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THE DISABILITY IN THE PHYSICALLY ACTIVE SCALE: THE PSYCHOMETRICS OF AN OUTCOME SCALE FOR MUSCULOSKELETAL INJURIES

A Thesis in

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by

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ABSTRACT

Outcomes assessment is an integral part of ensuring quality in athletic training. Unfortunately, no validated outcomes instruments have been created to measure disablement in a physically active person with a musculoskeletal injury. Therefore, the purpose of this study was to assess the psychometrics of the Disability in the Physically Active (DPA) scale: a self-report instrument created to measure disablement.

Design and Setting: Data were taken from participants at five settings. Participants entered at baseline or after a musculoskeletal injury (acute or persistent). Participants were asked to complete the DPA, global functioning (GF) scale and global rating of change (GRC) scale on multiple occasions.

Participants: A sample of 368 participants were included at baseline. Fifty-four participants with persistent symptoms and twenty-eight participants with an acute injury participated in the study. Test-retest reliability analyses were performed in 52 participants.

Measurements: We assessed the DPA's internal consistency by calculating a Cronbach alpha value. Test-retest reliability was determined with ICC (2,1) values. An exploratory factor analysis determined the factors in the DPA scale. Concurrent validity was assessed with a linear regression while sensitivity to change was assessed by calculating effect size (ES). Responsiveness was calculated by constructing a receiver operating characteristic (ROC) curve and a minimal clinical important difference (MCID) value.

Results: The Cronbach alpha score of the DPA was 0.908 and 0.890 in acute and persistent participants respectively. The $ICC_{2,1}$ value of the DPA for all participants was 0.969. The factor analysis revealed that the DPA had three factors. The DPA group mean

scores accounted for 97.5%-100% of the variation in GF group mean scores. The DPA demonstrated large effects on multiple occasions. The DPA demonstrated statistically significant AUC values and the MCID value for the DPA scale was established.

Conclusions: This study demonstrated that the DPA is a reliable, valid, sensitive and responsive instrument that measures multiple dimensions of disablement. In addition, the MCID value presents useful information for clinicians who use the DPA to measure treatment outcomes. Research should be completed using the DPA to measure the clinical efficacy of intervention used in athletic training.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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PREFACE

The purpose of this preface is to help the reader to understand the format of this thesis document. Although this document still contains the traditional number of thesis chapters, the substance in each of the chapters slightly differs. In addition, I wanted to inform the reader of the slight variations in formatting and terminology in this thesis.

Chapter 1 is the introduction and contains the usual sections of an introduction including statement of purposes, research significance and hypothesis. The information in Chapter 1 refers directly to research project presented in Chapter 4. Chapter 2 is a traditional literature review and therefore requires no explanation. Chapter 3 is the first of two manuscripts in this thesis. The manuscript in Chapter 3 is a research project that was the first step in my line of research and is directly related to the outcomes instrument studied in Chapter 4. I felt that it was important to add this manuscript to help the reader better understand some important concepts in disablement research. Chapter 4 is the second manuscript in this thesis and recounts the results of the last research project that I performed to validate a self-report outcomes instrument I created. Chapter 5 concludes my thesis and compares the hypotheses from Chapter 1 to the results of the project reported in Chapter 4.

Another matter to note in this document is the use of the singular “I” and plural “we”. I used the word “I” in Chapters 1, 2 and 5 while I used the word “we” in Chapters 3 and 4. I switch between the singular and the plural because the manuscripts in the latter two chapters have multiple authors. Lastly, you will note that the references are placed at the end of each of the chapters. I chose to treat each chapter as a stand-alone document with references at the end of each chapter rather than at the end of the thesis.

CHAPTER 1

INTRODUCTION

Chapter 1

INTRODUCTION

An effective clinician should routinely perform two rudimentary functions: 1) evaluate the quality of their service and 2) integrate evaluation feedback into daily practice. The medical health fields labels the first element as “outcomes assessment” and defines it as the effectiveness and/or efficiency of an intervention in reaching a desired result.[1] In athletic training, a desired result is a combination of both the patient’s and clinician’s goals for recovery. The second element is termed “evidence based practice”. An evidence-based approach to practice involves integrating the best clinically relevant research into the treatment process.[2] The relationship between outcomes assessment and evidence-based practice comes full circle when a clinician integrates evidence gathered from an outcomes study into his/her respective clinical practice. Outcomes assessments that include patient self-report of symptoms, functional limitations and disabilities have become more popular as evidence-based practice gains steady recognition.[3-5] The evolution of evidence-based practice in athletic training is dependent on the development of effective outcomes instruments.

An effective outcomes instrument is multi-dimensional and rooted in a disablement paradigm.[6-10] Disablement paradigms have been used in health care research to provide the framework for disability, the definition of its components, the sequence of the components, and the overall effect of disability on a person. [6-9, 11-19] Since the emphasis of a disablement paradigm is on defining the measurable components of disability, understanding disablement has much relevance to construction of an appropriate outcomes instrument. More importantly, disablement theory provides valuable

information regarding the emphasis that should be placed on each of the disablement components. Consequently, an effective outcomes instrument must focus on the clinical outcomes that will be truly telling of clinical improvement.

Just as important as having an outcomes tool that is rooted in disablement is ensuring that the instrument is psychometrically sound. An instrument must first be reliable before it can be proven to valid. Next, the instrument should detect changes as a patient improves from an intervention. An important aspect of an outcomes instrument is that a clinician can use it to assess the quality of their care. Consequently, the instrument should be able to detect clinically significant change. Outcomes instruments assist both clinicians and researchers to meaningfully assess a patient's response to the health care provided.

Statement of the Problem

Outcomes assessment has not become a part of certified athletic trainers' daily routine in most traditional settings. One constraint may be that athletic trainers typically do not need to bill for services and so are not mandated to measure outcomes. Other constraints that athletic trainers face includes lack of time, manpower, or an outcomes instrument that has relevance to a physically active population. It is not surprising that outcomes assessment has been limited in athletic training because only one athletic training outcomes assessment exists. The *Athletic Training Outcomes Assessment* (ATOA) was designed as a multidimensional generic tool to assess the changes in health status in physically active individuals.[20] Recent work demonstrated that the instrument contained conflicting, repetitive, and non-specific terminology. The ATOA was also shown to be a uni-dimensional scale rather than a multidimensional scale as originally intended.[21] In

order to promote the regular measurement of disability related outcomes, a multi-dimensional instrument should be created and psychometrically tested. In addition, the instrument should be constructed so as to be appropriate for the physically active population that a certified athletic trainer works with.

Statement of the Purposes

In order to create a psychometrically sound outcomes assessment tool, the tool must be reliable, valid, sensitive to change and responsive. Therefore, this study had five purposes.

1. Determine the standard values for the *Disability in the Physically Active (DPA) Scale* in the physically active. More specifically, I established standard values in healthy participants and participants with a history of acute and persistent musculoskeletal injury.
2. Assess the reliability of the DPA including internal consistency and test-re-test reliability. Internal consistency was assessed in participants with acute and persistent injuries. Participants with acute injuries were assessed one day after injury while participants with persistent injuries were assessed upon entry into the study. Test-retest reliability was assessed in both healthy participants and participants with persistent injuries. I assessed test-retest reliability by administering the DPA twice within a 24-hour period.
3. Examine the concurrent validity of the DPA by examining the relationship between DPA scores to perceived Global Functioning (GF) scores at every administration of the DPA in participants with acute and persistent injuries.

Both group mean GF and DPA scores as well individual GF and DPA scores were compared to assess concurrent validity.

4. Examine the sensitivity of the DPA in participants with acute injuries at every administration of the DPA. I assessed the sensitivity of the DPA every time the instrument was administered in participants with persistent injuries.
5. To determine the responsiveness of the DPA by two values. The first value, the area under the curve (AUC), was calculated to determine the responsiveness of the DPA. The second value, the minimal clinical important difference (MCID), established the clinical significance of the DPA.

Significance

The conventional first step in helping certified athletic trainers to assess their effectiveness is to create a new outcomes instrument. The need for athletic training outcomes research is more pertinent than ever considering the changing face of athletic training. Growing numbers of certified athletic trainers are now employed in clinical settings where treatment costs and efficacy are often closely scrutinized. In addition, the "physically active" population that certified athletic trainers now serve is a more diverse population than competitive athletes. The testing of an outcomes instrument that has been grounded in disablement theory and that can be used on the physically active is required to move certified athletic trainers forward in the employing principles of evidence-based healthcare practice.

Research Hypothesis

Hypothesis # 1: I hypothesized that the standard values reported by the healthy participants would not be considerably different from lowest possible score on the DPA. In addition, I hypothesized that more than ten percent of the healthy population will experience a floor effect at baseline. I did not expect that floor or ceiling effects would occur on any other administration of the DPA. The standard values for the baseline administration of the DPA in participants with a persistent injury will be higher than the values reported by the healthy participants but lower than the values reported by the acutely injured subjects on day 1 of the DPA administration. I also hypothesized that DPA scores would act predictably in participants with acute injuries. I expected that DPA scores would systematically decrease as the number of days after injury increased.

Hypothesis # 2: I hypothesized that the DPA would demonstrate appropriate internal consistency values in the total scores for each administration of the DPA in participants with acute and persistent injuries. Appropriate internal consistency scores should range between 0.70-0.90. I believed that a subsequent factor analysis of the DPA would demonstrate that the DPA is a multi-dimensional instrument. The expected DPA domains included impairments, functional limitations, disability, and quality of life measures. The DPA would exhibit appropriate test-retest intraclass correlation coefficient scores above 0.80 in both healthy and injured participants.

Hypothesis # 3: I expected that the DPA would demonstrate high concurrent validity when compared to GF scores in participants with acute and persistent injuries. I expected

that the DPA would explain a large percentage of variation in GF scores especially in participants with acute injuries given that acute injuries behave in more predictable patterns.

Hypothesis # 4: I expected that the DPA would be sensitive to change in both the acute and persistent injury groups and would demonstrate large effect sizes in participants that have experienced a clinically significant change. I expected that the largest effects would be seen on two occasions: between DPA scores in healthy participants and one day after acute injury, and between DPA scores on one day after injury and upon the participants' return to full participation. I expected large effects in participants with persistent injuries but did not expect that they will present in a predictable manner.

Hypothesis # 5: I expected that the DPA would demonstrate appropriate responsiveness by obtaining a statistically significant AUC value determined by a receiver operating characteristic (ROC) curve. In addition, I expected to determine the DPA's clinical significance by calculating a MCID value for participants with persistent and acute injuries. I expected that the MCID value would be larger in participants with acute injuries than in participants with persistent injuries. I also expected that the MCID values would behave consistently on every administration of the DPA in both sets of participants.

Delimitations

1. The competitive participants population was limited to a three sites: an NCAA Division I university in central Pennsylvania, a large high school in central Pennsylvania and an NCAA Division III college in western Michigan.
2. The recreational participant population was limited to two sites: a university intramural program and an outpatient orthopedic center. Both sites are located in central Pennsylvania.
3. Persistent injuries were operationally defined as injuries that had been symptomatic for at least one month.
4. Data collection for participants with acute and persistent injuries occurred at intervals in which change in health status was expected.

Limitations

1. Treatment for acute and persistent injuries were left to the judgment of the participants' physician, certified athletic trainer, or physical therapist and was not controlled as part of this study.

Assumptions

1. It was assumed that if change in disablement were to occur in participants with persistent injuries that it would occur within a six-week period.
2. It was assumed that participants responded truthfully to each question on the self-report instruments.

Operational Definitions

Acute injury – a musculoskeletal injury that has two characteristics: 1) a definite mechanism of injury and 2) enough disablement that the participant is limited from physical activity for at least two consecutive days.

Competitive athlete – a participant that competes in a sport that requires regular attendance at scheduled practices and/or conditioning sessions, and a coach that leads practices and/or competitions

DPA – a 16 item, multidimensional, outcomes instrument that was created using a disablement model

Global functioning – a tool that is a line ten centimeters in length where the left end represents 0% of normal functioning and the right ends represents 100% of normal functioning.

Global rating of change - a 15-point scale that measures perceived change in disability status.

Healthy participant - a participant that is free of an existing symptomatic musculoskeletal injury.

Internal consistency – the homogeneity of a health measurement scale.

Participation status – the self-reported status in physical activity as reported by a participant.

Persistent injury - a self-reported musculoskeletal injury that has been symptomatic for at least one month.

Physically active - an individual that engages in athletic, recreational, or occupational activities that require physical skills and utilize strength, power, endurance, speed, flexibility, range of motion or agility at least 3 days a week.[22]

Predictive validity – the ability of an outcomes instrument to predict an established outcome.

Recreational athlete - a person that participates in physical activity as regularly as they choose as a means to improve health and well-being.

Responsiveness – An instrument's ability to detect change over time that is clinically meaningful.

Sensitivity – the ability of an instrument to detect change in the disablement status of a participant that has experienced a clinically important change.

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CHAPTER 2

LITERATURE REVIEW

Chapter 2

"Quality resides in the exercise of appropriate judgment in the pursuit of appropriate objectives" [1]

Literature Review

To better understand outcomes assessment, this review has been structured around three broad topic areas. The first area focuses on outcomes and the frameworks that are used to measure outcomes. The relationship between outcomes and quality assurance is also discussed. The second topic concentrates on the history of outcomes assessment in both the allied health fields and medicine. The last topic area focuses on describing disablement in detail while focusing on how outcome assessment is shaped by nomenclature and disablement paradigms.

Outcomes and Outcomes Instruments

Quality Assurance

Outcomes assessments are part of a framework used to determine quality assurance. Avedis Donabedian was one of the first scholars to include the term "outcomes" as part of his assessment of care process. He determined that quality assessment consists of three elements: 1) structure, 2) process, and 3) outcomes.[1-4] He asserted that all three elements are interrelated but can be assessed separately. The first two elements, structure and process, delineate the effects of health care resources and professional standards on quality assurance. His third element, "outcomes", pertains specifically to the quality of an intervention. The relationship between each of the components allows that a change in one will affect the other emphasizing that none of the elements exists in a vacuum.[5] This

relationship was the impetus for management systems in health care, which will be discussed later in this review.

Donabedian did not consider the three quality assurance components to be attributes of quality when he first defined quality assurance. Donabedian explained that structure, process and outcomes were sources of information in clinical practices. He further defined structure to include three things: material resources, human resources, and organizational characteristics. Process entails the activities used by a clinician to ensure health. These included diagnosis, treatment, rehabilitation, prevention and patient education.[4]

Donabedian did not arbitrarily create an abstract concept when he defined quality assurance. Rather, he created a method to systematically improve health care. A critical component in improving health care is the quality monitoring cycle. Within this cycle, health care systems examine performance by examining the current structure, processes used and the subsequent outcomes. Donabedian posited that the next steps in the quality monitoring system are just as critical. These steps include determining a pattern analysis, advancing hypothesis that explain these patterns, changing patterns, and finally re-assessing the resultant change.

To this end, Donabedian's work with defining quality assurance in health care parallels the current work employing evidence-based practice principles. Evidence-based practice is the integration of clinically expertise with the most up to date clinical evidence from systematic review. A crucial part of employing evidence based principle is having outcomes data from both research and databases readily available to apply to clinical questions. Evidence based practice provides the steps to answer questions about the

efficacy of treatments and diagnostic tests that clinicians in the health care commonly use.[3, 6, 7] In essence, evidence based practice examines the processes that health care practitioners utilize. This is particularly important because a poor outcome by itself does not suggest what needs to be done differently.[8] Thus, an organization may possibly incorporate both Donabedian's quality assurance principles and evidence based practice principles to create its own set of best practices while taking into account their typical patient's expectations and the resources at their disposal.[5]

Lohr has asserted that one patient's outcome may differ noticeably from another based on the values and preferences of the patient.[5] Kane cautions that for outcomes to be used correctly, or generalized to a larger population, they must be corrected for case mix differences.[9] He stated that outcomes are probability statements and should be treated as such. Proponents of evidence-based practice do not assume that all patients will react in the same way to a preferred intervention. This premise undermines the argument that using evidence-based practice suppresses clinical freedom and creates a cookie cutter approach to health care. On the other hand, some believe that some health outcomes can not be totally controlled due to extraneous factors such social and psychological variables.[10]

Outcomes Theory and Measurement

When Donabedian first wrote about quality assessment, he referred to an outcomes continuum that ranged from full recovery on one end to death on the other end. Death is rarely an occurrence in rehabilitation outcomes so outcomes are usually measured on different continuums. On one end of the continuum is an able-bodied individual while on the other end is a patient who is experiencing disability. More recent models have even

included quality of life factors in the continuum. Unfortunately, disablement cannot be altogether avoided after a muscuoskeletal injury. Therefore, the main goal in the rehabilitation is to treat musculoskeletal injury so as to avoid further disablement; and typical interventions include surgical procedures, therapeutic exercise, and therapeutic modalities.

Outcomes measures can be placed into three categories and include “patient reported”, “clinician reported”, and “descriptive dataset”. Patient reported outcomes have recently gained acceptance because they are predictive of patient return to function. In fact, a few recent studies demonstrated that self-report outcomes predict a patients’ return to functional activities better than clinician reported outcomes.[11, 12]

Clinician-reported outcomes give the clinician the opportunity to record the patients’ status from their perspective. Most outcomes research tends to use clinician reported measures because of its quantifiable nature. Many health care professionals believe that legitimate research must be quantifiable and hence clinican-report outcomes are typically used. This trend is also ingrained in a managed care system. Many insurers want to see tangible results for treatment and instruments such as isokinetic dynamometers and arthorometers provide tangible “hard” evidence of improvement.[9]

Descriptive dataset outcomes are unlike “patient-reported” and self-report” outcomes. Whereas, “patient-report” and “self-report” outcomes give information about changeable variables, descriptive datasets give information about patient demographics. Demographics in descriptive datasets include age, gender, diagnosis, employment status, insurance, and income and education level. Although demographic variables are typically out of a clinicians’ control, they can influence the outcomes of an intervention.

The key difference between self-reported outcomes and clinician-reported outcomes is the type of information that is garnered about the outcome. As the word self-report implies, a self-report outcomes tool is subjective since it takes into account a patient's perception. By being subjective, self-report outcomes take into account the patient's expectations and values. In contrast, a clinician-reported outcome tool is composed of objective information gathered during an injury evaluation or treatment. Independently, both can give meaningful information about a patient's current limitations and status change. When used in conjunction with each other, a clinician gains a clearer picture of a patient's progress. In addition, descriptive datasets allow clinicians to better understand patterns found within patient groups. This information helps clinicians to use dataset trends in research when evaluating and treating patients.

Outcomes measures may be unidimensional or multidimensional in nature. A unidimensional outcomes measure evaluates only one aspect, or domain, of a patient with respect to their injury. A clinician who uses a pain scale to measure altered levels of pain based on an intervention has only covered one dimension in the patient's recovery. Conversely, a multidimensional outcomes measure would include measures of physical functioning, physical symptoms, social functioning, etc., in addition to a pain measurement scale. Multidimensional outcomes assessments provide a broader picture of patient recovery and clinicians prefer them to their unidimensional counterpart.

Typically unidimensional measures are based on measures of impairment. In research, a positive change in impairments is thought to have a similar change in disability. This is referred to as using impairment outcomes. The use of impairment outcomes stems from the need to quantify change. In the 1980's, laboratory measures of muscle force and

range of motion became more popular because they were objective. The flaw in rationale is that an impairment does not necessarily reflect a person's capacity to perform functional activities and activities of daily living.[13] As stated by the former editor of the journal *Physical Therapy* "Ironically we accepted the premise that a patient complained of disability to justify the initiations of treatment, but then decided that we needed more than the patient's feedback to justify discharge or treatment effectiveness."[13] Furthermore, by using impairment outcomes, the researcher assumes that there is a positive and linear relationship between impairments and disability.

Outcomes History

Outcomes assessment in the health care has a history that dates back to the 19th century. Even with this long history, studies show that Americans receive about half of the recommended medical care.[14] Today outcomes are inextricably linked to managed care systems such as Medicare and Medicaid. The original objective and the one that still remains is to improve the health care process. Therefore, the debate about outcomes assessment is not about whether it should be done. Rather, the debate lies in the methodology of outcomes assessment. This section will give a brief history of outcomes assessment and will then focus on two of the most common methods used today in health care.

Outcomes measurement is dated back to Florence Nightingale in the 1850's when she measured mortality rates in soldiers that fought during the Crimean War. She has been credited with reducing motality rate from 60% to 1% when she used data that she collected to improve the care process.[15]

Although outcomes were measured in the interim they did not become popular until the 1980's for a number of social and economic reasons. The big push came through managed care and legislation mandated during the Reagan era when mounting costs of health care became an issue. Along with rising costs came theories about how to efficiently and effectively run large health care systems. The leaders in outcomes assessment development were medical doctors and public health officials. Between 1984 and 1987 Medicare shifted from a retrospective payment system to a prospective payment system using a grouping system based on diagnosis.[16] These changes did not altogether reduce costs for another set of reasons: variability and accountability.[16]

Outcomes Research

Dr. John Wennberg testified before the Congress in 1985 stating that systematic outcomes measurement was needed to reduce variation in medical practice and to control health care costs.[10, 17] He used geographical data to prove that not all commonly used treatments benefited the patient and therefore should be seen as wasted money. He proposed that large databases should be used to gather data regarding outcomes. More specifically, he suggested that insurance claims databases should be used as the source of this information since this information was already being collected. Dr Wennberg anticipated that his plan would identify the best treatment options for health care providers to choose from. The resultant use of outcomes data was termed outcomes research.

In 1989 the Agency for Health Care Policy and Research (AHCPR) was created by congress to help with cost containment and variability in practice.[17] The AHCPR used a retrospective analysis of databases that included insurance claims, scientific reports,

hospital records and what are known as soft outcomes to determine the worth of medical procedures. Soft outcomes are termed as such because they tend to focus on patient satisfaction.[17]

In 1990, Dr Wennberg published a study using retrospective analysis that showed that non-invasive treatments for the prostate produced outcomes that were just as successful as more invasive surgical techniques that were commonly used. He emphasized that increased monetary costs did not ensure better quality of life and questioned why these less costly procedures were not used as often as their counterparts.

