894, p<0.05$. Therefore, these results reject $H_{02}$ demonstrating rehabilitation services provided by ATs are effective at increasing functional outcomes for the arm, shoulder and/or hand.
Research Hypothesis 3: Rehabilitation Services Offered by an AT Will Improve Functional Outcomes for Injuries to the Knee

A dependent $t$-test was used to analyze the difference between pre and post scores for athletic injuries to the knee to determine if there was improvement from rehabilitation services on function based on participants’ perceptions. There was a significant difference shown between pre and post scores demonstrating that rehabilitation services offered by ATs can cause an increase in function of the knee based on participants’ perceptions, $t(5) = -3.240$, $p<0.05$. Therefore, these results reject $H_{03}$ demonstrating rehabilitation services provided by ATs are effective at increasing functional outcomes for the knee.

Research Hypothesis 4: Rehabilitation Services Offered by an AT Will Improve Functional Outcomes for Injuries to the Foot and/or Ankle

A dependent $t$-test was used to analyze the difference between pre and post scores for athletic injuries to the foot and/or ankle to determine if there was improvement from rehabilitation services on function based on participants’ perceptions. There was a significant difference shown between pre and post scores demonstrating that rehabilitation services offered by ATs can cause an increase in function of foot and/or ankle based on participant perception, $t(11) = -14.732$, $p<0.05$. Therefore, these results reject $H_{04}$ demonstrating rehabilitation services provided by ATs are effective at increasing functional outcomes for the foot and/or ankle.
Research Hypothesis 5: Rehabilitation Services Offered by an AT Will Improve Functional Outcomes for Injuries to the Low Back

A dependent t-test was unable to be run on low back injuries because no low back injuries were reported for analysis. The null hypothesis for H05 could not be rejected or accepted due to no data reported for low back injuries.

Research Hypothesis 6: Rehabilitation Services Offered by ATs are Effective at Improving Overall Functional Outcomes and Decreasing Overall Pain for Athletic Injuries

A dependent t-test was used to analyze the difference between pre and post scores from all athletic injuries combined to determine if there were improvements in function and pain after rehabilitation. There was a statistically significant difference between pre and post scores demonstrating that participants believed that rehabilitation improved their functional outcomes, t(22) = -3.43, p<0.05. There was a statistically significant difference between pre and post scores of all athletic injuries, demonstrating that participants believed that rehabilitation decreased their pain, t(22) = 7.73, p<0.05. Therefore, these results reject H06 by demonstrating that rehabilitation services offered by ATs can cause an increase in function and decrease in pain based on participants’ perceptions of services rendered.

Research Hypothesis 7: Decreasing Pain will Improve Functional Outcomes of an Injured Athlete

A Pearson Product Correlation analysis was run to determine the correlation between pain and function. Pearson Product Correlation coefficients were computed and
revealed that pain and functional outcomes had a correlation, $r^2 = 0.098$, $n = 46$, $p < 0.05$, two-tails. Pearson Product Correlation revealed that by decreasing pain, there was an increase in function. Therefore, this research rejects $H_{07}$ showing that decreasing pain does have an effect on increasing functional outcomes of athletic injuries.

Six of the seven null hypotheses for this research study were rejected; stating the change in function and pain were significant following rehabilitation services performed by ATs. The results demonstrated that rehabilitation services offered by ATs can cause a decrease in pain, which increased functional outcomes related to athletic injuries based on participants’ perceptions.
CHAPTER 5: DISCUSSION

Introduction

There was limited research published on the effectiveness of athletic training rehabilitation services provided by ATs at the high school level. There have been calls to demonstrate the effectiveness of therapeutic interventions such as rehabilitation plans on functional outcomes, limitations, and disability (Michener et al., 2002; Williams et al., 1999). The purpose of this study was to determine if ATs were able to decrease pain and improve functional outcomes of the knee, foot, ankle, hand, shoulder, arm, and/or low back in a secondary school athletic population.

Demographics

This study examined the rehabilitation services provided at 6 of the 15 participating high schools. Each school employed an AT who provided rehabilitation services to the participants. Six of the 15 participating schools reported 23 athletic injuries requiring the AT to deliver rehabilitation services.

Rehabilitation of Upper Extremity

Lim et al. (2008) confirmed the accuracy of the Disability of the Arm, Shoulder and Hand (DASH) Questionnaire. The DASH Questionnaire and the Clinical Pain Assessment Tool were used to evaluate the functional outcomes of five upper extremity injuries. Lim et al. (2008) agreed that the DASH Questionnaire was accurate in reporting functional improvement in patients with an upper extremity injury. The DASH Questionnaire was accurate within this study in recording participants’ perceptions of functional improvement for activities of daily living and sport related functions. In
addition to increasing the functional skills necessary for sport, it was essential for ATs to focus on general participant goals for everyday function. Lim et al. (2008) reported a 63% improvement in function by using the DASH Questionnaire to assess patient function.

