DETERMINING RETURN-TO-PLAY PREDICTORS FOLLOWING
NON-SEASON ENDING INJURIES

A Thesis in
Kinesiology
by
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ABSTRACT

An objective assessment tool to assist certified athletic trainers (ATCs) in return to play (RTP) decisions of non-season ending injuries is not well established. This creates challenges in the RTP decision making process for sports medicine practitioners. Therefore, the purposes of this study were to 1) identify what disablement and demographic variables that best predict RTP status; 2) establish a normative baseline value of the Disability in Physically Active (DPA) measure; 3) identify DPA components that athletes report most affected by injury; 4) determine if the DPA is a sensitive, objective assessment tool that can be incorporated into the RTP decision-making process; 5) estimate the DPA critical value at which athletes RTP.

Design and Setting: Data were gathered from NCAA athletes participating in five of the Pennsylvania State Athletic Conference (PSAC) universities. Participants were asked to complete the DPA. Participants who suffered from a non-season ending injury were asked to complete the DPA post-injury and returning to participation.

Participants: A sample of 301 participants were included at baseline. An additional 278 participants from a previous study were included to assess normative baseline values. Twenty-five participants were included in the post-injury and return to participation analysis.

Measurements: Data from the DPA instrument and demographic variables as predictors of RTP were assessed by using multiple regression. Normative baseline values and DPA components most affected by injury were evaluated by comparing means. Sensitivity to change was assessed by calculating effect size (ES). Responsiveness was calculated by
constructing a receiver operating characteristic (ROC) curve and determining a critical value at which athletes RTP.

**Results:** Motion, muscular functioning, and skill performance (agility, balance, precision) accounted for 57.2% of variance in the number of days to RTP. The normative DPA baseline value was 6 points +/- 2. DPA components most affected by injury were pain, impaired motion, difficulty in sport participation, and difficulty performing the skills required for activity. The DPA demonstrated large effects from baseline to injury and injury to return-to-play. A critical value of 6.5 on the DPA was identified through ROC curve analysis for RTP, but overall the DPA score is a weak predictor of RTP (area under the curve = .675).

**Conclusions:** This study demonstrated that the DPA can detect disablement in the physically active population post-injury and upon returning to participation. In addition, the normative baseline value presents useful information for clinicians who use the DPA to measure disablement. Research should be completed on a larger sample to establish a more robust model of disablement predictors upon returning to participation.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>vii</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>viii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>ix</td>
</tr>
<tr>
<td>Chapter 1: INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>4</td>
</tr>
<tr>
<td>Statement of the Purposes</td>
<td>5</td>
</tr>
<tr>
<td>Justification of the Study</td>
<td>5</td>
</tr>
<tr>
<td>Research Questions</td>
<td>5</td>
</tr>
<tr>
<td>Delimitation</td>
<td>6</td>
</tr>
<tr>
<td>Limitations</td>
<td>6</td>
</tr>
<tr>
<td>Assumptions</td>
<td>6</td>
</tr>
<tr>
<td>Operational Definitions</td>
<td>6</td>
</tr>
<tr>
<td>References</td>
<td>8</td>
</tr>
<tr>
<td>Chapter 2: LITERATURE REVIEW</td>
<td>11</td>
</tr>
<tr>
<td>Disablement Frameworks</td>
<td>12</td>
</tr>
<tr>
<td>Nagi’s Disablement Model</td>
<td>13</td>
</tr>
<tr>
<td>International Classification of Impairments,</td>
<td>16</td>
</tr>
<tr>
<td>Disabilities, and Handicaps Model</td>
<td></td>
</tr>
<tr>
<td>Modifications and Additions to Disablement Models</td>
<td>17</td>
</tr>
<tr>
<td>Outcomes</td>
<td>26</td>
</tr>
<tr>
<td>Self-Assessment Tools</td>
<td>29</td>
</tr>
<tr>
<td>Short Form-36 Measure</td>
<td>30</td>
</tr>
<tr>
<td>Disability in Physically Active Measure</td>
<td>31</td>
</tr>
<tr>
<td>Return-to-Play</td>
<td>33</td>
</tr>
<tr>
<td>Predictive Values</td>
<td>36</td>
</tr>
<tr>
<td>Reinjury</td>
<td>39</td>
</tr>
<tr>
<td>Conclusion</td>
<td>41</td>
</tr>
<tr>
<td>References</td>
<td>43</td>
</tr>
<tr>
<td>Chapter 3: METHODOLOGY</td>
<td>48</td>
</tr>
<tr>
<td>Introduction</td>
<td>49</td>
</tr>
<tr>
<td>Participants</td>
<td>49</td>
</tr>
<tr>
<td>Instruments</td>
<td>51</td>
</tr>
<tr>
<td>Demographic Questions</td>
<td>53</td>
</tr>
<tr>
<td>Web-based Surveys</td>
<td>54</td>
</tr>
<tr>
<td>Study Protocol</td>
<td>56</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>59</td>
</tr>
<tr>
<td>References</td>
<td>62</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<p>| Table 3.1 Disability in Physically Active Scale Results. Reproduced from Vela | 53 |
| Table 3.2 Injured Athlete Tracking Report | 58 |
| Table 3.3 Instrument Sensitivity | 61 |
| Table 4.1 Sport Distribution | 67 |
| Table 4.2 Distribution of Injury Location | 68 |
| Table 4.3 Factor Analysis Using Injury Scores-RTP Scores | 70 |
| Table 4.4 Factor Analysis for the DPA Scale | 71 |
| Table 4.5 Initial Analysis Model with all DPA Variables Included | 74 |
| Table 4.6 Significant Predictive Model Using DPA Variables Only | 74 |
| Table 4.7 Regression Model with Significant DPA Variables and All Demographic Variables | 75 |
| Table 4.8 Regression Model Including Significant DPA and Demographic Variables | 75 |
| Table 4.9 Survey Results | 78 |
| Table 4.10 Survey Results from Vela | 79 |
| Table 4.11 Individual DPA Scores and Days to RTP | 80 |
| Table 4.12 Item-Total Statistics of the Injured Athletes | 82 |
| Table 4.13 Significant Findings with Demographic Variables | 84 |
| Table 4.14 Out of Competition | 86 |
| Table 4.15 DPA Effect Size | 87 |
| Table 4.16 Sensitivity and Specificity of the DPA | 88 |</p>
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 2.1</td>
<td>Nagi’s Disablement Scheme. Reproduced from Jette</td>
<td>14</td>
</tr>
<tr>
<td>Figure 2.2</td>
<td>ICIDH Classification Scheme. Reproduced from Jette</td>
<td>16</td>
</tr>
<tr>
<td>Figure 2.3</td>
<td>The Disablement Process Model. Reproduced from Jette</td>
<td>19</td>
</tr>
<tr>
<td>Figure 2.4</td>
<td>Institute of Medicine’s Disablement Scheme. Reproduced from Pope and Tarlov</td>
<td>21</td>
</tr>
<tr>
<td>Figure 2.5</td>
<td>The International Classification of Functioning, Disability and Health (ICF) Model. Reproduced from Jette</td>
<td>24</td>
</tr>
<tr>
<td>Figure 2.6</td>
<td>Transient Disablement in the Physically Active Model. Reproduced from Vela</td>
<td>26</td>
</tr>
<tr>
<td>Figure 2.7</td>
<td>Factors Associated with Recurrent Injuries. Reproduced from Croisier</td>
<td>40</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>ROC Curve</td>
<td>89</td>
</tr>
</tbody>
</table>
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CHAPTER 1