Other researchers who contended that outcomes research that uses database systems are inherently flawed contested his findings. In fact, a similar study performed by Concato and Feinstein on the same set of patients revealed a higher mortality rate in the patients that received a non-invasive prostate surgery. In the study, Concato claimed that outcomes analysis based on outcomes that are collected for different purposes and for insurance payment have the potential for distortion.[18] The call for randomized clinical trials and meta-analysis of previous trials continues to be the favored by opponents of outcomes research.

Since its start the AHCPR has gone on to publish at least 19 clinical practice guidelines by using outcomes research. The Clinton administration, which was the biggest backer of outcomes research, invested heavily in the AHCPR (ex. an estimated 700 million dollars in 1998).[18] The Health Care Financing Administration (HCFA) and the Joint Commission's Agenda for Change (JCAFC) are similar models that have used outcomes research to create practice guidelines. In the 190's these two organizations began creating more rigorous requirements for reporting outcomes in hopes of

eliminating distortion. The JCAFC has even started to focus more on indicators and report cards that address the actual outcomes rather than the structure or process of an organization.[15]

Outcomes Management

Within the same timeframe, Ellwood proposed the use of prospective experimental outcomes data to effectively evaluate medical treatment. Ellwood advocated health care reform to improve and ensure quality in medical practice.[19] He believed that systematic outcomes also stimulated competition among providers thus giving the consumer the upper hand. Ellwood believed that the ultimate goal for accountability is to find the best providers in a system and not the best treatment options. This process is referred to as outcomes management.

Although Ellwood has been credited with the outcomes management movement, the focus on outcomes has shifted to identifying best practices via critical pathways rather than the best providers. The idea of finding the best providers still remains a viable option in some managed health care systems, though. Kaiser Permanente has instituted a program whereby practice groups are given financial incentives for following practice guidelines.[20]

Outcomes management is a pragmatic approach to outcomes assessment. The rationale for an outcomes management system is to evaluate efficiency but not necessarily at the expense of effectiveness. In outcomes management, key outcomes are first identified then processes and practices are evaluated to determine how desired outcomes are reached. Similar to outcomes research the end product in outcomes management are practice guidelines.[16] These practice guidelines are also referred to as

critical pathways and are treatment paths for specific diagnoses. These treatment paths typically use a multidisciplinary team approach to coordinating apt care at the appropriate time in a traditional health care system.[15, 17]

The rationale behind outcomes management is to better manage the health care process by providing outcomes to the clinicians that will deliver an intervention. In theory, outcomes management adds consistency to a clinical effect and money expenditures by managing the processes that clinicians choose from. One criticism in managed care is that outcomes are evaluated by a group of clinicians that may not have the appropriate training in research methodology. In contrast, researchers who are not necessarily clinicians typically perform outcomes research.

Disability

The theoretical foundation of appropriate outcomes assessment in health care is disablement theory. One frustration in understanding disability is the failure of researchers and data collection agencies to use consistent disability definitions.[21, 22] This section focuses on defining disability, explaining the components of the disablement process, and providing popular models of disability.

Disability has been defined by a number of different researchers. The first definitions of disability were used in the 1950's when the Commission on Chronic Illness tried to measure disability prevalence. At that time, disability was measured as limitations in three areas: 1) in activities of daily living, 2) in functional capacity, and 3) in the ability to work, tend to home and/or family or attend school. Two more recent disability definitions come from the Institute of Medicine (IM) and the World Health Organization (WHO). The IM published a 1991 book titled *Disability in America* and used the

concepts put forth by the sociologist Saad Nagi. He defined disability as "the inability or limitation in performing socially defined roles and tasks expected of an individual within a sociocultural and physical environement".[22] The WHO also published a book titled *International Classification of Impairments, Disabilities, and Handicaps* (ICIDH) in 1980 that contained a definition of disability provided by Phillip Wood.[23] Wood defined disability as "any restriction or lack of ability to perform an activity in the manner considered normal for a human being".[22, 24]

The WHO later expanded the definition to include "the compound of integrated tasks, skills and activities expected of a person or of the body as a whole" in their most recent book *International Classification of Functioning Disability and Health* (ICF).[24, 25] The ICF has a different classification system than its earlier counterpart, the ICIDH. I will address Wood's disablement scheme used in the ICIDH because it has clearer definitions and an easier schema to understand and apply to outcomes and research. The ICF was published as a manual for health care practitioners to classify the effects of a disease state. Although the new complexity of the model makes it an ideal source to classify a health condition, it does not lend itself to the purpose of this paper.

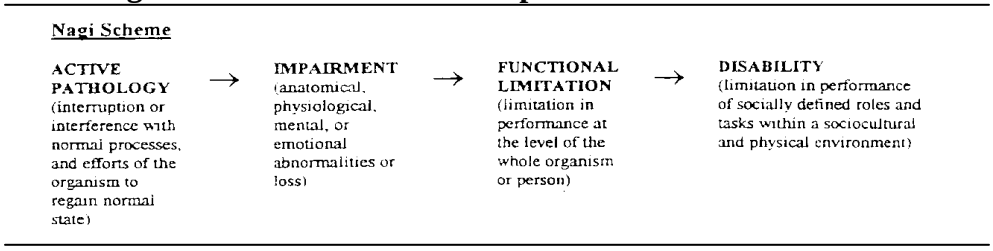
At face value, both definitions are similar. An important distinction is that Nagi and Wood have different disablement schemes. The key difference is that in Nagi's scheme, disability refers to social functioning, while in Wood's scheme disability refers to organismic functioning. The next section will elaborate on how the two models differ.

Disablement Process

Nagi's disablement scheme is built on four interrelated but distinct concepts: 1) active pathology, 2) impairment, 3) functional limitations, and 4) disability (see Figure 2.1). The

first step in the disablement process, active pathology, results from infection, trauma, metabolic imbalance, degenerative disease processes or other etiologies. Impairment, the next concept along the schema, refers to a loss or abnormality of an anatomical, physiological, mental or emotional nature. Next, a functional limitation is the manifestation of a loss or an abnormality at the level of the organism as a whole. Both impairment and functional limitations involve function, but the difference is the level at which the problems are revealed. Impairments are losses directly at the site of injury (eg. strength) while functional limitations are performance restrictions in tasks that use the whole body (eg walking). Nagi emphasized that not all impairments and functional limitations lead to disability but he believed that functional limitations are the most direct way through which impairments contribute to disability. [22] For example, a person suffering from an injury may have a number of impairments. According to Nagi's model, if the same person does not have any functional limitations, then that person should have little disability. The converse is not true, though. A person who has few impairments, but has more functional limitations, should have a high level of disability. The severity of disability is dependant on three factors: 1) the individual's response to the situation, 2) others' response to the situation, and 3) characteristics of the environment. In effect, disability in Nagi's model takes the injured person's as well as others people's values into consideration when determining the severity of disability.

Figure 2.1 Nagi's Disablement Scheme. Reproduced from Jette[25]



Wood's scheme is also built on four distinct concepts: 1) disease, 2) impairment, 3) disability, and 4) handicap (see Figure 2.2). A disease is defined as an abnormality within the individual. The disease state becomes impairment when a person becomes aware of it. Wood specifically calls this process "exteriorization".[23]

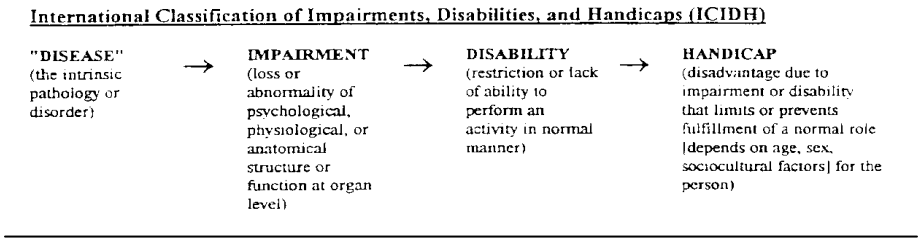
Impairment is "any loss or abnormality of psychological, physiological, or anatomical structure or function at the organ level".[23] Although both Wood's and Nagi's impairment definitions are similar, I believe that Wood's model is limited by his exteriorization belief. One of the potential limitations in exteriorization is that it does not explain why patients may have impairments without an active pathology. For example, an ankle study performed by Verhagen et al.[26] demonstrated that pain was still present in subjects 6.5 years after a lateral ankle sprain, which is longer than the normal healing time frame. Therefore, pain (an impairment) is present even when pathology is not.

The similarities in Nagi's and Wood's disablement schemes stop at the next step, disability. Disability, as mentioned earlier, is any restriction in the ability to perform an activity that is considered normal for a human being. Disability, as defined in Wood's model, has a broader definition when compared to Nagi's disability definition. Wood's definition encompasses both the functional limitations definition and disability definition found in Nagi's model. Problems may arise from such a broad disability definition because subtle distinctions between functional performance and daily activity performance may be lost. For example, a person may have problems with squatting (functional performance), but may not have a problem with their desk job (activity performance). In Wood's model, both of these problems are classified as disabilities.

Because the disability definition is so general, it may not be as sensitive as the definition in Nagi's model.

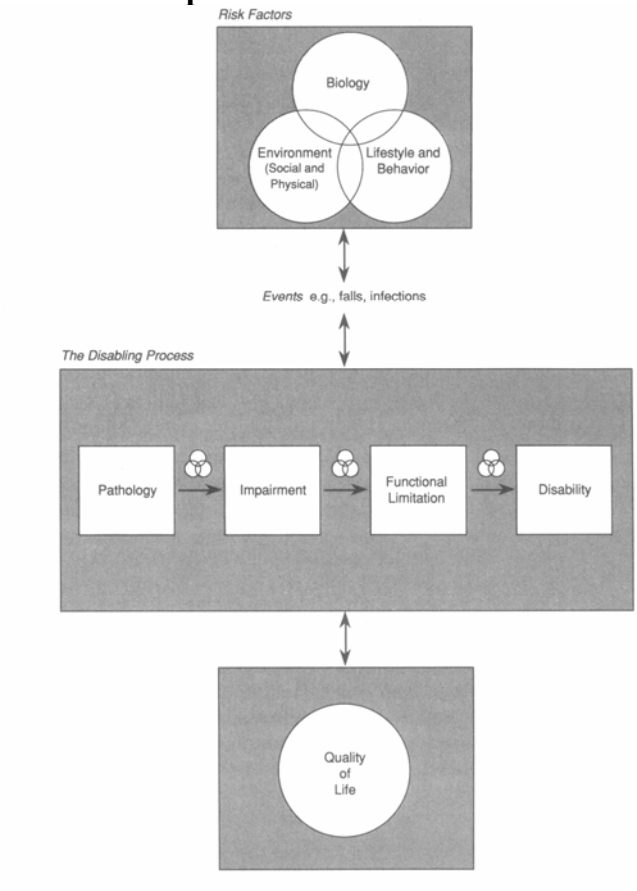
Handicap is the last component in Wood's disablement model and involves the "disadvantages" of a disabled person that limit a disabled person from fulfilling the roles that are normal for them. "Disadvantages", as used in the handicap definition, has a socialized meaning so that they occur because of other people's beliefs and/or comfort with a disabled person.

Figure 2.2 Wood's and the ICIDH Classification Scheme. Reproduced from Jette.[25]



Since their creation, both Nagi's model and Wood's model have been expanded to include another concept termed quality of life. Newer models that incorporate a quality of life component are known as Health Related Quality of Life models (HRQOL). Quality of life is defined as the "performance of social roles, physical status, emotional status, social interactions, intellectual functioning, economic status, and self perceived or subjective health status".[23] The IM expanded on Nagi's original disablement model and added a quality of life component to the margin of the scheme (see Figure 2.3). The IM believed that quality of life affects and is affected by the outcomes of each stage of Nagi's disablement model.[23] Therefore, QOL was not placed after disability in the disablement schema. The WHO is now also using a HRQOL model, which they term as a biopsychosocial model, in their classification system of disabilities.[24]

Figure 2.3 Institute of Medicine Health Related Quality of Life Disablement Scheme. Reproduced from Pope and Tarlov[23]



Disablement Components: Sequential or Cyclic

Both Nagi and Wood believed that the disablement components are sequential in nature. Nagi stated that limitations at lower levels of organization may be reflected at higher levels but the reverse is not true. For example, functional limitations may affect the level of disability but the opposite is not true. A recent study by Michael may provide some evidence to the contrary. There are some limitations to Michael's study so that the evidence should be examined with some skepticism, but the argument that the researcher makes may have implications for future resaerch.[27] Michael performed a review of 34 studies that dealt with muscle atrophy in both human and animal models. She applied a stringent critical appraisal to each study while applying a disablement model to themes

found in the literature. She found that the studies fell into three categories according to research trends: 1) adaptation, 2) injury/loss, and 3) integrity. She asserts that the literature establishes a cyclic nature of impairments and functional limitations. She feels that not only does form (impairment) follow function (functional limitations), but function also follows form. For example, an athlete may have a knee injury that causes impairments such as pain, range of motion loss, and muscle atrophy. The impairments then cause the patient to have problem with functional activities that require quadriceps strength. Because the patient is limited from doing functional activities, the patient subsequently compensates by using the other leg. In response to decreased use, the quadriceps undergoes more atrophy. This example not only shows how impairments affect functional limitations, but how functional limitations further affect impairment.

There are two limitations to Michael's study. The first limitation is that the researcher used flawed impairments and functional limitations definitions. Michael defined *impairment* as changes in tissue mass, composition, morphology and histochemistry. In most other disablement models, this definition applies to *pathology*. *Functional limitations* were defined as changes in contractility, peak force, and dynamometry. In other disablement models *functional limitations*, as defined by Michael, better matches the definition of *impairments*. The study's second limitation was that some of the studies might not apply to physically active humans. Seven studies were performed on animal models while some studies measured atrophy as a result of prolonged bed rest, weightlessness, or old age. It may be difficult to make generalizations from these articles to people that are physically active.

Relationships Between and Among the Disablement Components

A common, but possibly mistaken, belief is that the relationships between and among the disablement components are positive and linear. Buchner et al. has shown that there may be a curvilinear relationship between impairments and functional limitations.[28, 29] In his work with muscle force production and disability, Buchner shows that physical therapy benefits partly depend on the status of the target population. He found that rehabilitation in frail adults had a greater effect on functioning than it did on near frail and asymptomatic adults. When graphed, the relationship was found to be curvilinear in nature. This study shows the relationship between disablement and expectations. A sedentary, or frail, adult may not require a higher level of function so that they may be affected by a musculoskeletal injury in a different way then an adult whose day-to-day activities require a higher level of function such as an athlete. This study also implies that a more linear relationship may exist among disablement components in patients who have more severe injuries than in patients that do not.

A study performed by Braun[30] provides evidence that may support this idea. Braun followed 467 patients with a history of ankle sprain to identify impairments and functional limitations that subjects still had. Subjects completed a survey with questions about their level of impairment and function at six months and eighteen months post-injury. Braun stratified subjects into either a mild/moderate symptoms group or a moderate/severe group. He found that patients with moderate to severe residual symptoms had significantly greater difficulties with functional activities than did subjects with mild to moderate symptoms. It is intuitive that a subject with greater signs and symptoms would have more functional limitations, but not all research applies this

premise to their research analysis. Researchers should consider stratifying injury by severity when analyzing the relationships between the disablement components. In doing so, they may avoid confounding their results and gain more insight into the relationship between disablement components.

Trends in Rehabilitation Literature

Trends in rehabilitation research can be placed into three categories: 1) studies that improperly use disablement components, 2) studies that compared changes in impairments to changes in functional limitations and/or disability, and 3) studies that compared changes in functional limitations to changes in disability. The ankle literature is a particularly good area to illustrate the above trends and hence will be used to explain the trends. Although the primary focus for these trends is within research, there is still a connection with clinical practice. Changes for clinical practice are derived from research. Therefore, consistent use of correct nomenclature has an effect on collective consciousness of certified athletic trainers who engage in evidence-based practice.

Studies that Improperly Use Disablement Components

The studies that I focus on in this section have improperly used disablement schemes by measuring multiple disablement components but claiming to have measured only one. The authors then try to make generalizations about the relationships between disablement components.

A study by de Bie et al.[31] tracked 24 subjects with lateral ankle sprains two and four weeks post-injury. The purpose of the study was to predict ankle injury severity during hospital admission and compare the results to measures taken at two and four weeks post-injury. The outcome was defined as full functional recovery. The researchers compared

clinical tests to a function score assessment that included questions regarding pain, instability, “weight bearing” status, swelling and gait pattern. They found that the function score was most predictive of being a positive outcome and calculated function score to be 97% sensitive and 100% specific. The flaw in the researchers methods was that the assessment tool also contained measurements of impairments. Therefore, the authors cannot make the claim that function alone was a predictor of a positive outcome. Rather, they can say that an assessment that includes both impairments and functional limitations measurements is most predictive of a positive outcome.

Similarly, Pugia et al.[32] followed 29 subjects with an acute lateral ankle sprain 10 days post-injury. The purpose of the study was to find the relationships between swelling, “weight bearing” status and functional ability. They found that there was not a significant relationship between swelling and functional ability, but they did find that weight bearing status and function had a moderate correlation. Like the de Bie et al. study, Pugia et al. used a function score measurement that also contained impairment measurements. The results of the study may not have changed had the researchers strictly used a true function score, but they cannot conclude that swelling (impairment) does not correlate with functional level alone.

The danger in using improper terminology is that the results that the researchers report may be misleading. For example, a clinician may read that function testing alone provides the most useful information to determine disability. The clinician may decide to use function testing only when determining a patient’s outcomes. Unfortunately, if the researchers used a function instrument that contains both impairments and functional limitations, the researchers have misinformed the clinician. The more appropriate action

for the clinician may be to use a multidimensional outcomes instrument that measures both impairments and functional limitations.

Studies that Compared Changes in Impairments to Disability

The studies that follow in this section compared impairment changes to functional limitations and/or disability to gain further insight into the ability of clinical tests to predict return to function.

Wilson et al.[33] measured the reliability and responsiveness of range of motion testing (impairment), volumetric swelling testing (impairment), self-report of perceived ability (functional limitation), and motor score (functional limitation) in relationship to ankle sprain recovery. Thirteen subjects were measured for the above at 3 days and one week post-injury. Ankle sprain recovery was defined as the number of days between the initial injury and the return to sport participation without limitations. The researchers found that all the tests were reliable (ICC = .86-1.0), but only swelling, perceived athletic ability and motor score were responsive to change. The standard error of the mean for range of motion was so large that the measurement was not sensitive to change. The researchers hypothesized that range of motion measurements were not sensitive because only less severe ankle sprains (grade I and II) were used in this study.

Alonso and Khoury[34] used 27 subjects with acute ankle sprains and performed four stress tests to determine the ability of each test to predict recovery. The researchers used four tests for syndesmotic ankle injury to measure laxity or pain (impairments). The tests included an external rotation test, a squeeze test, a dorsiflexion compression test, and a palpation test. Each subject was tested within one week of injury and the test results were

compared to recovery time. Recovery time was defined as time until the subject could complete three tasks: 1) walk 10 meters without pain, 2) return to training, and 3) return to competition. Inter-rater reliability varied for the four tests with the external rotation test having the highest level of agreement between examiners (.36-.75). They found that there was not a significant relationship between a positive test and return to function.

Wilson et al. did find that volumetric swelling (impairment) was predictive of disability, but Alonso and Khoury did not find that impairments (pain and laxity) were predictive of disability. The difference in the results may be because of the type of impairment used in each study. A review article by Vela et al.[35] did demonstrate that ankle laxity tests have low sensitivity and specificity. Perhaps laxity tests are not predictive of return to function because the low sensitivity and specificity values. The same may not be true for swelling, though. Intuitively, clinicians know that swelling (impairment) changes quite dramatically in the first week after an ankle sprain. In the case of Wilson's study, swelling was a good disability predictor because it is responsive to change. One take home message may be that only certain impairments are good predictors of disability. More studies need to be performed to determine whether impairments, as a whole, are predictors of disability.

Risberg et al. found that impairments were able to predict disability level in a long-term outcomes study performed on patients with ACL reconstruction. The impairment measures used were pain, range of motion, flexion and extension strength as measured with an isokinetic dynamometer, and knee joint laxity. The disability measurement tool used was the Cincinnati knee score. They found that knee pain and extension strength were most predictive of disablement with pain being the most telling in reassessment at 3

and 6 months. Although the Cincinnati knee instrument is a considered a disability scale, it also has impairment measures of pain and swelling included in the scale. Intuitively, a measurement technique and a scale that measure the same variables will reveal high correlations between the variables.

Studies that Compared Changes in Functional Limitations to Disability

I will discuss three studies that used functional limitations as disablement predictors. Of the studies discussed thus far in this review, I believe that they are the strongest studies, especially those by Wilson and Gansneder[11] and Cross et al[12]. These studies are particularly good because they use a multivariate design when determining the relationships between the disablement components. A multivariate design is better suited in finding the relationships among disablement components because it accounts for the complexity of the relationships more so than a bivariate design would.

Gerber et al.[36] performed a 6-week and 6 month follow-up study on subjects who suffered from a lateral ankle sprain. Their purpose was to update the data regarding epidemiology and disability with ankle injuries. Subjects completed a questionnaire regarding injury mechanism and history, physical examination, and functional testing. Physical examination consisted of five tests: stability testing, palpation, swelling, range of motion, and strength measurements. Functional testing was a three hop for distance test performed in the anterior and lateral directions. The researchers controlled for rehabilitation as all subjects were placed on the same protocol and they took follow-up measures for 87 patients at 6 weeks and 80 patients at 6 months. An acceptable outcome was defined by three criteria: 1) the subject was pain free, 2) the subject had no self-reported decrease in function, and 3) the subject could successfully perform a functional

hop test at 80% of the uninvolved leg. At 6 weeks, 45% of the subjects had an acceptable outcome, whereas 60% of the subjects had an acceptable outcome at 6 months post injury. The percentage of functional limitations and impairments present were approximately equal at 6 weeks. By 6 months, impairments were present at higher percentages than were functional limitations. Interestingly, only 2% of the subjects had functional differences and half of the subjects that had an abnormal physical examination had an acceptable outcome. This implies that although impairments may be present, the patient is still functional and disability free.