The data collected for this study using the DASH Questionnaire demonstrated that rehabilitation services provided by ATs produced a 56.7% increase in functional outcomes scores. Injuries for the upper extremity were not similar, therefore we were unable to compare functional outcome scores or pain scores to draw meaningful conclusions. The average duration reported for upper extremity rehabilitation was 6.5 days. One participant, involving lateral epicondylitis, had a rehabilitation duration of 22 days. It was surprising to see that the injury having the longest rehabilitation duration yielded a decrease in function and no change in pain. Other factors might have impeded the participant’s progress throughout the rehabilitation plan. The other four cases showed an increase greater than 50% improvement from initial score.

The DASH Questionnaire provides researchers with a MDC and MCID value to determine clinical significance. MDC value is a difference of 12.7 points between the pre and post scores and a MCID is a 15-point difference between scores (Solway et al., 2002; Beaton et al., 2001). Four of the five cases, reported with a higher MDC and MCID compared to patients in Solway et al.’s (2002) and Beaton et al.’s (2001) studies. These MDC and MICD findings indicated that participants perceived their functional improvement was due to rehabilitation services and not due to questionnaire error. The average change in functional improvement for the four upper extremity cases that met
MDC and MCID was 40.8 points. The average overall improvement in function of the upper extremity injuries was 78.1%.

Rehabilitation of the Knee

Six knee injury outcomes were documented using the Cincinnati Knee Rating System and Clinical Pain Assessment Tool. One case pertaining to a subcondral fracture reported no change in functional outcome following rehabilitation services. The researcher is unaware of why the participant might have reported these findings. There could have been a wide variety of reasoning behind said results such as noncompliance, improper performance of exercises, or nonunion healing of fracture.

Two medial collateral ligament (MCL) injuries were reported and presented with different outcomes. The first MCL case reported a 48.3% increase in function and 4.2% decrease in pain following 6 days of rehabilitation. The second MCL case reported a 19.4% increase in function and 31.8% decrease in pain following 21 days of rehabilitation. The rehabilitation was performed by two different ATs at different institutions. The outcomes of these results might have been affected by the rehabilitation plan used, the severity of the injury, and the patient's activity level during the intervention. Feller et al. (2004) supported the idea that other factors could have impeded the outcomes of the two participants diagnosed with the same injury. In addition, no documentation was reported on either case if a physician confirmed the AT’s diagnosis through diagnostic tools such as radiographs or magnetic resonance imaging (MRI). These diagnostic tests might have ruled out other underlying injuries possibly not found through physical examination.
The remaining three knee injuries, patella subluxtion, lateral collateral ligament sprain, and bursitis, to the researcher’s knowledge, were also not confirmed by a physician’s examination. However, it has been demonstrated via pre and post scores reported by the participants that the rehabilitation plan designed by the AT could have increased their functional outcomes and decreased their pain.

To the researcher’s knowledge, the MCD and MCID values for the Cincinnati Knee Rating System have not been established. However, clinical significance of the importance of rehabilitation following a knee injury was displayed through pre and post scores. It has been documented that participants felt rehabilitation caused their functional outcome score to increase twice as much from initial score. This could imply that regardless of the content of the rehabilitation plan, rehabilitation services are beneficial to increasing function.

Rehabilitation of the Foot and/or Ankle

The Foot and Ankle Index (FADI) Sport Questionnaire and Clinical Pain Assessment Tool were used to evaluate the functional outcomes of 12 foot and/or ankle injuries. Overall, there was a 41.8% increase in function. Having a less than 50% increase in function, could have been in association with another factor such as chronic ankle instability (Carcia et al., 2008). Participants in this study did not disclose whether they suffered from chronic ankle instability, possibly causing a result in low functional outcome post scores.