INTRODUCTION
Chapter 1
INTRODUCTION

Much of the current research regarding return-to-play (RTP) decisions for athletes centers around concussions and physician clearances following musculoskeletal surgery. There is minimal research guiding when athletes should return to sport following non-surgical musculoskeletal injuries. Currently, certified athletic trainers (ATCs) and other health care professionals (physicians, physical therapists, etc) use subjective and objective measures to determine if an athlete is ready to return to sport. These measures include assessment of pain, swelling, range-of-motion, strength, and functional ability. However, it is unclear as to the best for making RTP decisions.\[^{1-6}\] Evidence-based medicine (EBM), “the integration of best research evidence with clinical expertise and patient values”\[^{7}\], has emerged as a new paradigm for health care, including the practice of athletic training. Within this context, EBM provides the need to research and implement useful tools that provide guidance as to when athletes can return to full participation with a reduced risk of reinjury.

The disablement process, which explains how acute or chronic pathologies affect the body’s ability to function, is rooted within the physical therapy and nursing literature where it is primarily discussed within the context of chronic disabling or handicapping conditions.\[^{8-10}\] However, disablement models can be applied to the physically active population as well.\[^{11-12}\] The opportunity exists to apply a model of disablement to an active population to assess an athlete’s ability to safely return to full participation and to measure treatment outcomes and clinical efficacy in athletic training.
Nagi’s model of disablement and the Institute of Medicine’s (IOM) model were developed as global models of the sequellae to disease and injury. Vela incorporated the Nagi model into the construction of the Disability in Physically Active (DPA) outcomes instrument. This instrument can be used to gather baseline measurements on a physically active population and assess disablement levels during and after an injury, and after returning to play. The DPA measure incorporates the disablement models’ concepts of impairment, functional limitation, and disability as they relate to an active pathology (a disruption in the cellular processes of the body to maintain a normal state). The DPA instrument was tested and validated on injured populations, but application to RTP decision making has not been investigated.

What appears to be consistent in the athletic training literature regarding RTP criteria is that health care professionals assess impairments (range of motion, swelling, muscle weakness) and functional limitations (the ability to run, shoot a foul shot, kick a soccer ball, throw a softball). Once athletes reduce levels of impairment and have successfully completed sport-specific functional tests with minimal to no pain or discomfort, they are typically cleared to resume non-restrictive participation. However, by looking only at impairment and functional limitations, the disability component (the inability to perform socially defined roles such as sitting in class, driving a car, or playing competitive sports) is overlooked. Moreover, quality of life factor (emotional well-being, happiness, energy, self-confidence) which is commonly affected by injury is not considered. The severity of impairments and functional limitations has been shown to decrease through treatment and rehabilitation intervention, but it is not
the common practice for a medical professional to also assess and measure levels of
disability and quality of life before permitting athletes return to full activity.