The purpose of the Cross et al.[12] study was to determine the association of self-reported and clinical measures to a positive outcome. A positive outcome was defined as the number of days before the subject was able to return to sport. Eleven subjects participated and completed a pain visual analog scale (VAS), a global functioning questionnaire (GF), the SF-36, and a physical examination. The physical examination consisted of active range of motion, isometric strength, and ambulation measurements. A regression demonstrated that the GF, SF-36 and ambulation measurements were significantly related to time to return to sport (disability). The three measurements accounted for 37.3% of the variation in disability.

Wilson and Gansneder[11] performed a prospective multivariate study to determine the ability of functional limitations and impairments to predict return to function in subjects with an acute ankle sprain. Like the study performed by Cross et al., disability was defined as the number of days to return to sport. Range of motion, joint swelling, activity score and self-report athletic ability measurements were taken approximately 3 days from injury onset. Self-report athletic ability is similar to a VAS scale in that the subjects rated

their perceived athletic ability on a scale of 1-10. The activity score was composed of six tasks: 40-meter walk, 40-meter run, figure eight run, single hop for distance, cross-over hop test, and stairs hop test. A dichotomous scoring system was used for each of the tasks. They found that impairment scores accounted for one-third of the variability in disability score. By adding functional limitations measurements, the accounted for variance increased to 67%. Functional limitations alone accounted for 66.5% of the variability in disability scores so that impairment measurements did not add significantly to the model.

Conclusions

Outcomes assessments are a vital part of quality assurance in health care that has roots in disablement theory. The controversies with outcomes assessment lie in two phenomena: 1) the link between outcomes and managed care and the subsequent ways in which they are measured and 2) the use and misuse of disablement theory as the theoretical underpinning of outcome measurement. Nonetheless, the advancement of appropriate and cost effective health care is highly dependant on continued outcomes assessment. Athletic training, as a profession, has yet to include regular outcomes assessment into daily practice as seen by the dearth of athletic training specific outcomes tools and literature. However, it is worth noting that athletic training, unlike other health care professions, is not constrained by managed care. Thus, our profession has the freedom to approach outcomes assessment, research, or management in a way that best suits the needs of the clinician and the expectations of the patient. We are consequently in

a very important and critical time where we can use established best practices rather than anecdotal evidence as the foundation for our profession.

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Chapter 3

Transient Disablement in the Physically Active with Musculoskeletal Injuries: A Descriptive Model

ABSTRACT

Objective: Disablement theory has been described by a number of investigators as the sequence of events that occur after an injury. Musculoskeletal injury has been described within the context of disablement theory, but little research has been conducted to establish how disablement is experienced in the physically active. Therefore, the purpose of this project was to describe the effects of sudden, transient disablement on physically active persons with musculoskeletal injuries.

Design and Setting: Interviews were conducted using grounded theory methods and a semi-structured interview guide. The interview guide was based on a disablement model and probing questions were classified into four areas: 1) impairments, 2) functional limitations, 3) disability and 4) quality of life. Subjects were recruited using theoretical sampling and were identified by a certified athletic trainer if they met the physical activity criterion. A group interview was used to confirm the existing model after the individual interviews were conducted.

Participants: Thirty-one physically active subjects (14 men, 17 women; mean age 21.2 years, range 14-53 years; 18 lower extremity injuries, 13 upper extremity injuries) with a symptomatic musculoskeletal injury participated in individual interviews. Six physically active subjects (3 men, 3 women; mean age 22.2 years, range 16-28) with a history of musculoskeletal injury participated in the group interview.

Measurements: Data for the individual and group interviews were collected through open-ended, tape-recorded interviews that lasted approximately one hour. Interviews were transcribed verbatim and all personally identifying information was removed. The

interviews were analyzed through a constant comparison method and data were collected until saturation occurred.

Results: Fourteen disablement components emerged and each component was generalizable to most musculoskeletal injuries. Impairments were marked by four complaints including pain, decreased motion, decreased muscle function and instability. Functional limitations were denoted by problems with changing directions, daily actions, skill performance, and maintaining positions. Disability was marked by problems with maintaining overall fitness and participation in desired activities. Lastly, problems in quality of life included altered relationships, increased uncertainty, decreased overall energy and changes in mood. The model was confirmed in the group interview.

Conclusions: The results of this study help certified athletic trainers to better understand how disablement manifests in the physically active and has implications for how disablement outcomes are measured. The groundwork for a conceptual model of disablement in the physically active has been established. Further research should be conducted to establish relationships between the model's components and disability in the physically active.

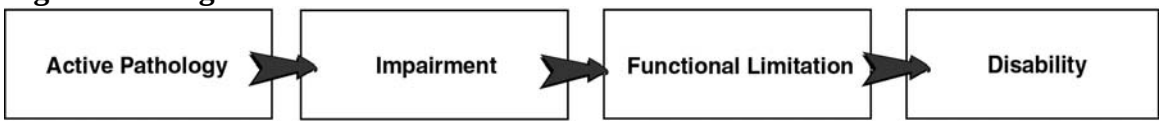
Key Words: disablement, conceptual model, physically active, qualitative research

INTRODUCTION

Many millions of people cope with disability daily. Estimates reveal that as many as 35-43 million Americans have one or more disabling conditions causing an economic burden exceeding 170 billion dollars annually. [1] Injury is the leading cause of short-term and long-term disability and is the most developed area within the entire province of disability prevention research.

Disablement paradigms have been used in allied health research to provide the framework for disability, the definition of the components, the sequence of the components, and the overall effect of disability on a person [2-14]. The simplest disablement model, described by Saad Nagi[10], has four components: 1) pathology, 2) impairments, 3) functional limitations and 4) disability (see Figure 3.1). Disability is the end product of the disablement process but is not an unavoidable consequence of having a pathology, an impairment, or even a functional limitation.[15] In fact, disability is preventable and disability prevention models assume that disability can be prevented at any point in the condition's natural history.[13]

Figure 3.1 Nagi's Disablement Scheme



One question that has not been investigated is whether the most used disablement paradigms are applicable to a physically active population. No research, to date, has attempted to develop a conceptual understanding of disablement as it relates to physically active persons. Rather, most research in the area of disability has focused on the discrete

components of the disablement process and their effects on disablement. Furthermore, rehabilitation research that measures disability rarely operationally defines disability [16-18]. Does disability have the same meaning for a physically active person? Do all components in the disablement scheme hold equal value for a physically active person? Ultimately, these questions should be answered so that researchers can appropriately and validly measure clinical outcomes [14, 19].

The purpose of this study was to describe the disablement process as experienced by a physically active person suffering from a musculoskeketal injury. The theory underlying the disablement scheme as used by the Institute of Medicine (IOM) served as the foundation for the qualitative interviews. A qualitative approach was appropriate in this study because it better develops the lived experience of disablement. Since little is known about this topic, this study was exploratory in nature and helps to establish a baseline understanding of the conceptual model.

The significance of this study is multifold. By better understanding the disabling effects of musculoskeletal injury, certified athletic trainers will be more effective clinicians in three areas: 1) making appropriate treatment decisions, 2) communicating with athletes regarding disablement, and 3) adding to the known body of knowledge about treatment and rehabilitation interventions. In addition, a conceptual model will direct the mode in which disablement is measured in our profession.[9, 14, 20, 21] This is particularly important when measuring outcomes as a result of treatment intervention. We expected that through this series of interviews, distinct themes would be uncovered under each of the four disability components: impairments, functional limitations, disability, and quality of life. Furthermore, we expected that meaningful disablement descriptors

would be uncovered in each theme. Collectively, this information is useful in creating self-report outcomes surveys to measure disability in recreational and competitive athletes.

METHODS

Design

The purpose of the study was to better understand the disabling effects of short-term disability on the physically active. Therefore, a low-level grounded theory that describes the disabling events and their effects on these athletes is an appropriate method. Using a grounded theory is especially relevant because theory in the allied health fields has described disability as a process with distinct components [22, 23].

The institutional review committee at the university at which data were collected approved the procedures that were used in this project. Informed consent was obtained from all subjects prior to participating in this study. All personal identifying information was removed from interview transcriptions to ensure participant confidentiality.

Participants

The participants were selected using the principles of theoretical sampling.[23] Since the purpose of this study is to understand the disabling process of injury in the "physically active", participants were included if they met a physical activity definition. Physical activity was operationally defined as someone that engages in athletic, recreational, or occupational activities that require physical skills and utilize strength, power, endurance, speed, flexibility, range of motion or agility at least 3 days a week.[24] This definition was

adapted from the definition given by the National Athletic Trainers Association for "physical activity". The definition was altered slightly to give a time frame "3 days a week". To ensure that the participant had truly experienced disablement, participants must have been limited from physical activity for at least two consecutive days as a result of their musculoskeletal injury. We stratified the population by two characteristics: 1) injury type and 2) physical activity level to ensure that the phenomenon of interest was fully disclosed. Injury type was stratified by either lower extremity or upper extremity injury. Both recreational and competitive athletes were recruited to discern whether the disabling process was different for each group.

The total sample included 31 participants (14men, 17 women; mean age 21.2 years, range 14-53 years; 18 lower extremity injuries, 13 upper extremity injuries) from four data collection sites. The competitive athlete sample was collected from a Division I intercollegiate and club sports athletics program at a major university in rural Pennsylvania that has over 650 varsity athletes in 29 sports competing yearly. In addition, competitive athletes were recruited from a high school athletic program in rural Pennsylvania that has students competing in 16 sports yearly. Recreational athletes were recruited from the student population of a major research university in rural Pennsylvania and from an outpatient orthopedic center in rural Pennsylvania. Tables 3.1 and 3.2 illustrate participant demographics.

Table 3.1 Total Participants Stratified by Setting and Injury Type

Setting	Upper Extremity Injury		Lower Extremity Injury	
	Male	Female	Male	Female
Collegiate	5	4	4	5
High School	2	0	0	4
Recreational	1	1	3	2

Table 3.2 Participant Demographics and Diagnosis

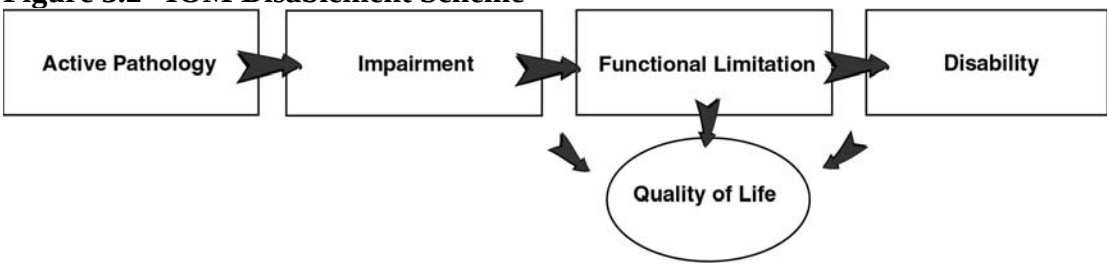
Participant	Gender	Age	Activity	Diagnosis
1	M	19	Gymnast	Ulnar fracture
2	F	19	Cheerleader	Lumbar spondylosis
3	M	21	Gymnast	Rotator cuff tendonitis
4	M	21	Basketball	ACL reconstruction
5	M	16	Swimmer	Biceps impingement
6	F	22	Cheerleader	Thoracic vertebra stress fracture
7	M	20	Volleyball	Wrist sprain
8	F	19	Gymnast	L4-L5 disc herniation
9	M	22	Baseball	Shoulder bursitis and Rotator cuff tendonitis
10	F	20	Gymnast	1st MTP UCL sprain
11	F	23	Gymnast	ACL reconstruction
12	F	18	Tennis	Mid-foot sprain
13	F	18	Cheerleader	Torn shoulder labrum
14	F	19	Gymnast	Elbow UCL sprain
15	M	21	Rugby	Mid-foot sprain
16	M	20	Gymnast	Bi-malleolar fracture
17	M	18	Volleyball	3rd degree lateral ankle sprain
18	F	18	Gymnast	Elbow dislocation
19	M	20	Volleyball	Torn shoulder labrum
20	F	21	Runner	Metatarsal stress fracture
21	F	22	Swimmer	Shoulder multi-directional instability
22	F	33	Runner	Hip flexor strain
23	M	54	Golf	Shoulder adhesive capsulitis
24	M	28	Golf & Runner	ACL reconstruction
25	M	29	Basketball	3rd degree ankle sprain
26	F	16	Basketball	3rd degree ankle sprain
27	F	16	Soccer	Bi-malleolar fracture
28	M	20	Gymnast	Fractured navicular
29	M	15	Basketball	Bankhart repair
30	F	16	Softball	Hamstring strain
31	F	14	Volleyball	ACL reconstruction

Data Collection and Analysis

Data were collected through a tape-recorded, semi-structured interview. The interview took place while the participant was still experiencing symptoms from a current musculoskeletal injury. The interview guide consisted of closed and open-ended questions and was built around the disablement model adopted by the Institute of Medicine and included four themed sections: impairment, functional limitation, disability and quality of life (see Figure 3.2). A comprehensive list of descriptive terms for common impairments, functional limitations, disability and quality of life issues was

provided so that the participants could refer to and choose problems that described their disablement process. The terms were taken from numerous self-report and clinician-report outcomes instruments. The participant was first presented with the list of impairments and was asked to identify all that applied to their current injury. Paticipants were then asked to elaborate and describe how each of the problems affected them. More specifically, participants were asked to give examples and qualifiers such as time frame and severity. The same procedures were used for functional limitations, disability and quality of life.

Figure 3.2 IOM Disablement Scheme



Interviews were transcribed verbatim with all personally identifying information removed. Following transcription, each interview was checked for accuracy by the interviewer.

The primary analytic technique was constant comparison, a process through which each piece of data is compared and contrasted with other data to build a conceptual understanding of the categories within disablement.[23] Data were coded and themes were identified that were tested against incoming data. As themes were expounded, categories were distinguished and described. The themes were modeled to represent impairments, functional limitations, disability and quality of life. Data collection continued until no new categories emerged signifying that saturation was reached.

Trustworthiness

The investigator followed the principles of grounded theory as described by Glaser and Strauss.[22, 23] Sampling included both competitive and recreational physically active participants with a variety of both upper and lower extremity injuries. Negative cases, or participants who might have had different experiences, were sought for inclusion. The model was checked for accuracy and the model was expanded based on information received from a group interview. The interview occurred after all the individual interviews had been completed and the theoretical model had been constructed. Six physically active subjects (3 men, 3 women; mean age 22.2 years, range 16-28) with a history of musculoskeletal injury participated in the group interview.

RESULTS

Under each disability component, themes arose that were common experiences of the participants. This section focuses on the subsections of each of the disability components. Included will be quotes that verify and detail the experiences described by the participants. In addition, the definitions for each of the disablement components are included to help the reader relate the themes to each of the components.

Impairments

Impairments are defined as a loss or abnormality of a physiological or anatomical nature attributable to an active pathology.[15] Four themes that arose under impairments were pain, decreased motion, decreased muscular functioning, and decreased stability.

These are all common impairments seen within the natural sequela of an acute or chronic musculoskeletal injury.

Pain

Pain was the impairment that was most often mentioned and was the underlying cause for most other impairments, functional limitations and disability. Although most patients spoke of pain as subsiding with time, pain was also one of the largest concerns for each patient. Pain was a concern not only during physical activity but also with activities of daily living. Joan, a 33-year-old recreational runner, spoke about the effects of pain on all the disablement dimensions.

> "The pain, I thought, was related to exercising and that if I stopped exercising that it [pain] would go away. That didn't happen and it's been months. It has affected my ability to exercise the way that I typically would. I can run, but it hurts considerably more afterwards. In daily activities it hurts when I walk. It hurts when I roll over at night. I can't do sit-up or crunches. As far as exercises goes it has knocks out a lot of things that I had done regularly, and just in normal life getting out of a car hurts. To go up and down stairs it hurts. It's not this excruciating pain that leaves me unable to do things but it's uncomfortable."

In some cases, pain was only experienced during highly skilled activities as in the case of Joe, a 20-year-old elite volleyball athlete who stated "Pain is a real problem sometimes when I don't have a perfect mechanical swing, or if my shoulder is off then it kind of tweaks that area and it's a very severe pain. I most likely would be pain free if I went through an entire day without playing volleyball."

Decreased Motion

Motion was a complaint that had two subcategories: 1) range and 2) speed/ease. In severe cases that typically required a surgical intervention, the major complaint was that the available range of motion was limited. Mike is a 54-year-old golfer who was diagnosed with adhesive capsulitis. He talked about his "number one problem" was being unable to move through a range of motion.

Movement is the number one problem because I have had dramatically decreased range of motion. Now, it has been some months and I have has substantial improvement so that I am more hopeful. I may still need surgery at some point. Over the last week I have made such progress in PT than I have over months that I am really happy with that, but it is still a problem because of the things that I can't do. I can't lift my arm over my head. I can't lift it behind my head.

In other cases the speed and/or ease of moving through a range of motion was the concern for the participants. John a 22-year-old baseball player with shoulder bursitis was concerned with his ability to move his arm quickly. "If I wanted to raise my arm really quickly above my head, like if I were to jump up and grab something, it would hurt. If I did need to move my arm above my head then I would have to go really slow."

Decreased Muscular Performance

Muscular performance has multiple components such as strength, endurance and power. All of these components were touched upon when the participants talked about a decrease in muscular performance. The complaint typically coincided with the participant's level of function. A 22-year-old recreational swimmer who was

rehabilitating her shoulder after a Bankhart repair for multi-directional instability felt that "I still haven't built up a lot of strength after my surgery." She went on to talk about her concern with endurance.

"I can only do stuff for a certain amount of time before my arm gives out and I can't move it anymore. It gets really tired. After doing rehab for 20 minutes I can't do anything. My arm is just dead. Just picking up anything I can tell that it is tired."

A person with a higher level of function typically talked about a decrease in power as their hindrance. Dan described his problem with power as "…my shoulder gets tired and sore and I can't keep up with it (workout). I can generate force early but it decreases over time. I can't produce as much power as I did before the injury."

Decreased Stability

Stability was described in two ways that can be best explained as being either mechanical or functional in nature. Decreased stability was a concern for participants with ligamentous injuries as was the case with a 20-year-old elite gymnast with a ruptured lateral collateral ligament of the 1st MCP joint of the foot.

"You need a lot of power and a lot of my power comes from legs and lower half and I cant push out of my R foot. I can't favor my L foot so every time I go to do anything powerful or forceful my toe will pop out of joint and then that's painful."

Interestingly, a functional form of stability was talked about as giving way or giving out. In these cases, the injury did not have to be ligamentous in nature. A tentative link between strength and stability can be made here. Participants described feeling fatigued

after exercising, or moving, for a period of time and subsequently feeling unstable. For Katie, a 16-year-old soccer athlete and dancer, functional instability was a concern when she said “It (ankle) doesn’t move very fast and not very easily and not very long and when it does move for too long it has a tendency to give out.”

Functional Limitations

Four themes arose that fell under the functional limitations category. Functional limitations have been defined as “a limitation in performance at the level of the whole organism or person.”[14] The specific focus of functional limitations is the limitation of actions that a person would normally do. The transition here is made from the local effects of an injury (impairments) to its effects on performance of an action (functional limitations).

Skill Performance

Two themes arose from skill performance. Participants described a decreased ability to perform basic skills that constitute larger components of sporting/physical activities. These activities included but were not limited to running, jumping, kicking, throwing and catching. In addition, participants mentioned that the quality of motion was hindered. Words that were used to describe these problems included “coordination”, “agility” and “balance”. Tom, a 20 –year-old competitive athlete who was recovering from a bi-malleolar fracture used the following description.

“I worked a lot on that to get my coordination back. I was on crutches for so long that when I finally did get back (to activity) it was tough to walk normally, and squat down. [It was tough] getting everything to function together: my knee, my hip and my ankle. It’s still a problem but it has gotten a lot better”

Daily Actions

The participants also talked about how their activities of daily living were affected negatively by their inability to perform simple daily actions. The limiting action was typically very specific to upper or lower extremity injuries. In John's case, his bursitis affected his daily actions in the following way.

"I wasn't able to move my right arm above shoulder level for example to reach for things out of a cupboard or something like that. If I had to lift things that were heavy and had to reach out far away from me to grab them then it would hurt my shoulder. If I go to lift something out in front of me or above my head then it was a little too heavy for my arm and I couldn't hold it up."

Lauren, a 21-year-old recreational runner with a stress fracture, also spoke of her injury as limiting her daily actions.

"Walking, though it isn't the most painful of things, it is something that your have to do in your everyday life especially being on such a huge campus. I think it bothers me because I am always doing it. It is so slow. I have to give myself an additional fifteen minutes to get to a place."

Maintaining Positions

One functional limitation dimension that was commonly talked about was a problem with maintaining certain positions. Patients spoke of the inability to stay in one position for a long period of time without becoming symptomatic. Such cases were lying down while sleeping, sitting down, bending over and squatting down. In addition, participants also intimated that they became more symptomatic after having to move out of a position

that was held for a prolonged period of time. An 18-year-old tennis player with a mid-foot sprain named Kelly described her problem with maintaining positions below.

"It bothers me more every time I wake up in the morning because I haven't used for the last six or seven hours. That is when it is the most painful. During the day I can walk without the crutches, but in the morning I can't put my foot down. It annoys me because I have just given it rest, but it seems worse. So it bugs me that it hurts me more when I am not doing anything than when I am doing something."