Carcia et al. (2008) have clearly stated lateral ankle sprains are the frequently reported musculoskeletal injury compared to all types of athletic injuries. Within this
study, six lateral ankle sprains were the most frequently reported. One participant sustained two ankle sprains within 8 weeks of each case. The first case was a lateral ankle sprain involving the anterior talofibular ligament (ATF), calcaneofibular ligament (CF), and posterior talofibular ligament (PTF). The second case only involved the ATF. The rehabilitation duration of the first lateral ankle sprain was 11 days. The initial functional outcome score was 34 out of 136 points for the first lateral ankle. Based on this score, the participant placed his/her self as having a severe injury, answering the majority of the functional outcome questions as “very difficult” or “unable to perform.” Following the rehabilitation period, the functional outcome score increased to 97 points. Approximately 8 weeks post rehabilitation, the participant sustained an ATF sprain causing an impairment of function which the participant rated a 87 out of 136 points. The rehabilitation period for the ATF sprain was 5 days. It can be seen that loss of function, according to the participant was not as severe following the rehabilitation of the initial injury. McKeon et al. (2008) reported individuals who underwent a balance training program for 4 weeks due to chronic ankle instability demonstrated an overall improvement of 97% based on pre and post scores from the FADI Sport Questionnaire. Based on the finding of McKeon et al. (2008), a conclusion can be drawn that any type of ankle sprain will benefit from rehabilitation. It can be noted the participant’s second ankle injury did not cause an excessive amount of functional loss due to rehabilitation services performed from pervious injury. In addition, the participant’s rehabilitation plan was shorter in duration compared to the initial injury and did not sustain another foot and/or ankle injury for the remainder of the participant’s sport season.
The remaining five lateral ankle sprains reported an average rehabilitation period of 6 days. The five lateral ankle sprains averaged a 39.1% increase in function and an average of 69.8% decrease in pain following a rehabilitation plan. Cases classified other than a lateral ankle sprain presented with an average of 37.8% increase in function and 76.6% decrease in pain. The two ATF/CF sprains presented with similar outcomes. Even though McKeon et al. (2008) suggests that a 4-week balance training program could improve function, those 10 cases had no additional reports of sustaining a second injury following a short rehabilitation program. Many factors not reported to the researcher could explain the outcomes of these injuries. For example, the researcher did not ask participants to report whether they were withheld from participation in athletics for the entire duration of the rehabilitation plan. Similarly, the researcher did not ask the ATs to report the type of rehabilitation plan. All rehabilitation plans were designed by the discretion of the AT according to the AT’s evaluation of the injury.

The FADI Sport Questionnaire has been identified as a reliable and responsive instrument for measuring functional outcomes in foot and/or ankle injuries (Hale & Hertel, 2005; Carcia et al., 2008). Even though Hale and Hertel (2005) have identified the FADI Sport Questionnaire as an accurate method to rating functional outcomes of the foot and/or ankle, they did not identify values for MCD and MCID (Carcia et al., 2008). The FADI Sport Questionnaire is identical to the Functional Ankle Ability Measure (FAAM) except for the “sleeping” and four related “pain” questions were not found within the FAAM questionnaire (Eechaute et al., 2007). The MCD and MCID listed for the FAAM were MCD = 12.3 points and MCID = 9 points (Eechaute et al., 2007).
Surprisingly, even though the FADI Sport and FAAM were identified as being identical questionnaires except for five questions, the FADI Sport Questionnaire did not have a specific MCD or MCID value documented. Therefore, the researcher was unable to determine the overall clinical improvement associated with those values. Only statistical and raw data were used to draw meaningful conclusions regarding functional improvement amongst the participants.

Pain Reduction

An aspect of rehabilitation services is pain reduction. This research documented either an increase or decrease and percent change for pain scores of all types of sport-related injuries identified in this study. The outcomes from this research showed an increase percent change of 44% for arm, shoulder, and/or hand injuries, 38.9% for knee injuries, and 74.7% for foot and/or ankle injuries. Participants reported that rehabilitation services provided by ATs were effective in decreasing pain, with the highest percent change seen with foot and/or ankle injuries. However in two cases, the participants reported no increase or decrease in function and an increase in pain after completion of the rehabilitation plan prescribed for their injury. Factors such as fear-avoidance and age could cause an effect on level of disability (Poiraudenu, Rannou, Baron et al., 2006; Poiraudenu, Rannou, Le Henanff et al., 2006). Functional ability could also have an effect on perceived level of pain. The case with no increase or decrease in pain, there was also a decrease in function; whereas the case with increased pain had no increase or decrease in function. Most of the cases reported where there was a decrease in pain had an increase in
function. Therefore, a possible conclusion could be drawn that participants correlate pain with functional outcomes or vice versa.

Unfortunately, based on MCD and MCID values, we were not able to identify the importance of change to the participants. Lee, Hobden, Stiell, and Well (2003) were the first to attempt to determine MCD and MCID values for visual analog scales associated with pain. Lee et al. (2003) reported MCID as a length measurement of 30mm instead of a numerical value on a Likert scale. Within this research, a Likert numerical value was used to determine the difference between pre and post scores, thereby disallowing the researcher to determine the clinical relevance associated with MCD and MCID for the values presented in this research.