There is also the potential for other variables to be predictors of RTP that are not
associated with the DPA scale. These variables include an athlete’s age, gender, team
starting status, sport and/or position, academic class (freshman, sophomore, junior,
senior, graduate student), and extracurricular club involvement which assesses how much
an athlete self-identifies with being an athlete. These variables were chosen because
research states that personal characteristics (age, level of sport involvement, and athletic
identity) and situational characteristics (impairment of daily activities, functional
limitations and/or disability measures), level of sport, and time of season when an injury
occurred) can influence injury and RTP.\textsuperscript{19,20}

\textbf{Statement of the Problem}

One of the challenges medical professionals face is the difficult decision of when
an athlete can return to full participation with minimal risks of reinjury. Current
recommendations suggest that athletes should have minimal pain and swelling, full range
of motion and strength (compared bilaterally), and the ability to pass a functional sport
progression.\textsuperscript{15-18,21-22} The RTP criterion specifically addresses impairments and functional
limitations, while consistently leaving out the factors of disability and quality of life.
Unfortunately, there is a lack of information regarding the level of disablement present
when an athlete returns to play and whether such information may correlate to the risk of
reinjury.
Statement of the Purposes

The purposes of this study were to: 1.) determine what disablement and demographic variables best predict RTP status in a sample of intercollegiate athletes; 2.) establish a normative baseline value of the DPA measure; 3.) identify those DPA components athletes report most affected by injury; 4.) determine the DPA’s sensitivity to change; 5.) estimate the DPA critical value at which athletes RTP.

Justification of the Study

Injured athletes feel pressure from external sources, including the media, fans, teammates, and coaches, to return to full participation as quickly as possible. In turn, pressure escalates for the athletic trainer to return the athlete in a timely fashion. Currently, there is no research exploring how the disablement process affects an athlete returning to play. Weiss states, “given the volume and severity of injuries that occur in any given year, the quest for continued knowledge about maximizing injured athletes’…recovery and hastening their return to a physically active lifestyle is a work in progress”.

By exploring the relationships between RTP and disablement factors I hoped to increase the awareness of sport health professionals regarding the importance of assessing disablement in athletes before allowing them to RTP. This study accounts the relationship between self-reported measures of disablement by the athlete and return to play.

Research Questions

The study is designed to answer the following questions:

1. What DPA and demographic variables best predict return to play status?
2. What is the normative baseline value of the DPA instrument?

3. What DPA components are reported to have the most affect on the injured participants?

4. Is the DPA a sensitive instrument to detect change in athlete’s status post-injury and upon returning to play?

5. What are the critical values of the DPA when athletes return to play?

Delimitation

The study population is delimited to athletes participating in the NCAA Division II Pennsylvania State Athletic Conference.

Limitations

The major limitation in this research was the small sample size and low response rate. Due to the small number used in the data analysis the results should be taken with caution until further research on a larger sample is concluded.

Assumptions

1. It is assumed that participants will respond truthfully to each question on the self-report instruments.

2. It is assumed that participants will understand the English language.

3. It is assumed that participants are computer literate.

Operational Definitions

Disability – the inability to perform socially defined activities

Disability in Physically Active Scale (DPA) – a 16 item, multidimensional, outcomes instrument that was created using a disablement model

Functional Limitation – restrictions in individual performance and actions
Impairment – loss or abnormality at the tissue, organ, or system level resulting in such signs and symptoms as pain, weakness, and swelling

Injury – trauma which disables the participant enough to be limited from participation for at least two entire practices or a competition

Quality of life (QOL) – the global well-being of the athlete

Return to Play (RTP) – process of determining when an injured athlete is cleared to return to full participation by the team physician or certified athletic trainer
References


CHAPTER 2

LITERATURE REVIEW
Chapter 2

Literature Review

This review will concentrate on disablement frameworks, outcomes assessment, return-to-play, and reinjury recurrence. The first area focuses on the evolution of two different disablement frameworks. The variety in conceptual definitions, framework appearance, differences in delineation from a pathology to the functional consequences, and the various approaches to constructing the disablement framework will be addressed. The second concept addresses the need for outcomes assessment along with the usefulness of self-reported assessment tools that measure disablement, specifically exploring the Disability in Physically Active Scale (DPA). The last two areas will focus on the relationship between disablement, return-to-play criterion, and the risk of reinjury. Insight into predictive values of physiological and psychological factors that could be influential in clinical return-to-play decision making will also be explored.