Changing Directions

Changing directions was a dilemma most participants talked about. More specifically, changing directions was a problem during physical activity as well as with activities of daily living. The problems with changing directions in daily activities was most present in participants with more disabling conditions. Words used to describe changing directions including turning, twisting, cutting and pivoting. A rugby player with a mid-foot sprain talked about the negative effects his injury had on his ability to make cutting motions.

"Cutting is a problem because it is a huge thing for rugby and like any sport you have to cut or cut and pivot. When I do my workouts for rugby I do cutting movements like z's or functional activities to increase my speed so that I can run better."

Disability

Disability has been defined as the "limitation in performance of socially defined roles and tasks within a sociocultural and physical environment. "[10] The emphasis on activities

highlights that disability refers to difficulty with a role, or activity, versus difficulty with a task (functional limitations).[25] Two themes emerged under the disability category: 1) fitness and 2) participation in physical activity.

Fitness

Participants describe a change in their overall fitness status especially in cases in which their normal, preferred activities were limited. Anecdotally, some participants describe not being "in shape" for specific activities. For example, a runner does not feel like they are in running "shape" unless they run. Jennifer, a 19 year old with spondylosis and two herniated lumbar discs described the effects of her chronic injury on her fitness level. During the time of this interview, Jennifer had been unable to participate in sport for approximately 6 months.

"I love to run and I feel very out of shape. I can't even power walk fast so that has gotten to be a problem. It's a big problem because I am so used to being fit. In the beginning I was getting worn out from walking and from stairs and I thought that it had to do with losing strength in my legs. I know that when I start training I am going to be a year behind everyone else. I already started lifting so I am starting to get the strength back and I've already started flexibility so I am getting all those components back but the last thing that I will do is run. "

Participation in Physical Activity

Participants believed that one of the most important aspects of the disablement process was the inability to participate in physical activity. Furthermore, physical activity had two facets. The first was that participants were unable to participate in the physical activity of their choice - be it organized sport or informal physical activity. The second facet was

that participants felt that they could not participate in leisure activities that were of a physical nature. Dan explained this limitation by stating, “I am a very active person outside of the gym and I do a lot of sports with my friends and sometimes I can’t participate in them because of my shoulder. This past summer I couldn’t go golfing. I also like to do sports like wake boarding but I couldn’t do that as much as I wanted to this summer as well.” Similarly, recreationally active participants also expressed the same concerns. Lauren mentioned, “I am limited in what leisure activities I can do. If I had my choice I would like to run in my free time. I would like to be active or I would like to go on walks.”

The major concern for all the participants was that they could not participate in the sport of their choice. Jennifer described her frustration by saying “I know that I can’t do gymnastics forever and eventually you have to give it up, but I didn’t expect it to already happen. I think that I can get back into it [gymnastics]. Right now it is always on my mind…it also upsets me when they [other athletes] complain about being sore. I am just like it would be great if I was just sore. I think some people just take it [being able to participate] for granted”

Quality of Life

Quality of life refers to factors that affect the quality or goodness of life including psychosocial and physical conditions. Five themes surfaced under the quality of life category. Interestingly, participants were able to verbalize the effects of their injury on their quality of life over the more corporal effects. Generally, participants experienced many, if not all, of these quality of life changes. The degree to which some of these were experienced was mostly dependant on two factors: 1) the chronicity of the injury and 2)

the level of competition. For example, increases in stress and pressure were most notable in participants that took part in competitive activities.

Uncertainty and Fear

Participants described that they felt uncertain about their recovery from their injury. In particular, participants were concerned about their ability to fully return to sport participation. In addition, some fears were expressed because their day-to-day life had changed so dramatically. Some participants even expressed a fear of re-injury. Although fear and uncertainty are known to be two discrete and separate psychological components, participants typically used these two words in conjunction with each other. Kelly describes her fear below.

"When I see some of my teammates doing the drill that I did when I fell down and I think that when I have to get back on court I will get so nervous to do that because I feel that it is so possible that it may happen again. The fact that I can't move my foot at all in one direction makes me think that I don't even have to be doing that drill [to get hurt again] and I can hurt it [foot] even more."

Stress and Pressure

Stress arose from musculoskeletal injuries for a couple of different reasons. On the one hand, participants described stress that came from the uncertainty of the injury/rehabilitation prognosis. James, a 16 year old swimmer with chronic shoulder pain described an increase in stress by saying, "Now I am stressed that I am putting a lot of pressure on myself and I don't feel that I am where I was before I got hurt. At the beginning of the season I was right on track to reach my goals and now I have taken a

few steps back so that I have to make up all that ground." On the other hand, participants said that being physically active was a form of stress relief and their injury had changed that. Lauren described how being more sedentary has affected her by saying " I rely on fitness activities to keep my emotions in control and that's something that has been affected by this [injury]. I feel that if I am active I feel better about myself. I feel that fitness is a stress relief and without that in addition to the stress of everything like having to get up early so that I can ride the bus [and] having enough time to walk to one place or another and having to wait for a bus [and] having to plan time to meet with my doctor."

Mood and Frustration

Participants talked about their mood being affected because of their energy. Some participants talked about being in a "bad mood" after a practice that didn't go well. For example, Dan talked about "feeling low" after practice because "I couldn't accomplish what I wanted to accomplish". Dan also mentioned how these feelings, in particular, "carry over to my whole life". Mike, as well as other participants, talked more specifically about how frustration altered their mood.

"One of the most depressing things for me is that I will not be able to play golf this year. I love playing golf. I don't play very often, usually about 9 holes once a week, but that is my treat for the whole week. I usually don't play until Sunday afternoon when I am done with all the stuff that has got to get done with the house and it's really is very intensely frustrating for me right now because there is no way that I can play golf."

Decreased Energy

The participants that had been removed from physical activity for rest talked about how being relatively sedentary influence their energy levels. These participants felt their energy levels decrease when not being active. Joan described how her injury affected her energy level and how they tied into her feelings of frustration and stress.

"Not being able to do the things that I want to do without having to think about it has been frustrating and I think for me that being able to exercise regularly has always been helpful in terms of managing my stress but also providing me energy to do other things. As a result of not being able to have my normal routine, I am a slug. The less I do, the less I want to do so I always feel tired because of the lack of sound sleep [and] the lack of exercise beyond walking and elliptical machines. For me it's a control issue and not being able to do what I want to do."

Altered Relationships

Participants with acute injuries and problems with mobility described that their relationships with friends and teammates were affected because of the difficulty with "getting around". Will explained his difficulty by saying "It seems like a lot of the team goes out and hangs out and I don't want to even put up with going out so sometimes the fact that I have to carry the crutches around so I'm not motivated to get out." On some occasions, participants felt that they were ostracized from the group because they were not fully able to participate in daily activities such as practice or team outings. These perceptions were more acute in the cases of the participants that were totally removed from practice situations. Lucy described the change in relationships as "one of the worst things that I had to deal with in the surgery". She went on to elaborate that she felt this

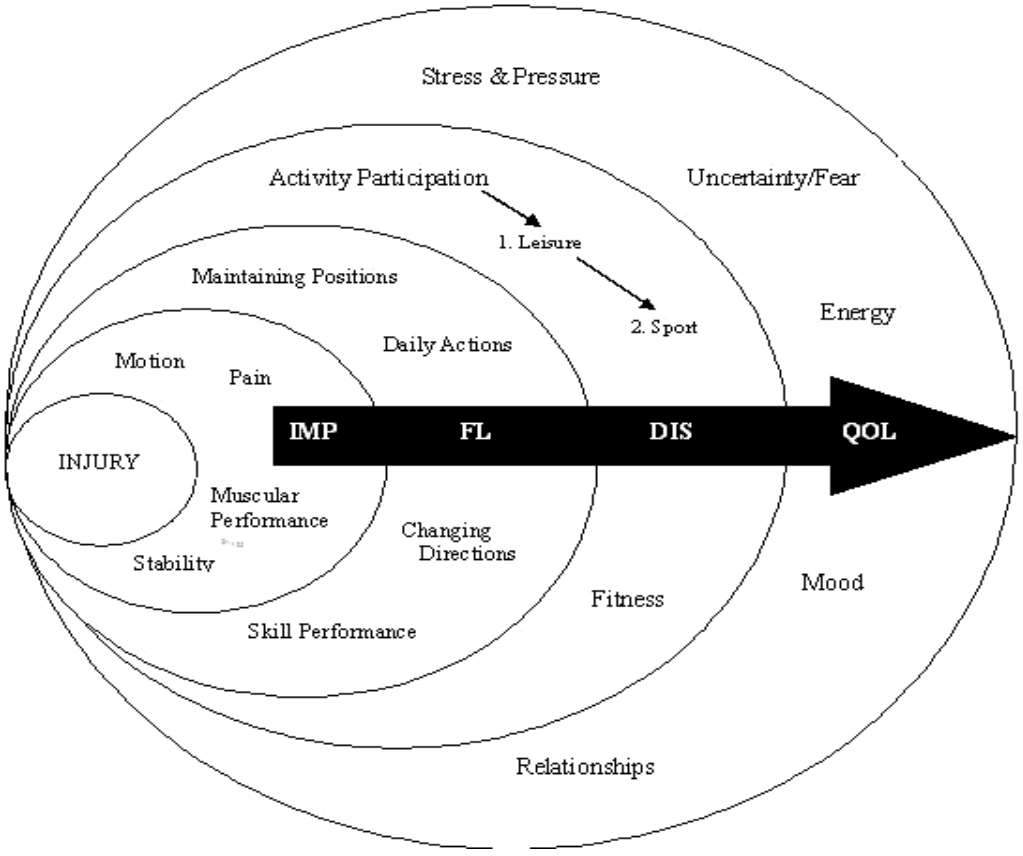
way because of how her interactions with the team changed by saying “because the team doesn’t really talk to me anymore.”

Disablement Model

We developed a model using the IOM framework to describe how physically active persons experienced disability. The four categories in the model are impairments (IMP), functional limitations (FL), disability (DIS) and quality of life (QOL). The model uses the same disablement components used by other sociomedical models but differs slightly in its visual presentation (see Figure 3.3).

We believe that the current socio-medical disablement models are true of the participants in this study but are often misleading by their simple linear projections. Rather, a model that represents disability as ripples in water may be able to better describe the disablement process. The disablement process starts in the center with a musculoskeletal injury. Impairments, functional limitations, disability and quality of life are found in the subsequent ripples. This model illustrates the recursive nature of the disablement process so that the effects of the disability components act as ripples that overlap and move back upon each other. This model concurs with the theory that disability components have a cyclical character.[14]

Figure 3.3 Transient Disablement in the Physically Active Model



In addition, the model also represents the progression from an injury that affects a localized structure to the more global effects of an injury, such as changes in quality of life. Another change from other disablement models is the placement of quality of life as the last component in this model. Other models place quality of life between functional limitations and disability.[26] This model, although different, does not dispute other models but rather places quality of life last because it is the broadest disablement component. This emphasizes that QOL is affected by all the disablement components and not just functional limitations and disability. For example, pain is considered an impairment but has a direct impact on quality of life.[27] Therefore, QOL changes may more appropriately belong as the end product of the whole disablement process.

DISCUSSION

The purpose of this study was to use a qualitative approach to describe the disablement process as experienced by a physically active person with a musculoskeletal injury. The four domains that compose the IOM disablement model were used to structure this study. In all, four impairments, four functional limitations, three disability and five quality of life categories emerged from interviews that used grounded theory methods.

Impairments

Since impairments are abnormalities at the site of the injury, the causes of these problems tend to be physiologic in nature. For example, an ankle sprain will set the acute inflammatory process in motion and the direct manifestations of the inflammatory process are regarded as impairments. The cardinal signs of inflammation (heat, pain, swelling, redness, and loss of function) can be used to best explain the signs and symptoms of injury.[28]

Pain and decreased motion were two problems that the participants repeatedly cited and are two common impairments seen after an injury.[27] Pain is related to two other impairments that the participants mentioned: motion and muscular performance. In fact, pain was commonly cited as the reason for changes in motion. Strength, endurance and power were all used to describe the changes that occurred with muscular performance. All these changes have been shown to occur after musculoskeletal injury.[28-32] The cause for altered muscular performances may be direct in cases of injured muscles or tendons. In the case of joint injury, studies have shown that muscles are commonly de-facilitated

around injured joints. Decreased stability, due to injury, has also been cited in the literature. Stability has been shown to have mechanical and/or functional components.[33] The mechanical component of instability is related to those injuries in which the supporting structures about a joint have been affected. The literature regarding ankle instability typically examines the relationship between joint laxity to instability. Interestingly, studies have also investigated the contributions of the neuromuscular system to laxity, which is termed functional instability.[34-38]

Functional Limitations

Functional limitations are the effects of impairments at the level of the whole person. For example, a patient may complain of pain after a lateral ankle sprain. The pain may limit range of motion and, therefore, may affect actions such as squatting, running, and jumping. A quandary that is presented with functional limitations is that they may vary widely depending on the injury and the normal actions of a patient. A clinician working with a patient with an anterior cruciate ligament tear and a patient with carpal tunnel syndrome will find that the specific functional limitations that each patient would describe would differ greatly. One patient may complain of the inability to climb stair and to squat down. Whereas the other patient may complain of an inability to grasp or carry heavy objects. Because qualitative research uses an inductive process, broader functional limitations groups were developed. The categories that surfaced from this study are general topic areas that apply to most patients regardless of injury. The categories that emerged include problems with maintaining positions, daily actions, changing directions and skill performance.

Nagi hypothesized that functional limitations are better predictors of disablement level because they "are the most direct way in which impairments contribute to disability."[10] Research has also shown that functional limitations are better clinical predictors of disablement.[16-18] Even so, much more emphasis is placed on impairment measures in both clinical practice and research. This is particularly true in research investigating post-operative outcomes.[39] Part of the reason is that functional limitations are harder to measure and quantify. From a historical perspective, impairment measurements such as isokinetic testing became popular in the 1980's because the results were easily quantifiable and therefore easier to prove a desired outcome had occurred.[12] Closely related to this issue is that through managed care systems quantifiable outcomes are typically preferred and thus affects the choices that health care practitioners make concerning outcomes measurement.

Disability

Disability is a limitation in the performance of socially defined roles. Ultimately, a normally physically active person wants to participate in the sport activity of their choice. If they are limited in being able to do so because an injury's deleterious effects then they are experiencing a form of disability. Consequently, an important outcome in this situation is full return to participation with minimal symptoms. Is return to play alone a satisfactory outcome, though? Although return to play is important, it is uni-dimensional and does not take into account changes in quality of life and activities of daily living. This is why fully understanding the disablement process and the way in which those that are physically active is so important.

The participants in this study talked about an injury not only affecting their ability to participate in their preferred sport they also mentioned that their recreational and fitness activities were also affected. These responses incorporate a sense of how they are affected in a variety of contexts rather than in just one facet. This is particularly interesting in the cases of competitive athletes. The clinical relevance is that in order to measure true treatment success a clinician may want to ask questions outside the realm of sport.

Quality of Life

Quality of life outcomes measures are a newer province in health care.[26] In the IOM's disablement model, quality of life includes both psychosocial and physical domains and is closely related to health status as defined by the World Health Organization.[2, 15] Although these measurements are not aimed at fully understanding the psychosocial aspects of injury, there is a general consensus that a relationship between injury and a patients' quality of life exists. It is understandable that an injury may affect a patients' sense of total well-being. Thus, quality of life is an important facet in understanding the impact of an intervention.

An interesting perspective with measuring quality of life is that it can be affected by a number of factors outside of the injury, but the themes that arose in this study were consistently linked to the musculoskeletal injury that the participant was suffering from. In addition, research has shown instruments that measure health related quality of life instruments are valid and reliable.[40-42] Participants time and again revealed five themes:

an increase in fear and uncertainty, an increase in stress and pressure, negative changes in mood and frustration, a decrease in energy levels, and negative changes in relationships.

Another point that should be made is that there appeared to be a relationship between chronicity and quality of life issues. Participants who had experienced an injury that required a prolonged rehabilitation process or that were precluded from participating in physical activity were most often the participants that were most affected by quality of life issues. More research needs to be performed to further elucidate this relationship.

IMPLICATIONS

Both athletic training clinicians and researchers can benefit by understanding the lived experience of a physically active patient undergoing disability. The quality assurance model set forth by Donabedian talks about the importance of patient values in the outcomes process.[43, 44] Part of understanding patient values includes understanding how a patient reports being affected by the disablement process. This in turn affects the process in which care is administered. By understanding disablement, clinicians and researcher alike can then measure the important patient outcomes to measure true treatment success.

A setback with discerning the effects of disablement on a physically active person is the failure of researchers and data collection agencies to use consistent disablement definitions[10, 21]. Therefore, researchers and clinicians in the health fields may have trouble understanding and applying disability research based on differences in terminology. An appraisal of the literature measuring musculoskeletal related disability shows that terminology variations are a pervasive problem. [7, 16, 17, 45-53]

CONCLUSIONS

This study is the first step in understanding disablement in the physically active. Our desire is to elucidate the disablement process so that clinicians will more carefully consider the clinical variables that they measure. In addition, the researchers anticipate that athletic training, as a field, will work more diligently towards integrating a disablement model into the context of clinical research. More research needs to be completed to fully understand the disablement process and the relationships between and amongst the disablement components. Ultimately, appropriate outcomes tools based on a disablement model need to be created to assess the effects of interventions in the treatment of musculoskeletal injuries in the physically active.

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Chapter 4

The Disability in the Physically Active Scale: The Psychometrics of an Outcomes Scale for Musculoskeletal Injuries

INTRODUCTION

Regular evaluation during the treatment process is an integral part of ensuring treatment success. Outcomes are the result of an intervention and are part of a quality assurance framework first described by Avedis Donabedian.[1-3] Like the business adage "You manage what you measure" suggests, outcomes assessment affords a clinician the benefit of daily scrutiny into treatment practices.[4, 5] In essence, by measuring outcomes a clinician can create their own best practices while considering their patient's expectations and the resources at their disposal. Outcomes also serve a broader function in athletic training by documenting the value of certified athletic trainers in a variety of settings.

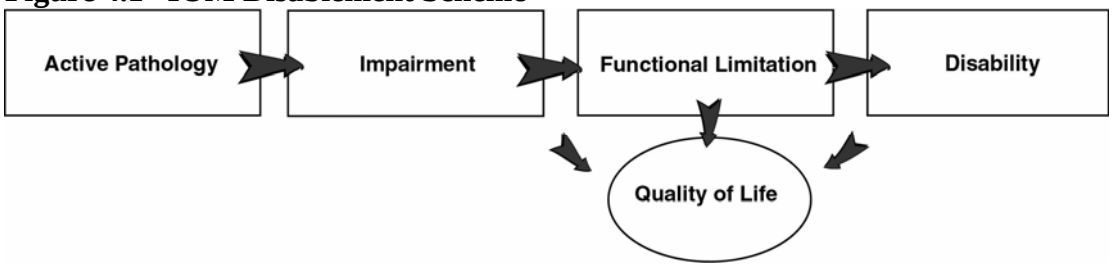
Outcomes assessment can take a variety of forms. In health fields, outcomes are commonly assessed through clinician-report and self-report instruments.[6-9] An outcomes instrument can measure a single construct, such as pain, or measure a wider set of constructs. Instruments that examine multiple constructs are known as multidimensional instruments. A high-quality multidimensional outcomes instrument is typically rooted in a disablement paradigm.[8, 10-12] A disablement framework provides the structure for which value is placed on the measurement constructs.

Despite the growing popularity of evidence based-practice, self-report outcomes assessment has yet to become routine in athletic training practice. Although there are a multitude of validated disease-specific outcomes instruments to use, these instruments may be too cumbersome and impractical for daily use in typical athletic training setting. Generic outcomes instruments are also problematic. Instruments, such as the Short Form 36 (SF-36) and its abbreviated version the Short Form 12 (SF-12), provide only general information regarding a patient's health and are not specific to the problems of a

physically active population.[13] The first step in ensuring that outcomes assessment occurs is to provide a concise psychometrically sound instrument to measure outcomes in the physically active. An instrument that meets the minimum requirements for appropriate psychometrics is reliable, valid and sensitive to change.[9, 14-16]

The purpose of this study is to test the psychometrics of a multidimensional, self-report outcomes instrument created for the physically active. The Disability in the Physically Active (DPA) scale is derived from a disablement framework modified by the Institute of Medicine (IOM) and includes measures of impairments, functional limitations, disability and quality of life (see figure 4.1).[17, 18]

Figure 4.1 IOM Disablement Scheme



METHODS

Instruments:

The Disability in the Physically Active Scale

The DPA is a self-report, multidimensional scale that is based on the IOM's disablement paradigm. The scale is composed of four distinct but interrelated components: impairments, functional limitations, disability and quality of life issues.[10, 17] The instrument was created from results from our previous study that used grounded theory methods to determine the most common problems that physically active persons experienced as a result of a musculoskeletal injury. Descriptors that were identified as suitable in the previous study were used to describe each of the problems. A copy of the

scale is included in Appendix B. Scale responses are based on an adjectival scale that ranges from 1-5 where 1 indicates that a patient does not have a problem with the listed item and 5 indicates that a patients is severely affected by the problem. The items were scaled as such to allow for ease of administration while still allowing for discrimination of the problem severity. The scaled responses are included in Table 4.1. Each item on the DPA is weighted equally and 16 points are subtracted from the final score so that the DPA is scored from 0 (floor) to 64 (ceiling). We felt that a scoring system with a floor score of zero would be more user friendly than a scale that ranged from 16-80. A higher score on the DPA indicates that the subject has more problems whereas a lower score is indicative of fewer problems. The complete DPA can be found in Appendix B

Table 4.1 DPA Scale Response Key

Values	Response
1	No problem
2	I have the problem(s), but it does not affect me
3	The problem(s) slightly affects me
4	The problem(s) moderately affects me
5	The problem(s) severely affects me

Prior to use in this study an expert panel (see table 4.2) reviewed the DPA scale for its item content relevance using methods described by Dunn et al. and developed by Aiken.[19, 20] Each judge rated the applicability of each DPA scale items to the 4 domains in the disablement model using a 1-5 scale. A rating of one represented a poor match whereas a rating of 5 represented an excellent match. A validity coefficient (V) was calculated from the responses given by each judge to test the statistical significance of the ratings for the construct. The item content relevance analysis revealed that all but one item had a coefficient higher than 0.75 indicating large relationships between the item and the “excellent match” rating. An item content relevance analysis with 7 judges should

yield a V coefficient that is equal to or above 0.75 to be statistically significant. This value was taken from a right tailed binomial probability table provided by Aiken. Analysis of other domain areas found that the expert panel established two items as better matches in other domain areas (see table 4.3). The judges considered daily actions and maintaining positions better disability measures than functional limitations.