Quality of Return to Play

Claiborne et al. (2007) stated time lost from initial injury to return to athletic competition could range from 5.4 days to 26.3 days depending on severity of injury. For this study, the researcher documented the average period for athletic rehabilitation services rendered by ATs as 7.3 days with the longest rehabilitation plan lasting 22 days. A recorded was not kept on the amount of time the participant was withheld from competition/practice after the initial day of injury or if the participant was performing rehabilitation while participating in their sport. Having data regarding whether the participant was withheld from practices/competition during the rehabilitation process would provide answers as to why certain participants slowly improved or showed no change over time. Individuals who had reported having performed their rehabilitation plan for a long duration could have experienced re-injury during rehabilitation. Such
information is essential in drawing meaningful conclusions on outcome studies because it will provide professionals with information whether it is beneficial to withhold an athlete from practice/competition during rehabilitation for the best results. The most important aspect of rehabilitation services is returning the athlete to play with minimal to no impairment.

The results from this study indicated that rehabilitation services provided by ATs at the high school level affect functional outcomes of injured student athletes. Ninety-one percent of the participants reported an improvement of their functional impairment due to rehabilitation services rendered by the AT located at their high school. There were two athletic injuries (subcondral fracture and lateral epicondylitis) where the participants did not feel the rehabilitation plan helped improve their functional impairment. The results also indicated that the rehabilitation services provided by ATs were effective in decreasing pain due to an athletic injury. By decreasing pain, ATs saw an increase in functional outcomes. Therefore, it can be concluded that pain and functional outcomes correlate with one another. The main hypotheses of this study were supported. It has been documented that there is a need for full time ATs to be employed at the high school level to provide proper medical coverage to student athletes (Claiborne et al., 2007). Based on the outcomes from this study and data from several injury surveillance systems from past research, it is essential to employ an AT at all high schools throughout the United States.

Limitations

This study had several limitations. The questions stated in the questionnaires used within this research focused on activities of daily living of the individual and on sport
specific skills. The Cincinnati Knee Rating System and the FADI Sport Questionnaire were the only questionnaires used where all or the majority of the questions were directed towards sport specific tasks. This type of limitation could have impaired the finding of this study because the individual might have shown improvement with activities of daily living but still might not have improved in sports specific tasks from the rehabilitation plan.

The second limitation of this study was possibly participants not complying with the rehabilitation plan designed by the AT. No records were reported to the researcher on how accurate the participant complied with the rehabilitation plan. It was unknown to the researcher if the rehabilitation plan was being conducted in-house, home program, or both. Therefore, it cannot be reported whether the exercises designed in the rehabilitation plan by the AT were performed properly and accurately. The rehabilitation plan was not documented to compare various exercises prescribed by the various ATs within this study to determine if the exercises affected functional outcomes.

The third limitation of this study was the limited number of injuries reported by the participating high schools. With such a low number of injuries reported, meaningful conclusions were difficult to draw. This might have been a result of ATs not participating in data collection or not complying with the procedures of data collection.

The fourth limitation of this study could have been co-morbidities. ATs were not asked to report any medical history obtained during the injury evaluation process to the researcher. Therefore, other medical conditions associated with the participants could have impeded participants’ prognosis during the rehabilitation plan. In addition, previous
injuries not sustained during the time of data collection or not meeting the inclusionary criteria were not reported to the researcher. These factors might have skewed the data, explaining why certain participants might have felt that the rehabilitation plan was not effective.

Conclusion

Since there is minimal research on the effectiveness of rehabilitation services provided by ATs in the high school setting, there is a need for further research. In conclusion, participants perceived that rehabilitation services provided by ATs were effective in rehabilitating athletic related injuries and decreasing pain at the high school level. This study has demonstrated that there was a noticeable difference in functional outcomes and decrease in pain from rehabilitation services provided by ATs at the high school setting. It has also demonstrated that rehabilitation services provided by ATs are effective in rehabilitating injuries related to the arm, shoulder, hand, knee, foot and/or ankle. The effectiveness of rehabilitation services provided by ATs for the low back injuries could not be evaluated within this study due to the lack of low back injuries reported.

Recommendations

A recommendation for future research on the effectiveness of rehabilitation outcomes on high school athletic injuries would be to examine various athletic injuries not mentioned in this study. Future researchers should report and analyze clinical outcomes such as range of motion and strength along with the patient’s perception of functional outcomes. Other areas that could be analyzed in regards to functional
outcomes of rehabilitation include sport in which the injury occurred, age, and gender to determine if there is a correlation between those factors and rehabilitation outcomes.
REFERENCES