Disablement Frameworks

Over the last ten years, researchers studying disablement have been trying to fill in the gaps between disability and outcomes. Disablement can be defined as the consequences or impact of a health condition on a person. Although disablement models are aimed to describe how chronic diseases/disorders affect systems, actions, and activities of daily living\textsuperscript{1-3}, the disablement framework can also be used to describe the events which occur after a musculoskeletal injury. Regardless of an acute or chronic injury/disease, the central goal of disablement models is to delineate the pathology and functional consequences a person may experience.\textsuperscript{2}
There are two prevalent disablement frameworks referenced in the literature, Saad Nagi’s and the International Classification of Impairments, Disabilities, and Handicaps (ICIDH) developed for the World Health Organization (WHO). These models were developed 30-45 years ago. While there are distinct differences in the frameworks, they both embrace the common fundamental concept of disablement which is that it “represents a series of related concepts that describe the consequences or impact of a health condition on a person’s body, on a person’s activities, and on the wider participation of the person in society”.

Different approaches were taken in the development of disablement models. One school of thought was taken from a medical viewpoint and the other from a social model. Contemporary disablement models use the biopsychosocial view which integrates the medical and social views and includes the concepts of impairment, functional limitation, and disability.

Nagi’s Disablement Model

Nagi’s Disablement Model (Figure 2.1) was developed in 1965 around four core concepts: active pathology, impairment, functional limitation, and disability. Nagi’s conceptual model, adapted from the medical model of disability, is a linear model that starts with an interruption of normal body processes or structures which is termed an active pathology and proceeds to describe various functional consequences of the pathology. Pathologies can result from infections, trauma, metabolic imbalance, degenerative changes, or other etiologies and be classified as a disease, injury or congenital/developmental condition. The pathologies are classified as acute, lasting less than three months, or chronic.
The second concept of Nagi’s theory is impairment. Impairment is the loss and/or abnormality of physiological, anatomical structure or function, and/or mental or emotional problems. Typically impairments occur as a result from an active pathology. Examples of impairments most likely to be discovered during a medical assessment include pain, swelling, decreased muscle strength and endurance, and loss of motion. These impairments can be assessed through clinical examinations, medical history taking, and/or diagnostic imaging procedures. Many times these impairment characteristics are used to determine the severity of an injury/active pathology.

The next concept in the linear model is functional limitations which describe the consequences of the pathology on an individual. Functional limitations are individual characteristics which limit one’s own performance. Functional limitations may include the inability or difficulty to walk, run, kick, throw, lift objects, climb stairs, and balance. Assessment of limitations can occur through self-reporting measures, interviewer’s observation which can include rating performance, and equipment-based evaluation of performance. Functional limitations are undoubtedly better clinical predictors of disablement than impairments, but focus in the clinical outcomes literature is on impairment measures.
Disability, according to Nagi, is a relational concept which can be viewed as the gap between personal capability and the demands of the environment. This definition purports that disability is geared towards limited/altered social function rather than an individual function like functional limitations.\textsuperscript{1-4,9} Disability is not inherent in a person, but a function of the interaction of the individual and the environment. Disability is also defined as the limitation in performing socially defined roles and/or activities of daily living (personal care, work, school, recreation). Phillips-Harris\textsuperscript{10} stated that disability occurs as a result of functional limitations which affect individual’s expected roles in society. This statement emulates Nagi’s initial definition of disability; “disability is a pattern of behavior that evolves in situations of long-term or continuous impairments that are associated with functional limitations”.\textsuperscript{1} However, Phillips-Harris also stated that “not all functional limitations result in disability”, meaning disability does not always occur even if impairments and functional limitations are present which negates the idea of a linear model. The lack of a universal definition of disability makes it difficult “to guide scholarly discussion, to advance theoretical work on the disablement process, to facilitate future survey and epidemiological research, and to enhance understanding of disability…”\textsuperscript{4}

Disability may not only be affected by an individual’s internalization of their condition, which may be compounded by their level of function, but also by the expectations and reaction of others (family, friends, coaches, teammates, media) and physical and sociocultural barriers.\textsuperscript{4} Disability is most commonly assessed through self-reports which measure the degree of difficulty present to perform a specific task.
International Classification of Impairments, Disabilities, and Handicaps Model

The second model (Figure 2.2) widely referenced is the International Classification of Impairments, Disabilities, and Handicaps (ICIDH) developed for the World Health Organization (WHO) in the late 1970’s and published in 1980. The WHO wanted to extend and alter the medical model, which incorporated a linear relationship from etiology, pathology, and manifestation, to a typical causal pattern model taken from a social model of disability approach. The ICIDH model is mostly suited to evaluate the effectiveness of health care in long-term pathologies.4,11

Figure 2.2 ICIDH Classification Scheme. Reproduced from Jette.2

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<thead>
<tr>
<th>“DISEASE”</th>
<th>IMPAIRMENT</th>
<th>DISABILITY</th>
<th>HANDICAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>(the intrinsic pathology or disorder)</td>
<td>(loss or abnormality of psychological, physiological, or anatomical structure or function at organ level)</td>
<td>(restriction or lack of ability to perform an activity in normal manner)</td>
<td>(disadvantage due to impairment or disability that limits or prevents fulfillment of a normal role (depends on age, sex, sociocultural factors) for the person)</td>
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The ICIDH model begins with the idea that a disease is present. The ICIDH’s definition of disease refers to an anatomical, physiological, or biochemical abnormality which is similar to Nagi’s definition of active pathology. The second concept in the ICIDH model is impairment which is defined by the WHO as “a loss or abnormality of body structure or of a physiological or psychological function”.4 The ICIDH definition of impairment is similar to the definition used in Nagi’s model. A difference in definitions exists within the elements of disability and handicap. ICIDH’s concept of disability encompasses Nagi’s central ideas of functional limitation and disability. The ICIDH defines disability as any restriction, resulting from an impairment, which does not allow a person to perform an activity in a normal manner.4,12-13 On the contrary, Nagi states that disability is a gap between a person’s capability and the demands on the environment
which may or may not be the result of impairments and/or functional limitations.