Table 4.2 Expert Panel Demographics

Member	Credentials	Years Experience	Expertise
1	**PhD, PT, ATC**	**28**	**Clinical outcomes research**
2	**EdD, ATC**	**27**	**Education outcomes**
3	**PhD, ATC, CSCS**	**11**	**Clinical outcomes research**
4	**PhD, ATC, FACSM**	**19**	**Epidemiologist**
5	**PhD, MBA, ATC**	**28**	**Survey research**
6	**MS, PT, ATC**	**20**	**Clinical outcomes**
7	**PhD, PT, ATC**	**25**	**Clinical outcomes**

Table 4.3 Item Content Relevance V Coefficient Analysis

Item	Domain	V Coefficient For intended domain	Significant V Coefficients For other domains
Pain	Imp	.93**	
Motion	Imp	.93**	
Muscular Functioning	Imp	.82**	
Stability	Imp	.86**	
Overall Fitness	FL	.75*	.54 (Dis)
Changing Directions	FL	.96**	
Daily Actions *(walking, squatting, lifting, carrying*	FL	.82**	.85** (Dis)
Maintaining Positions	FL	.61	.82** (Dis)
Skill Performance 1 *(running, jumping, kicking, throwing, catching)*	FL	.93**	
Skill Performance 2 *(coordination, agility, precision, and balance)*	FL	.89**	
Participation in Activities 1 *(leisure activities, hobbies, and games)*	Dis	.86**	
Participation in Activities 2 *(sport of preference)*	Dis	.86**	
Relationships	QOL	.75*	
Uncertainty , Stress and Pressure	QOL	.93**	
Overall Energy	QOL	.86**	
Mood	QOL	1**	

Imp = impairment, FL = functional limitations, Dis= disability, QOL = quality of life
*p<.05, **p<.01

The DPA was modified slightly based on the results of the item content relevance analysis. The question regarding fitness was refined so as to address the problems that a patient would have with activities performed to maintain fitness, such as cardiovascular training and weight lifting, rather than their actual fitness level. This slight modification made the fitness item a better disability measurement than a functional limitation. Maintaining positions was kept as a functional limitation rather than a disability because it is considered an action (functional limitation) and not an activity (disability).[10]

Global Functioning

Global functioning (GF) is a single item visual analog scale (VAS) that is a ten-centimeter line that is affixed by a number at each end of the line.[21] The left side of the scale is labeled with a 0% while the right side is labeled with a 100% (see appendix B for scale). Participants marked a perpendicular line along the scale that represented their current level of functioning as compared to their normal function level. Participants were asked to complete a GF scale every time that the DPA was completed.

Global Rating of Change

The global rating of change (GRC) is a retrospective, self-report, 15-point rating scale where the participant reports the degree of perceived change in an injury or pathology. The GRC scale has been used and validated in previous studies to establish whether a participant has experienced clinically meaningful change over time.[14, 22-25] Because the scale is self-report in nature, it is typically considered to be the external criterion, or gold standard, for actual change in a subject. The participant was first asked if there had been a change in their injury status since the time that they entered into the study. The participant then rated the amount of perceived change on either a positive 1-7 scale or a

negative 1-7 scale (see appendix B for scale). A clinically significant change can be positive or negative and a change greater to or equal to +4 or less than or equal to -4 is considered to be a clinically significant change.

Participants

All participants completed an informed consent approved by an institutional review board prior to participating in this study. Data were collected from physically active subjects classified as either competitive or recreational athletes from five different sites including a Division I and Division III intercollegiate athletics program, a large high school interscholastic athletics program, an intramurals program at a large university and an large outpatient orthopedic center.

Participants entered the study at three distinct points in order to allow for instrument analysis on both healthy and injured subjects. Injured participants were further stratified as experiencing an acute or persistent injury to test for differences between these two groups. The researchers used the definitions in Tables 4.4 and 4.5 for inclusion into the study as well as injury stratification purposes. Participants that reported experiencing chronic pain were excluded from the study because chronic pain does not behave in predictable patterns.[26] Participants self-reported all data on a demographic form so as to be grouped correctly.

Table 4.4 Inclusion Criteria Definitions

	Criteria	Definition
Inclusion	Physically Active	An individual that engages in athletic, recreational, or occupational activities that require physical skills and utilize strength, power, endurance, speed, flexibility, range of motion or agility at least 3 days a week.[27]
Exclusion	Chronic Pain	Pain that consistently does not get any better with routine treatment or non-narcotic medication

Table 4.5 Participant Stratification Definitions

Injury Status	Healthy	Free from musculoskeletal injury and full participation in sport.
	Acute	A musculoskeletal injury that precludes full participation in sport for at least two consecutive days.
	Persistent	A musculoskeletal injury that has been symptomatic for at least one month.
Competition Status	Competitive	A participant that engages in a sport activity that requires at least one pre-participation physical, regular attendance at scheduled practices and/or conditioning session, and a coach that leads practices and/or competitions.
	Recreational	All participants that meet the criteria for physical activity but do not meet the criteria for competitive status.

Three hundred eighty people volunteered to participate in the baseline portion of this study. Twenty participants were excluded for not meeting the physical activity requirement or for reporting that they suffered from chronic pain. A total sample of 368 participants (202 females, 166 males; 281 competitive, 87 recreational; age = 20.1±3.8 years) were included at baseline and the data were used to establish standard values for the DPA. Of the participants that completed baseline data, 271 subjects (153 females, 118 males; 210 competitive, 61 recreational; age = 19.7±2.0 years) self-reported that they were healthy while 97 subjects (49 females, 48 males; 71 competitive, 26 recreational; age = 21.1±6.4) had a current injury.

Fifty-four participants (32 females, 22 males; 40 competitive, 14 recreational, age = 22±8.3 years) were identified as having persistent symptoms and agreed to enter into the study (see Table 4.5). Twenty-eight participants (19 males, 9 females; 22 competitive, 6 recreational; age = 19.7 ±1.86 years) were identified as having an acute injury and agreed to participate in the study (see Tables 4.6 and 4.7). Three participants with acute injuries were not released for full participation by the end of this study and were unable to complete the last set of DPA, GF, and GRC scales. Data for these participants were treated as missing values. Test-retest reliability was performed in 21 (11 males, 10

females; 11 recreational, 10 competitive; age = 22.1±4.4 years) healthy and 31 (16 males, 15 females; 21 recreational, 10 competitive; age = 23.4±9.2 years) injured participants.

Table 4.6 Injury Locations for Acute and Persistent Subjects

Injury Location	Participant Group	
	Persistent	**Acute**
Head/neck	2 (3.7%)	0 (0%)
Shoulder/arm	9 (16.7%)	4 (14.3%)
Forearm/wrist/hand	4 (7.4%)	3 (10.7%)
Trunk/low back	10 (18.5%)	1 (3.6%)
Hip/thigh/leg	6 (11.1%)	2 (7.1%)
Knee	12 (22.2%)	6 (21.4%)
Ankle/foot	8 (14.8%)	12 (42.9%)
Not reported	3 (5.6%)	0 (0%)
TOTAL	**54**	**28**

Table 4.7 Acute Participants Number of Days to Return to Full Activity

Days to Return	Frequency
2 weeks or less	7 (25%)
2 weeks – 1 month	11 (39.3%)
1-3 months	4 (14.3%)
3-6 months	3 (10.7%)
Have not returned	3 (10.7%)
Total	**28**

Protocol:

Participants were recruited at baseline or after injury by the primary investigator with the help from certified athletic trainers at four of the five sites. The exception was at the orthopedic center where participants were recruited via flyers. Upon entry into the study, participants completed demographic information that ensured that they met the inclusion criteria for the study. All participants completed the same set of study packets that included a question regarding their participation status as well as three instruments: 1) the DPA scale, 2) a GF scale, and 3) a GRC scale (the GRC was not completed at baseline). Healthy participants completed the study packet once upon entry into the study. We

administered study packets to participants with an acute injury on four occassions. The first administration occurred on day one, or within 24 hours, of the initial injury. The participants also completed study packets on day 3 and day 7 after the injury. The last study packet that was completed was upon return to full participation as qualified by the certified athletic trainer or by a physician. These days were chosen based on effect sizes from a previous study that examined the psychometric properties of another self-report outcome tool.[28] Participants with persistent injuries were asked to complete a study packet upon entry into the study (baseline) as well as 3 and 6 weeks after completing the baseline measurement. This time frame was chosen because patients with persistent injuries are typically slow to change so that an extended time frame was necessary to capture change, if it occurred. Other studies that have examined the psychometrics of an instrument with a chronically injured population have used similar time periods.[22, 29, 30] Since treatment effectiveness was not relevant to this study, treatment protocols were not controlled or monitored in participants with acute and persistent injuries.

Statistical Analysis:

All data analyses were performed using SPSS (version 12.0; SPSS Inc, Chicago, IL). We conservatively treated missing values for interval data and replaced with mean values if less than 5 % of the total values for each variable were missing. Any missing nominal data were left as missing values.

Reliability

We performed a reliability analysis to assess the test-retest reliability and internal consistency of the DPA. Whereas test-retest reliability assesses the reliability of a

participant's responses when the same instrument is administered on two separate occasions, internal consistency assesses the consistency of the items within a scale.

We assessed the internal consistency of the DPA instrument by calculating a Cronbach alpha for the combined scale items. An acceptable Cronbach alpha is between .70-.90 while a score higher than .90 indicates that the scale is too homogenous and may only measure a single construct.[9] We also calculated the item total to assess the correlation of each item with the total score if the scale item was omitted. A score less than .20 indicates that the item should be dropped from the scale.[9] We performed an evaluation of internal consistency at day one for the acutely injured participants and at baseline for the participants who participated in the persistent injury group.

The test-retest reliability was established by calculating ICC (2,1) values between two separate test administrations.[31] Values greater than .75 show excellent test-retest reliability, .40-.75 show fair to good reliability and less than .40 demonstrates poor test-retest reliability.[32] We expected that the correlations between the test retest data to exceed 0.75. Test-retest reliability measurements were performed in both a healthy and injured population. We asked both sets of participants to complete the scale twice over a 24-hour period. A 24-hour period was designated as the appropriate time so as to avoid any significant change in a participant's injury status. To avoid answer recall, the items were presented in a different order on the second administration.

Scale Inventory

We performed a factor analysis to confirm that the DPA is a multidimensional scale and to further elucidate the appropriate grouping of the scale items. We used an exploratory, principal component analysis with varimax rotation with the aggregate DPA

instrument results from day one for the participants with acute injuries and baseline for participants with persistent injuries. These data were pooled to ensure that an appropriate n was reached for an accurate factor analysis. The Kaiser criterion was used so that eigenvalues greater than 1 were used to establish the components in the scale.[9]

Validity

We assessed concurrent validity in two ways: by comparing the group mean scores of the DPA with a participant's corresponding reported GF group mean score and by comparing all DPA scores with GF scores. DPA group mean scores for baseline, day 1, day 3, day 7 and return to participation were compared to the corresponding GF scores in participants with acute injuries. The same comparisons were made in mean scores for participants with persistent injuries at baseline, week 3 and week 6. The strength of the relationship between the DPA scale and GF scores was assessed through a linear regression. The researchers also used a linear regression to examine the relationship in all DPA and GF scores in participants with acute and persistent injuries. Participants with acute injuries completed the DPA and GF on 4 separate occasions while participants with persistent injuries completed the instruments on 3 occasions.

Sensitivity

We assessed the DPA's sensitivity to change by calculating the effect size (ES) for change in participants with acute and persistent injuries. Cohen's d for pooled variance was used to calculate ES since the variance of the two groups was not assumed to be homogenous. Cohen's d was calculated by subtracting the mean scores for the DPA on separate administrations divided by the pooled variance.[33] The equation is found below.

$$\text{Cohen's } d = M_1 - M_2 \,/\, \sigma_{pooled}, \text{ where } \sigma_{pooled} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$$

Effect size comparisons in acute participants were made on five separate occasions: between healthy baseline scores and day 1, between day 1 and day 3, between day 3 and day 7, between day 7 and return to full participation, and between day 1 and return to participation. We also made comparisons in participants with persistent injuries between baseline and week 3, between week 3 and week 6, and between baseline and week 6 for participants that reported experiencing a clinically significant change. Cohen's standards for effect size measurement were used to determine the magnitude of the effect. Cohen defined an ES as small (d=0.2), medium (d=0.5), and large (d=0.8).[33]

Responsiveness

We calculated the DPA's responsiveness with two different methods that required creating a receiver operating characteristic (ROC) curve for acute and persistent injury data.[9, 34] Both the GRC scores and DPA scores were used to calculate the plots for the ROC curve. Participants that reported having a GRC score ≥4 were considered to have undergone a clinically significant change whereas participants who had not undergone a clinically significant change were grouped into a stable group.[22-24] Grouping participants into two groups essentially created a dichotomous scale that distinguished if a subject had experienced a desired outcome. Change scores were calculated by subtracting the total DPA score from one administration to the next. For example, DPA scores at day 1 were subtracted from day 3 DPA scores in participants with acute injuries. The same occurred between day 3 and 7, and day 7 and return scores for participants with acute injuries. In participants with persistent injuries the baseline and week 3, scores as well as the week 3 and week 6 scores were subtracted to determine change scores. Sensitivity and specificity

values were then calculated for every point change on the DPA scale based on the number of participants that were classified as having experienced a clinically significant change versus those that were classified as being stable. Table 4.8 demonstrates a basic table used to calculate sensitivity and specificity while Table 4.9 shows the modifications made to calculate the ROC curve for each point change score (from two separate administrations) of the DPA scale.

Table 4.8 Sensitivity and Specificity Calculation

		Target Disorder	
		Absent	*Present*
Test	*Positive*	A	B
	Negative	C	D

Sensitivity = A/A+C & Specificity = D/D+B

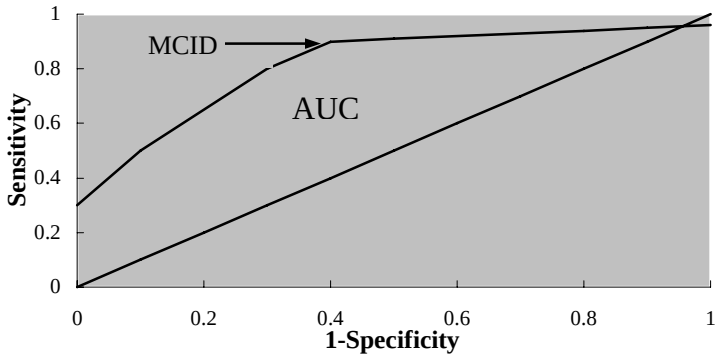
Table 4.9 GRC Calculation Table

	GRC			
DPA Δ Score	Clinical Δ Present*		Δ Absent**	
1 point	10	A	B	10
2 points	15	C	D	5
3 points	19	↓	↓	1

* = GRC ≥ 4, ** = GRC < 4

Each point change was then used to plot an ROC curve where the Y-axis represented the sensitivity values and the X-axis represented 1-specificty values (see figure 4.2). An optimal test, or measure, should create a curvilinear plot that extends above a diagonal line from lower left hand corner to the upper right hand corner. The area under the curve (AUC) is termed D' and tests the "goodness" of a test. A total of 3 ROC curves were calculated for participants with acute injuries and 2 ROC curves were calculated for participants with persistent injuries.

Figure 4.2 ROC Curve Construction



We determined the minimal clinical important difference (MCID) value by choosing the point on the ROC curve that is nearest the upper left corner.[9, 34] This point represents the smallest overall error rate whereas a move to the right of that point increases sensitivity but decreases specificity. The MCID represents the change value on the DPA scale that indicates that the participant has undergone a clinically significant change.

RESULTS

Standard Values

Standard DPA values in healthy and injured participants are found in Table 4.10. The mean difference in DPA score between baseline in healthy participants and day one of injury was 35.48 points. Subsequent changes per day were not as large with scores ranging from 7.8, 6.62, and 15.7 at days 3, 7 and upon return respectively. DPA mean scores in participants with persistent injuries showed a downward trend that was more gradual than that observed following acute injuries.

At baseline, 40.6 percent of the participants had a total DPA score of 0, signifying a floor effect. With the exception for the return to participation DPA scores in participants with acute injury, no other administration of the DPA resulted in more than 10% of the

participants reporting a score of 0. Table 4.11 and 4.12 report values for GF and participation status for healthy and injured participants.

Table 4.10 DPA Scale Values in Participants at Baseline and with Injury

	DPA Scale	Mean	SD	Range	Floor Effects*
Baseline (n=271)	Uninjured	3.68	5.65	0-34	40.6%
Baseline (n=97)	Injured	21.82	13.31	0-52	5.2%
Acute (n=28)	Day 1	39.16	11.72	16-59	0%
	Day 3	31.36	13.84	8-53	0%
	Day 7	24.74	15.67	0-49	3.6%
	Return†	9.04	7.00	0-23	17.9%
Persistent (n=54)	Baseline	27.27	11.18	8-52	0%
	Week 3	24.54	10.95	6-54.42	0%
	Week 6	18.91	12.31	0-53.11	3.7%

† n=25; * percent of participants that scored the lowest score possible

Table 4.11 GF Scale Values in Participants at Baseline and with Injury

	GF Scale	Mean	SD	Range
Baseline (n=271)	Uninjured	95.96	7.13	56-100
Baseline (n=97)	Injured	81.8	16.75	17-100
Acute (n=28)	Day1	47.11	21.18	5-77
	Day3	62.21	16.19	23-90
	Day7	74.29	18.05	29-100
	Return†	94.12	6.97	73-100
Persistent (n=54)	Baseline	78.19	20.47	17-100
	Week 3	81.26	14.08	39-100
	Week 6	87.4	14.01	29-100

† n=25

Table 4.12 Participation Status According to Day

		No participation	Conditioning only	Limited participation	Full participation
Baseline (n=263)	Uninjured	1 (.4%)	1 (.4%)	6(2.2%)	255(94.1%)
Baseline (n=95)	Injured	5 (5.2%)	16 (16.5%)	15 (15.5%)	59 (60.8%)
Acute (n=28)	Day1	20 (71.4%)	6 (21.4%)	2 (7.1%)	0
	Day3	16 (57.1%)	8 (28.6%)	3 (10.7%)	1 (3.6%)
	Day7	11 (39.3%)	7 (25%)	7 (25%)	3 (10.7%)
	Return†	0	0	0	25 (89.3%)
Persistent (n=54)	Baseline	6 (11.1)	10 (18.5%)	7 (13%)	31 (57.4%)
	Week 3	5 (9.3%)	9 (16.7%)	8 (14.8%)	32 (59.3%)
	Week 6	3 (5.6%)	2 (3.7%)	11 (20.4%)	36 (66.7%)

† n=25

Reliability

The Cronbach alpha score of the overall DPA instrument in injured participants one day following injury (n=28) was 0.908. All items in the scale demonstrated an item total correlation above .20 indicating that it should not be removed. The Cronbach alpha for

the baseline scores of the participants with persistent injuries (n=54) was 0.890. All items in the scale demonstrated an item total correlation above .20 as well. Tables 4.13 and 4.14 illustrate the results for internal consistency in participants with acute and persistent injuries.

Table 4.13 Internal Consistency Values in Acute Participants (n=28)

Item	Mean	Item-Total Correlation	Alpha If Item Removed
Pain	2.78±.74	.560	.905
Motion	3.04±.88	.596	.903
Muscle Performance	2.68±1.16	.667	.900
Stability	2.82±1.12	.711	.899
Changing Directions	2.75±1.48	.465	.909
Daily Actions	2.82±.94	.559	.904
Maintaining Positions	2.14±1.35	.578	.903
Skill 1	3.5±.64	.713	.902
Skill 2	2.67±1.28	.611	.902
Fitness	2.54±1.26	.638	.901
Activities 1	2.54±1.20	.604	.902
Activities 2	3.68±.61	.733	.902
Uncertainty	1.5±1.29	.744	.897
Relationships	.79±1.03	.421	.908
Energy	1.36±1.16	.646	.901
Mood	1.57±1.43	.551	.905

Table 4.14 Internal Consistency Values in Persistent Participants (n=54)

Item	Mean	Item-Total Correlation	Alpha If Item Removed
Pain	2.39±.86	.508	.885
Motion	2.37±.96	.517	.884
Muscle Performance	2.11±1.08	.576	.882
Stability	1.75±1.13	.362	.890
Changing Directions	1.65±1.08	.618	.880
Daily Actions	1.68±1.15	.690	.877
Maintaining Positions	1.94±1.32	.291	.894
Skill 1	2.19±1.26	.642	.879
Skill 2	1.57±1.14	.601	.881
Fitness	1.61±1.27	.630	.880
Activities 1	1.31±1.19	.643	.879
Activities 2	2.25±1.22	.590	.881
Uncertainty	1.54±1.14	.509	.884
Relationships	.63±.98	.506	.885
Energy	.91±1.05	.489	.885
Mood	1.37±1.28	.598	.881

The $ICC_{2,1}$ value of the DPA for all participants (n=52) was 0.969. ICC's remained stable when the participants were stratified according to injury status. The ICC for injured participants (n=31) was 0.943 while the ICC for injury free participants (n=21) was 0.961.