ICIDH’s final element, handicap, combines individual limitations with the reasons an individual cannot perform specific social roles, in essence this integrates Nagi’s attributes and relational concepts. A published report by WHO in 1993 addressed shortcomings existing in the ICIDH model. Issues with internal consistency and measurement feasibility in surveys, conceptual clarity including overlap between the dimensions and lack of relationship clarity among the concepts, and insufficient attention to the environment’s role were addressed as the existing shortcomings to the ICIDH disablement model.\textsuperscript{1,11}

**Modifications and Additions to Disablement Models**

Over time, modifications have occurred to Nagi’s model and the WHO’s ICIDH model. Revisions have occurred because of a lack of universally accepted terms and measures within conceptual frameworks therefore making comparisons across studies problematic in the research and clinical fields. The central concepts have undergone a slight change in wording and the addition of societal, environmental, individual, and risk factors along with quality of life status have occurred.

Verbrugge and Jette (1994) took components of Nagi’s and ICIDH’s schemes to develop the Disablement Process model (Figure 2.3). Their model maintained Nagi’s definitions of the four concepts of pathology, impairment, functional limitation, and disability; however they believed the unidirectional pathways of Nagi’s and ICIDH’s models did not suit the medical pathway of a pathology and therefore took a sociomedical approach or social epidemiological perspective to developing the disablement process model. Verbrugge and Jette can be credited with the addition of sociocultural and
personal factors within the original framework. They believed sociological, psychological, and environmental factors alter how a pathology is affected. This belief led to the inclusion of risk factors, intra-individual factors, and extra-individual factors that may modify the main pathway of a pathology. They also created subdimensions of social roles within the disability concept that included activities of daily living (ADL), instrumental activities of daily living (IADL), paid and unpaid role activities, social activities, and leisure activities. It is often difficult to determine whether a variable is directly responsible for a disability or if the variable is linked to a process that triggers disability.

Demographic, lifestyle, social, behavioral, psychological, environmental, and biological characteristics are classified as risk factors. These factors typically exist prior to the onset of a pathology. The risk factors have the capability of affecting impairments, functional limitations, and disability. Intra-individual and extra-individual factors are referred to as buffers which do not exist prior to the pathological onset. The buffers are attempts to reduce the progression of the pathology. Intra-individual factors encompass lifestyle and behavior changes, psychosocial attributes, coping abilities, and activity accommodations. Extra-individual factors include the medical care, rehabilitation, medications, and other therapeutic regimens an individual receives combined with the amount of external support and modifications occurring in the person’s environment.
Pope and Tarlov\textsuperscript{14} adopted and extended Nagi’s disablement framework to include an altered definition of disability and quality of life factors. The revised framework was reported by the Institute of Medicine (IOM) in 1991. The definition of disability was reworked to state that disability is “a limitation in performing certain roles...
and tasks that society expects an individual to perform". The revised Nagi model also includes the possible impact psychological factors, the environment, the culture, the economic system, and the political system may have on disability. In 1997, the IOM reported Pope and Brandt’s second modification to Nagi’s model (Figure 2.4). This addition was the inclusion of secondary conditions which occurred as a result of the disabling condition. These conditions can take shape as an active pathology, impairment, functional limitation, or additional disability. For example, if a patient is on crutches due to a lower limb pathology and is not using the crutches correctly, they could develop axillary soreness. Pope, Brandt, and Tarlov (through the IOM) along with Vela’s research shows how there are secondary conditions, known as feedback loops, which reinforce the cyclic nature of the disablement process and contradicts the unidirectional model originally presented in the disablement theory.
Quality of life was first included in the disablement theory as an endpoint where one’s happiness, life satisfaction, and well-being are at risk when someone has a disability. Pope and Tarlov included physical and emotional status, social interactions, intellectual functioning, economic status, self-perceived or subjective health status, and the performance of social roles as part of QOL. However, since the first inclusion of
QOL, researchers/clinicians have altered its positioning within the disablement theory. QOL is an integral part in the disablement process because all the concepts affect QOL and it in turn affects all the concepts.

Vela’s research shows that a relationship between injury and QOL exists. A stronger relationship between chronic injuries and QOL than acute injuries and QOL was demonstrated in her research. Subjects who suffered from chronic injuries showed lower quality of life. Vela discussed how a relationship between an injury and quality of life exists because QOL is affected by impairment, functional limitations, and disability. However, more research needs to be performed to further elucidate the relationship between a musculoskeletal injury and QOL.

Quality of life can be measured subjectively by assessing internal self perceptions or objectively based on external judgments of QOL. A multidimensional evaluation of QOL is needed and should include the components of psychological well-being, perceived QOL, behavioral competence in multiple areas, and the objective environment. Overall, QOL includes a multitude of indicators which is the reason the narrow concept of health-related quality of life (HRQOL) was adopted. HRQOL encompasses a state of complete physical, mental, and social well-being. HRQOL, according to Ebrahim, can be defined “as those aspects of self-perceived well-being that are related to or affected by the presence of disease or treatment”. Ebrahim also states that HRQOL is an umbrella concept which encompasses measures of impairment, disability and handicap. One reason to investigate HRQOL is to evaluate the impact of interventions. Implementing HRQOL scales in assessments, specifically self-reported tools, allows clinicians to learn how an individual defines and reacts to the disablement
situation and gain valuable information regarding otherwise dismissed topics such as mood, relationship, and stress level that could lead to a more holistic therapeutic intervention.

Modifications also occurred to the WHO’s ICIDH model, which as of 2001 is referred to as the International Classification of Functioning, Disability and Health (ICF) (Figure 2.5). There is some reference to the revisional model as ICIDH-2, but according to Jette this reference was used in the interim when revisions were occurring. The goal of the revisions was to create “a common language for describing the functional states associated with health conditions.” Common language could aid in improving communications among health care workers, facilitate scholarly discourse, and increase the ease to create longitudinal studies and compare results of disablement research findings in hopes to improve patient care and health care policies/management. Other revisions to the model included the addition of environmental factors and defining associations between the disablement concepts.

The ICF’s revised disablement framework envelops the biopsychosocial model with the idea that each dimension of disablement interacts with intrinsic variables of the individual along with the social and physical environment. Coherent views of the biological, individual, and social dimensions are imprinted in the visual model. The ICF defined three domains of human function: body functions and structures (biological), activity limitations (individual), and participation restrictions (social). Nagi and the ICF models are similar, but the terminology is not identical. Body functions and structures can be defined as the physiological function and anatomical parts of the body. Impairments occur if there is a deviation or loss in body function or structure. The
activity domain refers to “the execution of a task or action by an individual” or can be construed as activity limitation which would result in the ability to perform an individual action or task. Functional limitations are the reciprocal to the activity domain. The last domain, participation or participation restriction, is similar to the disability concept. This domain is either the involvement in a situation or problems experienced with performing a life situation.

**Figure 2.5 The International Classification of Functioning, Disability and Health (ICF) Model: Reproduced by Jette.**

Two contextual factors, environmental and personal factors, were also included into the ICF framework. Environmental factors include the physical, social, and attitudinal environment which envelops a person’s life. Personal factors can be construed as intraindividual factors; they are the demographic information which makes each individual unique. The addition of these factors illustrates that disablement is a dynamic process, not a linear progression which was presented in the early disablement models by
Nagi and the ICIDH. While the ICF provides a more modern disablement framework, future research lies in clearly differentiating the framework’s concepts and categories and developing valid and reliable assessment tools to measure the concepts within the framework.\textsuperscript{18}

Previous disablement research has not focused on how the components of the disablement process affect the physically active individual experiencing a musculoskeletal injury. For example, Nagi’s model is used to describe permanent disability on an individual whereas many people suffering from a musculoskeletal injury report only temporary disability. However, Wilson and Gansneder’s research demonstrated that Nagi’s model could be applied to athletes with temporary disability.\textsuperscript{8} Recently, Vela (2005) investigated if disability has the same meaning for physically active individuals and if the disablement framework components have the same value for a physically active individual. She developed a sociomedical model of disablement, the transient disablement in the physically active model, using the IOM framework to define how disability is experienced by the physically active individual. Her model (Figure 2.6) “represents disability as ripples in water” rather than as a linear process. The ripples represent how the components “overlap and move back upon each other” which is similar to the feedback loops discussed earlier. Unlike other models, Vela places QOL last in the model because all the other components can affect QOL, not just functional limitations and disability, which are two areas the majority of the other disablement models visualize.
Even though there is no consensus as to which model or common concept language should be used when describing disablement, Vela’s model is currently the only one which chooses to focus on disablement in the physically active population. Future research needs to focus on studies which incorporate the transient disablement model in a large, diverse physically active population to determine the model’s usefulness in describing disablement outcomes.

**Outcomes**

There is a growing need for the production and evaluation of outcome measures in the health science profession that will assist in establishing appropriate practice guidelines/protocols and determine the quality and effectiveness of care.
research infuses disablement theory as the theoretical foundation and is defined as “the end results of medical care – the effect of the health care process on the health and well-being of patients and populations”. Originally, outcomes research focused on disease and mortality rates and was not concerned with researching patient function or quality of life. Through the rise of third-party reimbursement and quality care assurance, the roots of outcomes research are to now justify medical practice protocols and guidelines which were once thought to be efficacious and beneficial to the patient. Unfortunately, outcomes of many treatments are not understood or validated because assessment tools are not adequate or well understood. There is currently a need for researchers to construct and compare assessment tools that evaluate patients’ symptoms, functional status, and differences in health care interventions and outcomes.