Scale Inventory

The principal factor analysis revealed that the DPA scale had three factors above the Kaiser value. Factors 1 and 2 were labeled "impairo-disability" and "functional limitations" respectively and were comprised of 6 items. Factor three 3 was named "quality of life" and contained 4 items. Table 4.15 illustrates the factor structure of the DPA scale with reference to the anticipated domain for each item.

Table 4.15 Factor Analysis for the DPA Scale (n=94)

			Factors		
Item	**Domain**	**Eigenvalue**	**Impairo-disability**	**Functional Limitations**	**Quality of Life**
Participation in sport of choice	DIS		.750		
Pain	IMP		.743		
Fitness	DIS	7.55	.735		
Muscular performance	IMP		.735		
Motion	IMP		.626		
Participation in leisure	DIS		.616		
Changing directions	FL			.819	
Skill performance 2	FL			.793	
Skill Performance 1	FL	1.79		.610	
Maintaining positions	FL			.559	
Stability	IMP			.560	
Daily actions	FL			.537	
Uncertainty	QOL				.833
Mood	QOL	1.05			.813
Relationships	QOL				.767
Energy	QOL				.728

Validity

The concurrent validity of the DPA scale was calculated with a linear regression in both acute participants (n=28) and persistent participants (n=54). There was an inverse relationship between DPA and GF group means scores (r = -.987, p=.002) in participants

with acute injuries with the DPA mean scores accounting for 97.5% of the variation in GF mean scores (see figure 4.3). DPA and GF group mean scores in participants with persistent injuries also demonstrated an inverse relationship (r = -1.0, p=.003) with all of the variation in GF group mean scores being accounted for by DPA group mean scores (see figure 4.4).

The second set of linear regression comparisons were made for all DPA and GF scores. The relationship between individual DPA and GF scores in participants with acute injuries (n=109) was r = -.751 (p<.001) with DPA score accounting for 56.4% of the variation in GF score. In participants with persistent injury (n=162), the relationship between DPA and GF individual scores was calculated at r = -.714 (p<.001) with DPA scores accounting for 51% of the variation in GF scores.

Figure 4.3 DPA and GF Regression in Acute Participants

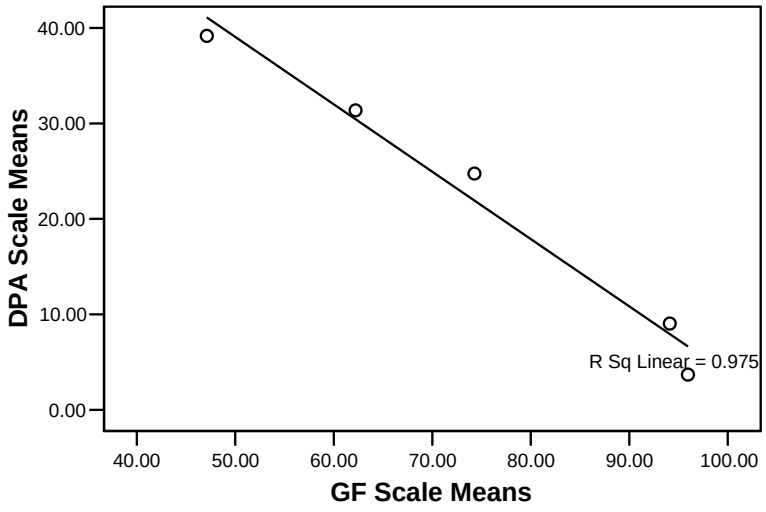
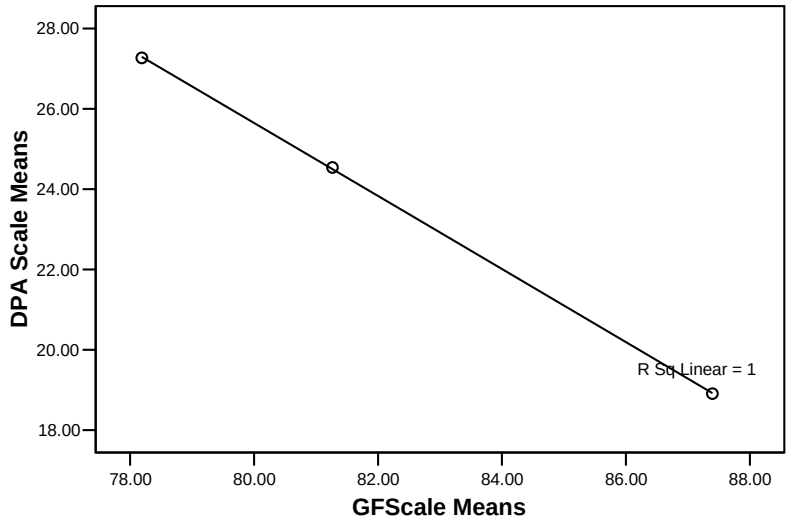


Figure 4.4 DPA and GF Regression in Persistent Participants



Sensitivity

Cohen's ES using pooled variance in participants with acute injuries can be found in Table 4.16. There was a large effect between three separate administrations of the DPA: between baseline and day 1, between day 7 and return to participation, and between day 1 and return. The ES between baseline and day 1, as well as between day 1 and return were markedly larger than other ES measurements. The ES measures in participants with persistent injuries revealed a small effect between baseline and week 3 administrations of the DPA. The ES increased to a large effect between week 3 and baseline as well as between baseline and week 6.

Table 4.16 DPA Effect Size in Participants with Acute and Persistent Injuries

	Day	X1-X2*	ES	Interpretation
Acute	Baseline – Day 1	35.48	-3.86	Large
	Day 1 - Day 3	7.8	0.61	Medium
	Day 3 – Day 7	6.62	0.45	Small
	Day 7 – Return	15.7	1.29	Large
	Day 1- Return	30.12	3.12	Large
Persistent	Baseline – Week 3	2.73	0.38	Small
	Week 3 – Week 6	5.63	1.28	Large
	Baseline – Week 6	8.36	1.63	Large

* X1 = mean of day 1; X2 = mean of day 2

Responsiveness

Fifteen participants (53.6%) with acute injuries reported experiencing a clinically significant change by day 3 after injury. The number increased to 18 participants (64.3%) at day 7 and 24 participants (96%) upon return to full participation. The AUC values constructed for participants with acute injuries ranged between .895 ($p<.001$) to .911 ($p<.001$) for days 3 and 7 respectively (see figures 4.5 and 4.6). An ROC curve could not be plotted for participants upon return to full participation because only one patient reported not having experienced a positive clinically meaningful change. The MCID value calculated for the ROC curve on day 3 was 8.225 points (sensitivity = .733, 1-specificity = .077) while day 7 was 8.5 points (sensitivity = .889, 1- specificity = .100).

Of the participants with persistent injuries 18 (33.9%) reported experiencing a clinically significant change between baseline and week 3. At week 6, 22 participants (42.3%) reported experiencing a clinically significant change. The AUC at week 3 was .702 ($p=.017$) and .902 ($p<.001$) at week 6 (see figures 4.7 and 4.8). The MCID values for weeks 3 and 6 were 5.50 (sensitivity = .611, 1-specificity = .257) and 4.62 (sensitivity = .909, 1-specificity = .233) respectively.

Figure 4.5 ROC Curve for Acute Participants at Day 3

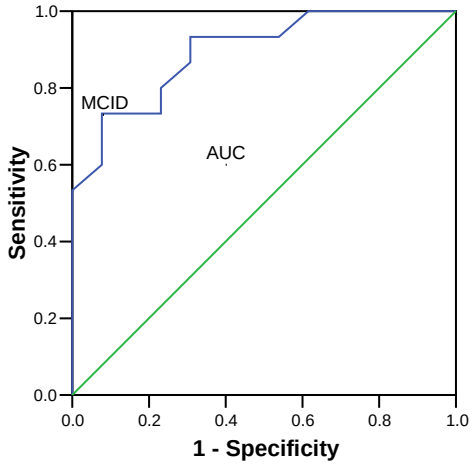


Figure 4.6 ROC Curve for Acute Participants at Day 7

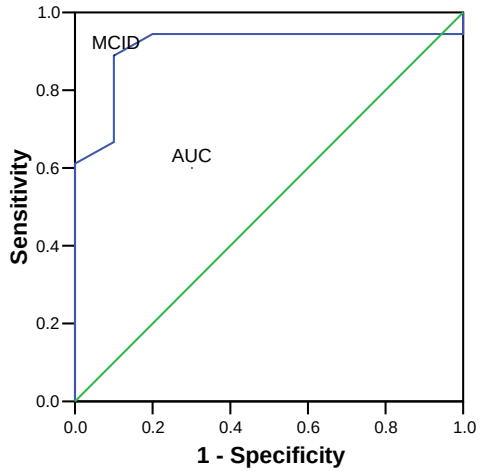


Figure 4.7 ROC Curve for Persistent Participants at Week 3

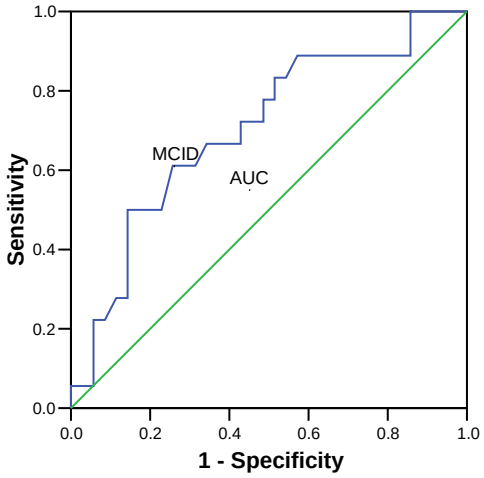
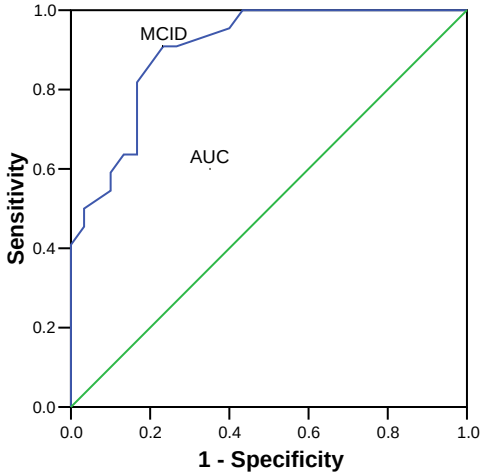


Figure 4.8 ROC Curve for Persistent Participants at Week 6



DISCUSSION

Outcomes measurements have taken several different forms and are used in a variety of ways in the health fields. Nursing and medicine, for example, use clinical pathways rooted in evidence based medicine principles to make clinical decisions regarding patient treatment. Regardless of the use of outcomes information, documenting outcomes is an important part of quality assurance. Athletic training has yet to create a systematic way to

document outcomes for interventions provided by certified athletic trainers. A possible solution that meets both the need for documentation and efficiency is self-report outcomes tools. Self-report outcomes measurements have been shown to be highly predictive of disablement level in a number of studies.[35-37]

Much of the research regarding outcomes literature discusses the importance of using and creating an outcomes tool based in disablement paradigm. Disablement paradigms, such as the one created by the IOM, detail the interrelated but discrete events that ultimately lead to disability. The relationship between disablement components is particularly important and relates directly to the important constructs that are measured after musculoskeletal injury. Gerber et al. found that although patients with lateral ankle sprains complained of impairments 6 months post injury a majority had a positive outcome as predefined by the researchers and had little disablement.[38] This implies that a patient may have little disablement even if impairments are present. This study highlights what Nagi proposed when he created his disablement paradigm now used by the IOM. Impairments are an important part of the disablement paradigm but functional limitations are more directly related to disability and thus have a more substantial impact on disability. Thus, to obtain a broader sense of the effects of disability as experienced by a patient, a multidimensional outcomes instrument is warranted.

The DPA is a multidimensional, self-report outcomes instrument that was created specifically for a physically active population. The psychometric properties of the DPA were tested in order to validate the scale for use in both clinical and research settings.

Standard Values:

The DPA displayed a floor effect with 31.3% of the healthy participants at baseline reporting a perfect score. Since the DPA was created to measure disablement it is intuitive that a high percentage of a healthy population should report a perfect score. Standards regarding floor and ceiling effects state that no more than 10% of subjects should have a floor or ceiling score.[9] The DPA did not meet these standards on two occasions: at baseline with uninjured participants and when participants with acute injury returned to full participation. Floor or ceiling effects did not occur in injured participants with any of the administrations. Typically, lower floor and ceiling scores occurred when the mean score for the associated GF score was below 90%. One of the possible reasons that an instrument could experience floor or ceiling effects is because the instrument does not provide responses with discrete intervals. The DPA was created with a response set that was made to avoid such a problem. The DPA provides a response that allows participants with subtle problems to be identified rather than making a broad jump between “no problem” and “the problem slightly affects me”. Since the DPA was created for a patient undergoing the disablement process it is more appropriate to assess floor and ceiling effects with an injured population.

Reliability:

The Cronbach alpha value for the internal consistency of the DPA in participants with acute injuries was .908. This value only slightly exceeds the value suggested for adequate internal consistency. Upon examining the item-total correlation, no item fell below 0.20 indicating that no item in the scale, if dropped, significantly altered the relationships among other items. The analysis revealed that two items on the scale changed the alpha

score so that it slightly dipped below 0.90 if the items were dropped. The alpha value declined to 0.897 if the item “uncertainty” was dropped from the scale. The drop was even smaller when the item “stability” was removed changing the score to 0.899. Both decreases were not large enough to warrant dropping the items from the scale. The Cronbach alpha of the DPA in participants with persistent injuries fell within the acceptable range with a 0.890. All item-total correlations were above 0.20 so that no items were dropped from the scale for further analysis.

The DPA’s test-retest ICC values were all above 0.75. Therefore, the DPA has excellent test-retest reliability according to values set forth by Shrout and Fleiss.[31] When the injured and uninjured groups were stratified the results of the analysis did not vary a great deal with ICC values of 0.943 and 0.961 for the injured and uninjured groups respectively. The administration of the DPA occurred within a 24-hour period of each other. Some sources maintain that test-retest reliability administration should be distanced by approximately a week to reduce a subjects’ recollection of previous answers.[9, 39] Other published studies have shortened the period between administrations. Williams and Myers used a mean interval of 1.8 days while Hart used an interval that ranged from 24 hours to 72 hours between scale administrations.[40, 41] Marx et al. used a range of days between two to fourteen days.[40] We decided to use a 24 hour period for two reasons: 1) to ensure that the injured subjects did not change significantly over time and 2) to maximize subject adherence to completing the scale.

Scale Inventory

An important part of an appropriate outcomes scale is one that is comprehensive enough to gain a full understanding of disablement, but concise enough to reduce

administrative burden while still maintaining precision.[41] Outcomes experts opine that a quality outcomes tool should be grounded in a disablement theory so as to fully divulge the nature of disablement in a patient. Therefore, an appropriate outcomes tool would measure more than one disablement dimension. The exploratory factor analysis was used to ascertain whether the DPA was truly a multidimensional scale. The DPA was based on the disablement model used by the IOM, which has four distinct components: impairments, functional limitations, disability and quality of life. Therefore, the DPA should contain no more than 4 factors.

The factor analysis with the data from the 94 injured participants revealed that the DPA is a multidimensional instrument. The DPA had three factors rather than the four that were expected, though. The first factor was a mixture of two disablement dimensions: disability and impairments. The second factor was composed of all the functional limitation measurements and one impairment measurement, while the last factor was a combination of all the quality of life items. What is interesting and should be mentioned is that the disablement framework used in this study is based on highly interrelated but distinct components. A factor analysis simply looks at the relationships between subject responses to questions about disablement and not at the relationship between the responses and actual level of disability.

Disability measures constituted much of the first factor and the highest correlations arose from disability measurements in factor 1. It should come as no surprise that the first factor accounted for much of the variability in DPA answers. Ultimately, disability is the biggest complaint for most patients. Although a clinician is typically approached by an injured patient whose main concern is the ability to complete activities that they would

normally do, disability can vary from patient to patient for a number of reasons. One of the reasons stems from the fact that disability is based largely on a patient's expectations.[10, 12, 17] Expectations may even vary amongst competitive athletes.

What is slightly surprising to the researchers is that multiple impairment measures comprised the first factor. A possible explanation may be that patients are trained to think of injury from an impairment perspective. A clinician commonly talks or educates patients about their injury by talking about their impairments. A patient may equate their problem with participating in their sport with signs or symptoms that are easy to see or feel. Rarely, will we find a patient that thinks in the sequential order that is used to describe the disablement process. Regardless, this interesting result may mean that impairment and disability measures are highly related but not necessarily highly predictive of each other.

The next factor is made-up of functional limitations and an impairment measure. The only impairment measurement in this factor, "stability", is associated with the ability of a patient to change directions and to perform actions related to activities which may explain why the participants responded to these questions in a similar way. Self-report outcomes that are rooted in disablement paradigms and contain functional limitations measurements have been shown to be better predictors to return to participation status or disablement.[36, 37, 42, 43] Studies performed by Cross et al. and Wilson and Gansneder demonstrated that self-reported functional measures added significantly to the variation found in subject disability level.[35, 37]

The last factor was composed of all the quality of life items. These items factored together remarkably well and had the highest inter-item correlation values. Health related

quality of life instruments have gained steady recognition in the health fields because they provide a broader picture of how injury truly affects a patient.[44, 45] The DPA has shown that it also contains this dimension of disablement.

Validity

Criterion validity has two forms: concurrent and predictive. Whereas concurrent validity tests an instrument against a gold standard, predictive validity is compared to a desired outcome such as return to play. The GF scale has been used in a number of studies to gain a broad understanding of global functioning as related to one dimension. The psychometric properties of the VAS have been established in previous studies.[13, 21] In particular the VAS is reliable, sensitivity to change, and is often used as a gold standard to establish criterion validity.[14]

We found a high correlation between the group means of the DPA and GF scores in participants with acute injuries. As GF mean scores increased, DPA means decreased signifying that the participants were improving over time. The correlation was significant and DPA mean scores accounted for 98.7% of the variation in GF mean scores. In participants with persistent injuries there was a perfect correlation between GF and DPA mean scores with all the variance in GF mean scores being accounted for by DPA mean scores. These findings establish that the DPA has appropriate concurrent validity and demonstrates that the DPA can be used in a physically active population with musculoskeletal injuries.

The correlation values remained strong when all DPA and GF scores were compared in participants with acute and persistent injuries. In both cases, as GF scores increased

DPA scores decreased. In addition, the DPA accounted for more than 50% of the variation in GF scores (51% for persistent and 56.4% for acute).

Sensitivity

We assessed the DPA's sensitivity to change by calculating pooled variance ES between administrations of the DPA. The greatest effects should occur between baseline and day one of injury, and between day 1 of injury and upon return to participation for participants with acute injuries. The same was not expected in participants with persistent injury. We expected that most subjects with persistent injuries would typically improve over the course of this study but the change was not expected to occur with the same regularity as with an acute injury. Therefore, effect sizes were calculated with patients that reported a clinically significant change via the GRC scale.

Large effects did occur on the two occasions that the researchers had hypothesized as well as on one additional occasion. The largest effect occurred between baseline and day 1 of injury where the mean change was 35.48 points. The ES of –3.86 indicates that scores increased on the DPA between baseline and day 1 administrations. The ES ranged from small to medium on days 3 and 7 but increased to a large effect after day 7. This indicates that change did occur early in the recovery process but not to the same magnitude as after day 7. Mean change scores on the DPA did remain relatively consistent between administrations of the DPA after day 1, but the standard deviations did tend to be larger after injury occurred. In fact, standard deviations increased on day 3 and 7 after injury. Although not ideal, it was expected that variation between patients would occur after injury depending on the injury type and treatment protocols. Fritz and Irrgang found similar large standard deviations in a study that examined the

psychometrics of the Oswestry and Quebec instruments.[22] In addition, the pattern for ES followed the pattern in which patients reported experiencing a clinically significant change. Three days after injury, approximately half of the participants reported having experienced a clinically significant change producing a medium ES. On day 7, the number of subjects with a clinical significant change only slightly increased to 64% producing a small effect. By the last administration of the DPA the number of participants having reported a clinically significant change jumped to 96%, which was reflected in the large ES. Therefore, in participants with acute injuries the DPA has displayed adequate sensitivity to change.

We calculated ES for participants in the persistent injury group who had reported a clinically significant change on the GRC scale. Initially, the ES was small between baseline and the second administration of the DPA at week 3. By this point only 33.9% of the participants had reported experiencing a clinically significant change with an average GRC of 4.94 points indicating a moderate change. By week 6, 42.3% of the participants reported experiencing a clinically significant change with an average GRC of 6.18 points. When we calculated ES between baseline and week 6, an even larger ES was established. The change in effect size may be due to the size of the clinical change between administrations. The small ES at week 3 was produced with fewer participants who reported a smaller clinical effect. At week 6 more participants reported experiencing a clinical effect with a larger magnitude.

Responsiveness

We used two methods for determining the responsiveness of the DPA in participants with acute and persistent injuries. The first measurement, the AUC, was statistically

significant in every analysis in both data sets. Large AUC values indicate that the DPA is highly capable of detecting meaningful changes in an individual's condition.[14] The AUC was not calculated with the last administration of the DPA in acute participants because all but one participant responded that they had experienced a clinically significant change. This did not provide enough data points to allow for an ROC curve to be constructed. The AUC value in participants with persistent injuries at week 3 was also statistically significant but not quite as large as the AUC in participants with acute injuries. The value increased at the 6-week mark when more participants reported experiencing a clinically significant change on the GRC scale.

The second method we used to determine the DPA's responsiveness was intended to help clinicians who use the DPA. Establishing MCID values is important because it provides the clinician with a means of interpreting reports from individual patients. In participants with acute injuries the MCID value ranged from 8.225 to 8.5 points at days 3 and 7 respectively. This means that if a patient with an acute injury were to report an 8 to 9 point change on the DPA scale, then they in most cases have experienced a clinically significant change. In participants with persistent injuries, the MCID values were lower and ranged from 5.5 to 4.62 signifying that a change between 5 to 6 points was clinically significant.

Recent research has contended that the 1-SEM, which is a measure of statistical significance, may be more appropriate for measuring the MCID value.[46] Because research using the 1-SEM measurement has had mixed results, we chose to work with the ROC curve in determining the MCID value. Further research may need to be completed to determine the MCID value for the DPA in a larger sample.

CONCLUSIONS

The results of this study indicate that the DPA is a reliable, valid, sensitive and responsive instrument in physically active participants with musculoskeletal injuries. The test-retest reliability of the DPA was well above the norms for appropriate reliability. The internal consistency of the DPA was slightly higher in participants with acute injuries but fell within acceptable norms in participants with persistent injuries. The DPA group mean scores displayed near perfect concurrent validity when compared to a gold standard. The DPA was a sensitive instrument in participants between baseline, day 1 of injury, and upon return to full participation in participants with acute injuries. The DPA was not as sensitive in participants with persistent injuries although the ES on two separate occasions were still large. Finally, the DPA is an excellent instrument in detecting when participants have undergone a significant change. Furthermore, we established the clinical significant values for the DPA in participants with musculoskeletal injuries.

More research should be conducted to with larger sample sizes and across diverse settings to ensure that the DPA can be used by all certified athletic trainers regardless of setting. In particular, a large scale, prospective study that implements the DPA and clinician-reported outcome variables could be used to demonstrate certified athletic trainers effectiveness with treating and rehabilitating musculoskeletal injuries in the physically active. Furthermore, the DPA can be used in research and clinical practice to assess treatment efficacy. The information garnered by using the DPA adds valuable insight into the complicated puzzle of clinical decision making.

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CHAPTER 5

CONCLUSIONS

Chapter 5

Conclusions

The purpose of this study was to test the psychometric properties of the DPA in physically active participants. Consequently, the researcher tested the DPA's reliability, validity, sensitivity to change and responsiveness. The researcher suggested that the DPA would satisfactorily meet the criteria necessary to demonstrate the appropriate psychometric properties. The first part of this chapter is intended to review the research hypotheses, study results and implications for future research with the DPA. The latter part of this chapter will integrate the major themes of the first four chapters of this dissertation to focus on the big issues in disablement and outcomes assessment.

Hypothesis # 1:

We hypothesized that the standard values reported by the healthy participants would be similar to the lowest possible score on the DPA. In addition, we hypothesized that more than ten percent of the healthy population will experience a floor effect at baseline. We did not expect that floor or ceiling effects would occur on any other administration of the DPA. The DPA standard values for participants with a persistent injury will be higher than the values reported by the healthy participants but lower than the values reported by the acutely injured subjects on day 1 of the DPA administration. We hypothesized that DPA scores would act predictably in participants with acute injuries. We expected that DPA scores would systematically decrease as the number of days after injury increased.

Discussion

The hypotheses concerning the DPA's standard values were accurate with the exception of the expected floor effects. A floor effect occurred twice in this study: with healthy participants at baseline and when acutely injured participants returned to full participation. Although the literature regarding standard values states that an instrument should have no floor or ceiling effects, these findings should be expected if physically fit participants are symptom free.[1] Therefore, the standard values of a disablement instrument may be more appropriately measured in an injured population. Otherwise, the standard values responded in a predictable manner. The mean DPA score in healthy participants (3.68±5.65) was not considerably different than the lowest possible score. The mean DPA scores in participants with acute injuries were higher than in participants with persistent injuries. The DPA mean scores decreased as the number of injury days increased in participants with acute injuries. Finally, the standard values for the baseline administration of the DPA in participants with a persistent injury were higher than the values reported by the healthy participants at baseline.

Hypothesis # 2

We hypothesized that the DPA would demonstrate appropriate internal consistency values in the total scores for each administration of the DPA in participants with acute and persistent injuries. Appropriate internal consistency scores should range between 0.70-0.90. We believed that a subsequent factor analysis of the DPA would demonstrate that the DPA is a multi-dimensional instrument. The expected DPA domains included impairments, functional limitations, disability, and quality of life measures. The DPA

would exhibit appropriate test-retest intraclass correlation coefficient scores above 0.80 in both healthy and injured participants.

Discussion

The DPA demonstrated appropriate internal consistency in participants with persistent participants while the Cronbach alpha value was marginally high in participants with acute injuries. A closer look at the item-total correlations in participants with acute injuries demonstrated that no one item should be eliminated from the scale. In addition, the alpha value only changed slightly if any item was removed from the scale. Therefore, we believe that no item should be removed from the scale.

A subsequent factor analysis revealed that the DPA is a multidimensional tool. Contrary to the research hypothesis, the DPA had only three factors and not the four that we expected. The factors did, however retain easily recognizable domains. The first domain was a combination of disability and impairment items while functional limitation items and quality of life items produced the second and third domain respectively.

The ICC values for test-retest reliability analyses were well above the 0.75 required for excellent test-retest reliability in both the healthy and injured groups.[2] As we expected, the DPA demonstrated ICC values above 0.80.

Hypothesis # 3

We expected that the DPA would demonstrate high concurrent validity when compared to GF scores in participants with acute and persistent injuries. We expected that the DPA would explain a large percentage of variation in GF scores especially in

participants with acute injuries given that acute injuries behave in more predictable patterns.

Discussion

As we expected, the DPA demonstrated excellent concurrent validity. Concurrent validity was established in two ways with both acute and persistent injury groups. The first approach involved using DPA and GF group means in a linear regression in both injury groups. Both analyses demonstrated that the DPA has adequate concurrent validity. The perfect correlation/regression in participants with persistent injuries was contrary to the research hypothesis that predicted a better relationship between the GF and DPA mean scores in participants with acute injuries. The linear regression with DPA and GF group means in participants with acute injuries was near perfect, though, with 97.5% of the variation in GF scores being accounted for by DPA mean scores.

The second analysis also employed a linear regression to examine the relationship between DPA and GF scores, but analyzed GF and DPA individual scores rather than group means. The relationships, although not as strong, were still statistically significant in both groups of participants. As we hypothesized, the relationship between DPA and GF scores was larger in participants with acute injuries with 56.4% of the variation in GF scores being explained by DPA scores. The analysis in participants with persistent injuries demonstrated that the DPA explained 51% of the variation in GF scores. Like the previous analysis the DPA demonstrated adequate concurrent validity when compared to a participants perceived level of functioning.

Hypothesis # 4

We expected that the DPA would be sensitive to change in both the acute and persistent injury groups and would demonstrate large effect sizes in participants that have experienced a clinically significant change. We expected that the largest effects would be seen on two occasions: between DPA scores in healthy participants and one day after acute injury, and between DPA scores on one day after injury and upon the participants' return to full participation. We expected large effects in participants with persistent injuries but did not expect that they will present in a predictable manner.

Discussion

The DPA demonstrated sensitivity to change in participants with acute and persistent injuries. Large effects were seen on three occasions in the acute injury group. We had predicted large effects on two of the three occurrences: between baseline and day 1 of injury and between day 1 and upon to return to participation. The third large effect, which we had not expected, occurred between day 7 and upon return to full participation. In all instances large effects were found when a large number of participants reported a clinically significant change in their status as reported on the GRC scale. The large effect sizes between DPA administrations indicate that the DPA is a sensitive instrument.

Large effects were seen between DPA administrations in participants with persistent injuries as well. The largest effects were found on two occasions: between week 3 and week 6 and between baseline and week 6 of injury. A small effect was calculated between baseline and week 3 when only 33% of the participants reported experiencing a clinically significant change. We believe that there are two possible explanations for the small ES. The corresponding average GRC score at week 3 was 4.94 points whereas the

average GRC at week 6 was 6.18 signifying a greater change occurred later for participants with persistent injuries. In addition, the mean difference between baseline and week 3 DPA scores was a smaller value at 2.73 points when compared to the 5.63 and 8.36 point changes that occurred between weeks 3 and 6 and between baseline and week 6 respectively. We also expected that the effects would not be as large for participants with persistent injuries because they are typically slower to change and more stable over time. Despite the small effect between baseline and week 3, the researcher believe that the DPA is a sensitive instrument in participants with persistent injuries.

Hypothesis # 5

We expected that the DPA would demonstrate appropriate responsiveness by obtaining a statistically significant AUC value determined by a receiver operating characteristic (ROC) curve. In addition, we expected to determine the DPA's clinical significance by calculating a MCID value for participants with persistent and acute injuries. We expected that the MCID value would be larger in participants with acute injuries than in participants with persistent injuries. We also expected that the MCID values would behave consistently on every administration of the DPA in both sets of participants.

Discussion

The DPA produced a statistically significant AUC value on all occasions that a ROC curve was constructed: days 3 and 7 for acute participants and weeks 3 and 6 for persistent participants. The significant AUC values indicate that the DPA is a responsive instrument that is able to distinguish between participants who have and have not experienced a clinically meaningful change as reported on a GRC scale.

We determined the MCID value for the DPA in both acute and persistent injury groups. The value for the participants with acute injuries was larger (8-9 points) than the value (5-6 points) for participants with persistent injury as the researcher expected. In both sets of participants the MCID values were consistent between the ROC curves that were created on days 3 and 7 as well as on weeks 3 and 6. The MCID represents the change value on the DPA scale that indicates that the participant has undergone a clinically significant change. This value is particularly useful for clinicians that use the DPA instrument to measure treatment efficacy.

Future Research with the DPA

This research project lays the groundwork by testing the psychometrics of the DPA in a physically active population. This study was somewhat limited by the size of acute and persistent injury groups so that future research is warranted with larger sample sizes. In addition, more research needs to be completed with specific injury groups to validate the use of the DPA for randomized controlled trials. We believe that one of the strengths of the DPA is that it is a multidimensional instrument based on a disablement paradigm. Thus, the DPA should be used in research to better understand the effects of disablement on the physically active. Moreover, the DPA should be used to elucidate the ways in which injuries are affected through various treatment interventions. Studies similar to those completed by Cross et al. and Wilson and Gansnedar need to be completed to select the disablement variables that are truly telling of a patients' disability level using the DPA.[3, 4] Similar to the work that has been completed with the SF-36, we believe that the

DPA may be condensed to contain fewer items while maintaining its strengths: reliability, validity, sensitivity and responsiveness.

Bridging the Gap Between Theory and Practice

The second part of this chapter is meant to summarize what is known and unknown about disablement and outcomes research as well as cover some of the implications for athletic training. I believe that there are two important content areas that need to be discussed: 1) disablement as the theoretical underpinning of outcomes assessment and 2) the role of outcomes assessment in quality assurance in athletic training practice.

Disablement Theory and Practice

Disablement paradigms have been well established in a general population, but have not been applied to a physically active population. I used grounded theory methods to create a descriptive model explaining how a physically active person with a musculoskeletal injury experiences disablement. What is now known about disablement is just the tip of the iceberg in disablement research. Further qualitative and quantitative studies are needed to fully create a model that explains relationships between and among disablement components as well as how they are experienced following a variety of musculoskeletal injuries. The premise of the first study I performed was to understand disablement in injuries that follow known and understood patterns. This same methodology can be used to shed some light on injuries that are more complex, such as low back pain.

Of particular interest to me were two concepts that I feel help to explicate the normal disablement process and variations occurring in a physically active population. These concepts are highly related yet distinct.

The first concept is clearly spelled out in the Nagi's disability definition where he made clear that patient expectations are important.[5] It is not surprising to find that physically active persons have different expectations than a sedentary population. Disablement likely affects these two populations quite differently. It is important to take into account a patient's expectations throughout the recovery process and not focus strictly on variables that can be measured objectively. By changing the focus from impairment to disablement measurements, certified athletic trainers (ATC) might find that research is more meaningful and illuminating. Therefore, I feel that in order to fully understand disablement ATCs must understand patient expectations. ATCs must also understand how the disablement process is experienced. This information could be used collectively to create valuable outcomes instruments for research and clinical use. A number of studies have shown self-report, multidimensional instruments to be valid and reliable.[6-8] In fact, self–report information are more predictive of recovery from an injury than objective measurements.[3] Hence, ATCs are not limited to clinician reported instruments to gain more information about treatment efficacy or clinician effectiveness.

The second concept that is related to expectations is what I call "functionality". This term refers to the concept that disability occurs when there is a gap between actual function and desired function.[9] Buchner and de Lateur demonstrated this concept well in their study of elderly persons lower extremity muscular strength losses.[10] They found that although many elderly people experience losses of muscle strength as they age, disability

wasn't as pronounced in this population. Most elderly participants were still functionally able to subsist on a day-to-day basis so that disablement was negligible. The same cannot be expected in a physically active population where the necessity to be highly functional is imperative. What makes this concept potentially more complicated is that there may be functional requirement variations even within the physically active community. A runner may not be affected as greatly by a shoulder injury as a baseball player. Nonetheless, the runner will still have problems with activities of daily living such as reaching and lifting. A clinician must determine the full spectrum of a patient's "functionality" expectations. The implications are that ATCs must take functionality into account in all aspects if life including sport and activities of daily living. By doing this, ATCs will examine disablement from a global perspective

Quality Assurance in Practice

Systematic outcomes measurement is important for the continued growth of the athletic training field in two closely related but distinct areas: quality assurance and evidence based practice. A treatment's outcome is largely dependent on processes as outlined by Donaebedian.[11] Regular outcomes measurement of important clinical variables ensures that we, as a profession, are assessing our clinical practices. In fact, this practice is so essential to our field that it is clearly stated in the National Athletic Trainers' Association Standards of Practice.

What is surprising is that on the whole, outcomes are not regularly assessed. Part of the reason that other health care professions have exceeded athletic training in outcomes assessment has been managed care. Within most professions, third party reimbursement

exerts an ever increasing pressure to demonstrate treatment's efficacy. Some people, like myself, see athletic training's relative freedom from managed care as a positive aspect of our profession. Unfortunately, systematic outcomes measurement is a beneficial aspect of managed care that ATCs do not reap.

There are some valuable lessons to be learned from other health professions and the ways in which outcomes assessments are integrated into clinical practice. I believe that athletic training is at a critical crossroad where the profession can choose a path of growth that will integrate athletic training into new settings. Outcome measurement, however, must be available if growth is to occur. Athletic training, like medicine, can choose to modify an existing database such as the National Collegiate Athletics Association injury surveillance system to measure outcomes. Like nursing, athletic training can create clinical pathways that include timelines and incorporate multiple health care practitioners to improve the treatment process. Athletic training can take the route of clinical research with controlled trials that measure treatment efficacy. Regardless of the path or paths taken, our profession should create a strategy that guarantees the incorporation of evidence-based practice and outcomes measurement into daily practice.

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APPENDIX A

INFORMED CONSENT FORM FOR SOCIAL SCIENCE RESEARCH
The Pennsylvania State University

Title of Project:

Validation of an Athletic Training Outcomes Survey for the Physically Active

Principal Investigator:

Luzita Vela, MS, ATC
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Academic Advisor:

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1. Purpose of the Study:
The purpose of this project is to test a survey created for physically active people that have experienced a sport related injury.

2. Procedures to be followed:
You may enter this study at three different points. The first point is prior to injury while the next two points are after you 1) experience a new athletic injury or 2) after you have had persistent problems from an injury for at least one month.

Step 1: If you enter the study while you are healthy, you will be expected to complete a packet of papers that asks about how well you function in physical activity and daily activities. The packet will take approximately 15 minutes to complete. You may also be asked to complete one questionnaire that takes five minutes to complete within 24 hours of completing the same questionnaire for the first time.

Step 2: Acute Injury Group
If you suffer a new injury during physical activity, you will be asked to complete another set of questionnaires within 24 hours of your injury and again on days 3, 7, and when you are released back into full activity. The set of questionnaires will take approximately 15 minutes to complete each.

OR

Step 3: Persistent Injury Group
If you experience problems from an athletic injury for longer than a month, you will be asked to complete a set of questionnaires after 3 weeks and again in 6 weeks. The set of questionnaires will take approximately 15 minutes to complete each.

3. Discomforts and Risks:
Some of the questions relate to your quality of life and may seem somewhat intrusive to you. The risk of this happening is small and your information will be kept confidential at all times. You have the opportunity to refuse to answer any questions that you choose.

4. Benefits:

a. The benefits to me:
There are no direct benefits to you.
b. The benefits to society:
Your participation will benefit athletic trainers and other injured physically active persons by helping to validate a survey that can be used by athletic trainers to make sure that they are treating an athlete in the best possible way.

5. Duration/Time:
Your participation in this study will take approximately 15 minutes to complete the baseline questionnaires. If you become injured you will be asked to complete the same set of questionnaires again 4 times totaling approximately one hour of time. If you are placed in the persistent injury group you will be asked to complete the same set of questionnaires again on 2 separate occasions totaling approximately 30 minutes.

6. Statement of Confidentiality:
Your participation in this study is confidential. Only the investigators will have access to personal identifiers and to
any information that can be associated with your identity. All information that you complete will have a code number assigned rather than your name to ensure your confidentiality. Although your athletic trainer(s) may know of your participation in this study, they will not have access to any of the surveys that you complete. All completed surveys will be stored in a locked file cabinet in the Penn State Athletic Training Research Laboratory. In the event of publication of the research, no personally identifying information will be disclosed.

7. Right to Ask Questions:
You may ask questions about the research procedures and your questions will be answered. Further questions should be directed to Luzita Vela at liv102@psu.edu or 814-865-7936 (office).

You may also contact the Office of Research Protection, 212 Kern Graduate Building, University Park, PA 16802, 814-865-1775 for additional information concerning your rights as a research participant.

8. Voluntary Participation:
Your participation is completely voluntary and that you can withdraw from the study at any time by notifying Ms. Vela with no adverse consequences.

You have been given an opportunity to ask any questions that you may have and all such questions or inquiries have been answered to your satisfaction.

You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records.

_____
Participant Name (please print in all caps)

_____ _____
Participant Signature Date

I, the undersigned, verify that the above informed consent procedure has been followed.

_____ _____
Investigator Signature Date

CHILD ASSENT FORM FOR SOCIAL SCIENCE RESEARCH
The Pennsylvania State University

Title of Project:

Validation of an Athletic Training Outcomes Survey for the Physically Active

Principal Investigator:

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814-865-2725

9. Purpose of the Study:
The purpose of this project is to test a survey created for physically active people that have experienced a sport related injury.

10. Procedures to be followed:
You may enter this study at three different points. The first point is prior to injury while the next two points are after you 1) experience a new athletic injury or 2) after you have had persistent problems from an injury for at least one month.

Step 1: If you start the study while you are healthy, you will be expected to complete a packet of papers that asks about how well you function in physical activity and daily activities. The packet will take approximately 15 minutes to complete. You may also be asked to complete one questionnaire that takes five minutes to complete within 24 hours of completing the same questionnaire for the first time.

Step 2: Acute Injury Group
If you suffer a new injury during physical activity, you will be asked to complete a set of questionnaires within 24 hours of your injury and again on days 3, 7, and when you are release back into full activity. The set of questionnaires will take approximately 15 minutes to complete each.

OR

Step 3: Persistent Injury Group
If you experience problems from an athletic injury for longer than a month, you will be asked to complete a set of questionnaires after 3 weeks and again in 6 weeks. The set of questionnaires will take approximately 15 minutes to complete each.

11. Discomforts and Risks:
Some questions are personal and so you may feel some slight discomfort when answering them. The risk that this will happen is small and all information that you share will be kept confidential. You have the opportunity to refuse to answer any questions that you choose.

12. Benefits:
a. The benefits to me:

There are no direct benefits to you.

b. The benefits to society:

Your participation will benefit athletic trainers and people who participate in sports. Athletic trainers can use the survey to make better treatment choices.

13. Duration/Time:

Your participation in this study will take approximately 15 minutes to complete the baseline questionnaires. If you experience a new injury you will be asked to complete the same set of questionnaires again 4 times totaling approximately one hour of time. If you are placed in the persistent injury group, you will be asked to complete the same set of questionnaires again on 2 separate occasions totaling approximately 30 minutes.

14. Statement of Confidentiality:

Your participation in this study is confidential. Only the investigators will have access to personal identifiers and to the information that can be associated with your identity. All information that you complete will have a code number assigned rather than your name to ensure your confidentiality. Although your athletic trainer(s) may know of your participation in this study, they will not have access to any of the surveys that you complete. All completed surveys will be stored in a locked file cabinet in the Penn State Athletic Training Research Laboratory. In the event of publication of the research, no personally identifying information will be disclosed.

15. Right to Ask Questions:

You may ask questions about the research procedures and the questions will be answered. Further questions should be directed to Luzita Vela at liv102@psu.edu or 814-865-7936 (office).

You may also contact the Office of Research Protection, 212 Kern Graduate Building, University Park, PA 16802, 814-865-1775 for additional information concerning your rights as a research participant.

16. Voluntary Participation:

Your participation is completely voluntary and that you can withdraw from the study at any time.

When you sign your name, this means that you agree to participate in the study and that all of your questions have been answered satisfactorily. You will be given a copy of this consent form to keep for your records.

_____

Your Name (please print in all caps)

_____ _____

Minor's Signature Date

I, the undersigned, verify that the above informed consent procedure has been followed.

_____ _____

Investigator Signature Date

PARENTAL INFORMED CONSENT FORM
FOR SOCIAL SCIENCE RESEARCH
The Pennsylvania State University

Title of Project:

Validation of an Athletic Training Outcomes Survey for the Physically Active

Principal Investigator:

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17. Purpose of the Study:
The purpose of this project is to test a survey created for physically active people that have experienced a sport related injury.

18. Procedures to be followed:
Your child may enter this study at three different points. The first point is prior to injury while the next two points are after your child 1) experiences a new athletic injury or 2) after your child has had persistent problems from an injury for at least one month.