Much of the “newer” outcomes research has focused only on the effects of treatments/rehabilitation on impairment outcomes such as pain levels, range of motion, and strength. Impairments are a primary focus in research because these characteristics are important to patients and surgeons, the physical measures are regarded as trustworthy, and easier to measure and quantify than functional impairments which actually serve as better clinical predictors of disablement. Physical therapists and certified athletic trainers are trained specifically to focus on impairments or functional limitations which could play a role in why most outcomes research focuses on these two areas. While health care practitioners commonly research impairment outcomes, a weak relationship between impairment and disability has been established in previous research. However, Fritz and Irrgang showed that when patients with low back pain had improved clinical status they also had a decrease in their level of impairment
indicating a relationship between impairment and disablement is possible. Unfortunately, the strength of this relationship was not addressed.

Functional measures are not explored as vastly as impairments because they are primarily observable results which are rarely quantified. With the outcomes movement, researchers are starting to look beyond impairment outcomes and including functional limitations and disability factors.\(^5\) Because there is not necessarily a linear relationship between impairment, functional limitation, and disability, the outcomes research needs to produce evidence that a relationship exists between these three concepts. For example, reducing impairments will improve functional limitations and decrease the amount of disability. Meanwhile, Marx et al believe that disability affects quality of life more than any other concept.

Outcome assessment tools can measure a single outcome or can be multi-dimensional in nature. Most multi-dimensional outcomes instruments are rooted in a disablement framework. However, most outcome assessment tools used in the clinical setting measure only one outcome which can be cumbersome and time-consuming if a clinician wants to test multiple facets of the disablement process. Another problem with previous outcomes research is that two disablement concepts are often linked together and tested. For example, if a researcher asked someone to bring a comb to one’s head, the outcome measure tested could be reaching ability, a functional limitation. Meanwhile the outcome of combing one’s hair, a disability, is not measured.\(^1\) Relationships between disablement concepts are important to elucidate when measuring outcomes of a musculoskeletal injury. Researchers need to clarify the variables they are testing and be consistent with the terminology they are using. If using single outcome measurements,
results could show a patient has little disablement, but is still experiencing impairments unknown to the clinician. Researchers have extrapolated that functional limitations have a closer link to disability than impairments, which was originally proposed in Nagi’s disablement model. To assess all the effects of disability, a multi-dimensional tool that encompasses all the concepts of the disablement paradigm would be ideal for a clinician.

**Self-Assessment Tools**

Many of the assessment tools used in health care are becoming patient-centered rather than performance-based. Evaluating the efficacy of treatment interventions by acknowledging the views and experiences of the patient is the central foundation to patient-centered assessment tools. “Softness” of behavioral, subjective, self-assessment, patient-centered tools leads many clinicians to hold strong to assessing interventions through what they believe are the more credible performance-based measures. Wilson and Gieck state, “the assumption that behavioral and self-report measures are categorically less useful than physical measures should be rejected by sports medicine practitioners”. Results from a study they performed on ankle sprains demonstrated that “simple motor performance and self-report measures employed 3 days postinjury were as responsive to change as highly reliable impairment measures such as volumetric displacement”.

Different outcome scales for athletic patients with ankle, knee, and back injuries are the most common found in the musculoskeletal literature, but there is minimal evidence to support the use of one tool over another. Most of the scales are formatted as a questionnaire and are used as outcome measures because they typically reflect disablement characteristics explicit and significant to the patient.
When choosing, assessing or constructing a self-report measurement tool, validity, reliability and responsiveness are important characteristics to consider.\textsuperscript{22-23} If the assessment tool is measuring what the instrument is intended to measure it is considered to be valid;\textsuperscript{6} although other measures of validity such as content, construct and predictive should also be evaluated. Reliability measures assess the test-retest repeatability, between and within observer repeatability, and internal consistency. How to determine responsiveness, “a measure’s ability to detect changes from one occasion to another which exceed those expected by chance”,\textsuperscript{21} has been at the forefront of much debate. A majority of the debate focuses on an external standard to judge a scale’s ability to detect significant change. Without having gold standards to judge another scale, determining responsiveness beyond chance would be hard to establish. Due to the lack of gold standard disablement outcome measures, future research in this area should be a top priority.

Self-reported measures discussed in this literature review include the Short Form-36 (SF-36) and the Disability in Physically Active (DPA) scale. These two self-reported measures assess health-related outcomes. It has been shown that self-report outcomes rooted in a disablement framework and containing functional limitation measures are better predictors of disablement and return to participation status. While the SF-36 does measure disablement, it has not been validated on an athletic population. Thus, the DPA was constructed for the physically active population.

**Short Form-36 Measure**

The SF-36 is a common questionnaire that serves as a generic measure of physical and mental health.\textsuperscript{7,23} The SF-36 has been validated and used with musculoskeletal
injuries, however it was validated on a non-athletic population. Although it provides
general health related outcomes, the SF-36 is not specific to the pathology the patient is
experiencing. Currently, there is no gold standard to measure quality of life. Studies seem
to benefit from using a generic questionnaire along with a more specific follow-up
assessment tool.23-26 Unlike the SF-36, the DPA has been tested and validated on an
athletic population and is an ideal generic self-assessment tool to incorporate in the
measurement of disablement levels.