Step 1: If your child enters the study while healthy, he/she will be expected to complete a packet of papers that asks about his/her level of function in physical activity and during daily activities. The packet will take approximately 15 minutes to complete. Your child may also be asked to complete one questionnaire that takes five minutes to complete within 24 hours of completing the same questionnaire for the first time.

Step 2: Acute Injury Group
If your child suffers a new injury during physical activity, he/she will be asked to complete a set of questionnaires within 24 hours of his/her injury and again on days 3, 7, and when he/she is released back into full activity. The set of questionnaires will take approximately 15 minutes to complete each.

OR

Group 2: Persistent Injury Group
If your child experiences problems from an athletic injury for longer than a month, he/she will be asked to complete a set of questionnaires after 3 weeks and again in 6 weeks. The set of questionnaires will take approximately 15 minutes to complete each.

19. Discomforts and Risks:
Some of the questions relate to your child's quality of life and may seem somewhat intrusive to him/her. The risk that this will happen is small and your child's information will be kept confidential at all times. Your child also has the opportunity to refuse to answer any questions that he/she chooses.

20. Benefits:

a. The benefits to me:

There are no direct benefits to your child

b. The benefits to society:

Your child's participation will benefit athletic trainers and other injured physically active persons by helping to validate a survey that can be used by athletic trainers to make sure that they are treating an athlete in the best possible way.

21. Duration/Time:

Your child's participation in this study will take approximately 15 minutes to complete the baseline questionnaires. If your child experiences a new injury he/she will be asked to complete the same set of questionnaires again 4 times totaling approximately one hour of time. If he/she is placed in the persistent injury group he/she will be asked to complete the same set of questionnaires again on 2 separate occasions totaling approximately 30 minutes.

22. Statement of Confidentiality:

Your child's participation in this study is confidential. Only the investigators will have access to personal identifiers and to the information that can be associated with your child's identity. All information that your child completes will have a code number assigned rather than your name to ensure your child's confidentiality. Although your child's athletic trainer(s) may know of his/her participation in this study, they will not have access to any of the surveys that your child completes. All completed surveys will be stored in a locked file cabinet in the Penn State Athletic Training Research Laboratory. In the event of publication of the research, no personally identifying information will be disclosed.

23. Right to Ask Questions:

Your child and I may ask questions about the research procedures and the questions will be answered. Further questions should be directed to Luzita Vela at liv102@psu.edu or 814-865-7936 (office). You and your child may also contact the Office of Research Protection, 212 Kern Graduate Building, University Park, PA 16802, 814-865-1775 for additional information concerning my rights as a research participant.

24. Voluntary Participation:

Your child's participation is completely voluntary and that he/she can withdraw from the study at any time with no adverse consequences by notifying Ms. Vela.

You have been given an opportunity to ask any questions you may have and all such questions or inquiries have been answered to your satisfaction.

You must be 18 years of age or older to consent to your child's participation in this research study. If you consent to your child's participation in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records.

I give permission for my child, _____, to participate in this research project

(Please print in all caps)

_____ _____

Parent's Signature Date

I, the undersigned, verify that the above informed consent procedure has been followed.

_____ _____

Investigator Signature Date

APPENDIX B

To be completed by the Principal Investigator
Subject ID:_____

Disability in the Physically Active Scale

Instructions: Please answer **each statement** with one response by shading the circle that most closely describes your problem(s) within the past **24 hours.** Each problem has possible descriptors under each and not all descriptors may apply to you but are given as common examples.

KEY
1 - no problem
2 - I have the problem(s), but it does not affect me
3 - The problem(s) slightly affects me
4 - The problem(s) moderately affects me
5 - The problem(s) severely affects me

	No problem	Does not affect	Slight	Moderate	Severe
	1	**2**	**3**	**4**	**5**
Pain – *"Do I have **pain**?"*	O	O	O	O	O
Motion - "*Do I have impaired **motion**?"* **Ex.** decreased range/ease of motion, flexibility, and/or increased stiffness	O	O	O	O	O
Muscular Functioning - *"Do I have impaired **muscle function**?"* **Ex.** decreased strength, power, endurance, and/or increased fatigue	O	O	O	O	O
Stability - *"Do I have impaired **stability**?"* **Ex**. the injured area feels loose, gives out, or gives way	O	O	O	O	O
Changing Directions – *"Do I have difficulty with **changing directions** in activity?"* **Ex.** twisting, turning, starting/stopping, cutting, pivoting	O	O	O	O	O
Daily Actions – "*Do I have difficulty with **daily actions** that I would normally do?"* **Ex**. walking, squatting, getting up, lifting, carrying, bending over, reaching, and going up/down stairs	O	O	O	O	O
Maintaining Positions – *"Do I have difficulty **maintaining the same position** for a long period of time?"* **Ex.** standing, sitting, keeping the arm overhead, or sleeping	O	O	O	O	O
Skill Performance – *"Do I have difficulties with **performing skills** that are required for physical activity?"*					
1.) **Ex**. running, jumping, kicking, throwing, & catching	O	O	O	O	O
2.) **Ex.** coordination, agility, precision & balance	O	O	O	O	O
Overall Fitness - *"Do I have difficulty maintaining my **fitness** level?"* **Ex**. conditioning, weight lifting & cardiovascular endurance	O	O	O	O	O
Participation in Activities – *"Do I have difficulty with **participating in activities**?"*					
1.) **Ex**. participating in leisure activities, hobbies, and games	O	O	O	O	O
2.) **Ex.** participating in my sport(s) of preference	O	O	O	O	O
Well-Being – *"Do I have difficulties with the following…?"*					
1.) Increased uncertainty, stress, pressure, and/or anxiety	O	O	O	O	O
2.) Altered relationships with team, friends, and/or colleagues	O	O	O	O	O
3.) Decreased overall energy	O	O	O	O	O
4.) Changes in my mood and/or increased frustration	O	O	O	O	O

PHYSICAL ACTIVITY PARTICIPATION STATUS

Please circle the phrase that best represents your current status in physical activity

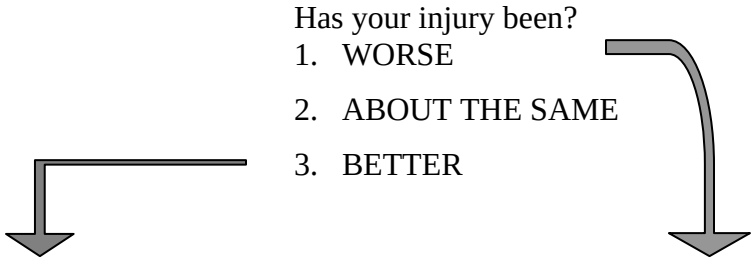
1. no participation
2. participation in conditioning (weight lifting, cardio, etc..), but unable to participate in sport
3. limited participation in sport
4. full participation in sport

GLOBAL FUNCTIONING SCALE

Consider your ability to complete normal, daily activities is 100% on the scale you see below. Rate how well you are functioning now when compared to normal by marking a perpendicular line on the scale below.

GLOBAL RATING OF CHANGE SCALE (Acute)

Overall, has there been a change in your injury status since the time that you were injured? Please indicate if there has been any change by circling one of the following options.



If better, circle the most appropriate answer from the scale below

1. Almost the same, hardly any better at all
2. A little better
3. Somewhat better
4. Moderately better
5. A good deal better
6. A great deal better
7. A very great deal better

If worse, circle the most appropriate answer from the scale below

1. Almost the same, hardly any worse at all
2. A little worse
3. Somewhat worse
4. Moderately worse
5. A good deal worse
6. A great deal worse
7. A very great deal worse

APPENDIX C

Figure Test Re-Test Values in All Participants (n=52)

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.969	.946	.982	63.140	51	52	.000
Average Measures	.984	.973	.991	63.140	51	52	.000

One-way random effects model where people effects are random.

Figure Test Re-Test Values in Injury Free Participants (n=21)

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.961	.907	.984	49.936	20	21	.000
Average Measures	.980	.951	.992	49.936	20	21	.000

One-way random effects model where people effects are random.

Figure Test Re-Test Values in Injured Participants (n=31)

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.943	.885	.972	33.821	30	31	.000
Average Measures	.970	.939	.986	33.821	30	31	.000

One-way random effects model where people effects are random.

Figure Item Statistics on Day 1 after Injury (n=28)

	Mean	Std. Deviation	N
fitness1	2.5357	1.26146	28
stabil1	2.8214	1.12393	28
muscle1	2.6786	1.15642	28
daily1	2.8214	.94491	28
directi1	2.7500	1.48137	28
Participation in Activities 1 - Day 1	2.5357	1.20130	28
Participation in Activities 2 - Day 1	3.6786	.61183	28
motion1	3.0357	.88117	28
positio1	2.1429	1.35303	28
skill11	3.5000	.63828	28
skill21	2.6667	1.27657	28
pain1	2.7778	.73703	28
uncer1	1.5000	1.29099	28
rela1	.7857	1.03126	28
energy1	1.3571	1.16155	28
mood1	1.5714	1.42539	28

Figure Inter-Item Correlation Matrix on Day 1 after Injury

	fitness	stabil	muscle	daily	directi	Activities 1	Activities 2	motion	positio	skill1	skill2	pain	uncer	rela	energy	mood
fitness	1.000	.514	.681	.394	.292	.341	.567	.182	.518	.575	.291	.403	.625	.234	.395	.421
stabil	.514	1.000	.581	.771	.617	.403	.667	.642	.431	.490	.490	.343	.472	.157	.419	.205
muscle	.681	.581	1.000	.386	.297	.395	.529	.121	.385	.627	.351	.478	.608	.375	.530	.385
daily	.394	.771	.386	1.000	.364	.348	.602	.453	.368	.461	.307	.301	.410	.111	.263	.244
directi	.292	.617	.297	.364	1.000	.286	.644	.575	.240	.333	.757	.151	.145	-.036	.291	.000
Activity	.341	.403	.395	.348	.286	1.000	.445	.471	.521	.362	.555	.265	.418	.305	.442	.442
Activity	.567	.667	.529	.602	.644	.445	1.000	.503	.371	.711	.569	.329	.445	.298	.324	.346
motion	.182	.642	.121	.453	.575	.471	.503	1.000	.337	.494	.691	.228	.374	.213	.421	.278
positio	.518	.431	.385	.368	.240	.521	.371	.337	1.000	.429	.415	.479	.530	.129	.296	.379
skill1	.575	.490	.627	.461	.333	.362	.711	.494	.429	1.000	.561	.385	.539	.394	.500	.366
skill2	.291	.490	.351	.307	.757	.555	.569	.691	.415	.561	1.000	.157	.277	.244	.375	.149
pain	.403	.343	.478	.301	.151	.265	.329	.228	.479	.385	.157	1.000	.657	.363	.389	.619
uncer	.625	.472	.608	.410	.145	.418	.445	.374	.530	.539	.277	.657	1.000	.501	.692	.725
rela	.234	.157	.375	.111	-.036	.305	.298	.213	.129	.394	.244	.363	.501	1.000	.499	.565
energy	.395	.419	.530	.263	.291	.442	.324	.421	.296	.500	.375	.389	.692	.499	1.000	.566
mood	.421	.205	.385	.244	.000	.442	.346	.278	.379	.366	.149	.619	.725	.565	.566	1.000

The covariance matrix is calculated and used in the analysis.

Figure Item Statistics at Baseline in Persistent Subjects (n=54)

	Mean	Std. Deviation	N
pain_pers	2.3889	.85598	54
motion_pers	2.3704	.95752	54
muscle_pers	2.1111	1.07575	54
stabilit_pers	1.7547	1.13113	54
directio_pers	1.6481	1.08432	54
daily_pers	1.6792	1.14552	54
position_pers	1.9444	1.32347	54
skill1_pers	2.1852	1.26004	54
skill2_pers	1.5741	1.14269	54
fitness_pers	1.6111	1.26516	54
active1_pers	1.3148	1.19471	54
active2_pers	2.2453	1.22714	54
uncertai_pers	1.5370	1.14452	54
relation_pers	.6296	.97702	54
energy_pers	.9057	1.05086	54
mood_pers	1.3704	1.27821	54

Figure Inter-Item Correlation Matrix at Baseline with Persistent Participants (n=54)

	pain	motion	muscle	stabilit	direct	daily	position	skill1	skill2	fitness	active 1	active 2	uncert ai	relatio n	energ y	mood
pain	1.000	.558	.464	.315	.211	.399	.053	.264	.250	.526	.376	.348	.226	.198	.249	.331
motion	.558	1.000	.674	.364	.328	.391	.106	.270	.285	.448	.358	.427	.056	.250	.165	.225
muscle	.464	.674	1.000	.469	.277	.453	.296	.346	.346	.462	.515	.529	.089	.094	.141	.203
stabilit	.315	.364	.469	1.000	.336	.336	.161	.181	.330	.163	.240	.245	.064	.245	.063	.015
directio	.211	.328	.277	.336	1.000	.469	.302	.615	.562	.394	.408	.385	.414	.284	.270	.354
daily	.399	.391	.453	.336	.469	1.000	.333	.556	.460	.472	.622	.386	.220	.403	.445	.362
position	.053	.106	.296	.161	.302	.333	1.000	.346	.296	.133	.143	.096	.145	.042	.132	.146
skill1	.264	.270	.346	.181	.615	.556	.346	1.000	.541	.330	.374	.568	.440	.271	.283	.437
skill2	.250	.285	.346	.330	.562	.460	.296	.541	1.000	.340	.335	.426	.395	.363	.250	.330
fitness	.526	.448	.462	.163	.394	.472	.133	.330	.340	1.000	.569	.558	.368	.324	.243	.511
active1	.376	.358	.515	.240	.408	.622	.143	.374	.335	.569	1.000	.509	.247	.328	.505	.392
active2	.348	.427	.529	.245	.385	.386	.096	.568	.426	.558	.509	1.000	.190	.199	.174	.386
uncertai	.226	.056	.089	.064	.414	.220	.145	.440	.395	.368	.247	.190	1.000	.536	.543	.764
relation	.198	.250	.094	.245	.284	.403	.042	.271	.363	.324	.328	.199	.536	1.000	.610	.565
energy	.249	.165	.141	.063	.270	.445	.132	.283	.250	.243	.505	.174	.543	.610	1.000	.503
mood	.331	.225	.203	.015	.354	.362	.146	.437	.330	.511	.392	.386	.764	.565	.503	1.000

The covariance matrix is calculated and used in the analysis.

Figure Factor Analysis with Acute and Persistent Participants

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.548	47.177	47.177	7.548	47.177	47.177	4.008	25.047	25.047
2	1.790	11.185	58.362	1.790	11.185	58.362	3.366	21.037	46.085
3	1.047	6.543	64.905	1.047	6.543	64.905	3.011	18.821	64.905
4	.916	5.726	70.632						
5	.721	4.506	75.137						
6	.653	4.082	79.219						
7	.550	3.436	82.656						
8	.485	3.031	85.687						
9	.462	2.887	88.574						
10	.383	2.396	90.970						
11	.376	2.350	93.320						
12	.321	2.004	95.324						
13	.237	1.482	96.806						
14	.198	1.239	98.045						
15	.186	1.160	99.204						
16	.127	.796	100.000						

Extraction Method: Principal Component Analysis.

Figure Rotated Component Matrix in Factor Analysis

	Component		
	1	2	3
fitness1	.735	.226	.311
stabil1	.453	.560	.006
muscle1	.707	.330	.174
daily1	.539	.537	.205
directi1	.246	.819	.099
Participation in Activities 1 - Day 1	.616	.386	.283
Participation in Activities 2 - Day 1	.750	.398	.083
motion1	.626	.403	.096
positio1	.073	.559	.224
skill11	.468	.610	.266
skill21	.310	.793	.214
pain1	.743	-.015	.309
uncer1	.214	.166	.833
rela1	.117	.149	.767
energy1	.121	.315	.728
mood1	.363	.038	.813

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Figure DPA and GF Regression in Persistent Participants

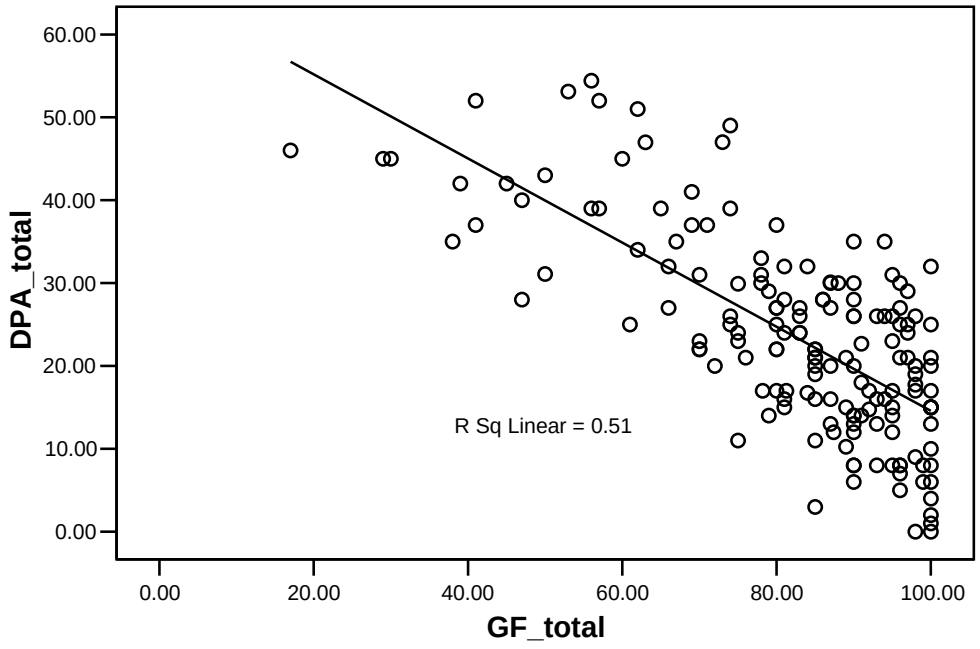
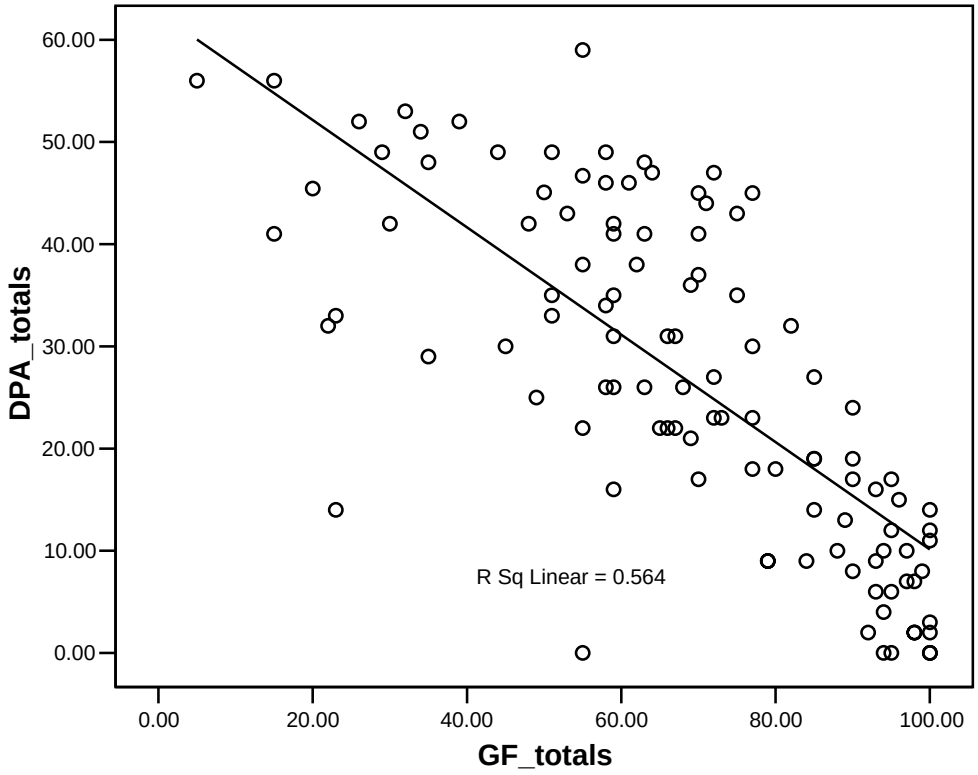


Figure DPA and GF Regression in Acute Participants



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EDUCATION

2002-2005 **The Pennsylvania State University**
PhD: Kinesiology with a Specialization in Athletic Training *GPA: 3.66/4.0*

1998 - 2000 **Barry University**
Masters of Science: Athletic Training *GPA: 3.8/4.0*

1993 - 1998 **Texas Woman's University**
Bachelors of Science: Kinesiology *GPA: 3.79/4.0*

CERTIFICATIONS

National Athletic Trainers' Association Board of Certification, No. 119802613

Commonwealth of Pennsylvania Department of State Athletic Trainer License, No. RT003217

American Red Cross Professional Rescuer

PROFESSIONAL SERVICE

2003 – Present Journal of Athletic Training, Manuscript Reviewer

2003 & 2004 National Athletic Trainers' Association Meeting and Clinical Symposia, Moderator

2001-2002 Michigan Athletic Trainers' Society Student Athletic Trainer Committee, Secretary

SELECTED HONORS AND AWARDS

2004 Doctoral Student Presentation Nominee, NATA-REF

2003 Doctoral Student Presentation Nominee, NATA-REF

2002-2005 The Pennsylvania State University Bunton-Waller Fellow

SCHOLARLY ACTIVITY

PUBLICATIONS:

Olmsted LC, **Vela LI**, Denegar CR, Hertel J. Prophylactic ankle taping and bracing: A numbers needed to treat analysis. *J Athl Train*. 2004;39(1): 95-100.

Vela LI, Tourville TW, Hertel J. Physical examination of acutely injured ankles: An evidence-based approach. *Athletic Therapy Today*. 2003; 8(5): 13-19.

Vela L. Quality of life in athletic training: A look forward [editorial]. *Athletic Therapy Today*. 2001: 6(3).