Disability in Physically Active Measure

The impetus of the design of the DPA arose from Vela’s research on disablement
in the physically active population. Vela investigated the relationship of disablement to
physically active persons while using the IOM’s disablement model as her framework
during the assessment tool construction. Psychometric properties of the DPA were
measured in two separate studies by Vela.

The purpose of Vela’s qualitative study was to describe how sudden, transient
disablement affects physically active people with musculoskeletal injuries. Individual and
group interviews were conducted to elucidate emergent themes within the concepts of
impairments, functional limitations, disability, and quality of life that a physically active
individual with a musculoskeletal injury is experiencing. Vela’s emergent themes within
the four disablement concepts were used as a foundation for a conceptual model of
disablement in the physically active population (Figure 2.6) and incorporated into the
DPA assessment tool. Pain, decreased motion, decreased muscular functioning, and
decreased stability emerged as common impairments of a musculoskeletal injury. Pain
was the most common impairment and the element which affected other impairments, functional limitations and disability the most.

The transition from impairments to functional limitations demonstrates how an injury affects the performance of an action. There were four themes which emerged from the functional limitation domain. The emergent themes were skill performance, activities of daily living, maintaining positions (such as sitting in one position for a period of time), and the ability to change directions. Within the domain of disability, the limitation to perform socially defined roles within the environment, three primary themes, overall fitness status and the ability to participate in physical activity (leisure and sport of preference) appear in Vela’s research. The last grouping occurred within the quality of life domain. Uncertainty and fear, stress and pressure, mood and frustration, decreased energy, and altered relationships were the themes uncovered from injured participants. An increase in the severity of these themes arose when the participant was suffering from a chronic injury and/or was competing at a higher level of competition.

Vela conducted another study, quantitative in nature, to validate the DPA outcome instrument. Physically active participants entered the study at three distinct points. Standard values for the DPA were established through the participants included at baseline. From baseline data or recruitment measures, participants with either persistent symptoms or an acute injury were asked to participate in the study. Specific time frames were set for each group to fill out a study packet that included the DPA scale, a global functioning scale, and a global rating of change scale. The study’s results yielded that internal consistency of the DPA instrument were within acceptable norms along with test-retest reliability. The overall reliability of the DPA instrument in participants with acute
injuries was calculated to .908. A factor analysis was performed to confirm the multi-dimensional nature and appropriate groupings of the four domains of the DPA.

Three factors emerged rather than the expected four disablement components. The first factor included a mixture of disability and impairments, the second factor incorporated all the functional limitation measures with the addition of one impairment item, and the last factor was composed of all the quality of life measures. The item-correlation did not fall below .20 which indicated that the relationships among items would not significantly change if any item in the scale was dropped. The responsiveness of the DPA tool was calculated using effect sizes. The results showed that participants with acute injuries had large effect sizes, specifically between baseline, injury and return to play measures. This demonstrated the DPA’s sensitivity to measure when an injured participant had undergone change.

In conclusion, the DPA was found to be a reliable, valid, and responsive instrument in the physically active population suffering from a musculoskeletal injury. To strengthen the argument for incorporating the DPA tool into clinical practice, future research lies in testing the DPA across a variety of settings and within a larger sample, assessing treatment efficacy through the use of the DPA, and determining the predictive value of the DPA against different outcomes, specifically return-to-play.

Return-to-Play

An important outcome in the disablement framework for an injured athlete is the return to full participation. Return-to-play is a common term used when discussing an injured athlete and is a core concept in the medical profession. Return-to-play is considered the point of recovery when athletes can return to full participation in their
sport or activity without putting themselves or others at undue risk. The concept of return-to-play can also be thought of as the decision-making process of determining when an athlete can return to full participation. Every athlete, coach, and parent wants to know how long the injured patient will be out of competition and what they can do to return faster. This decision-making process creates a challenge for practitioners and has a great impact on the athlete waiting to return to activity.

There are different return-to-play management models discussed in the literature, but there is no gold standard outcome measurement utilized by health care professionals. Return-to-play criterion varies from practitioner to practitioner and unfortunately there are little to no controlled studies that compare different return to play strategies. There is a plethora of current research being published on return-to-play guidelines for concussions and musculoskeletal surgical cases. Conversely, the articles being published regarding return-to-play criteria for musculoskeletal injuries, specifically non-surgical cases, are limited in number. Regardless of the type of injury, there is no consensus in the literature as to when athletes can safely return-to-play which leaves a variety of return-to-play guidelines being utilized by clinicians. The only consensual agreement is that the goal of the clinician is to return the athlete to full functional activity without undue risk of reinjury.

Many health care professionals focus RTP decisions on similar entities such as strength and flexibility testing, diagnostic imaging results, functional testing, and risk management strategies. Functional testing, completing all sport-specific tasks with no pain or obvious limitation, is the standard practice method for determining RTP, however, little evidence exists supporting functional testing. Cascio states, “no one
single outcome criterion has been shown to correlate with successful return to sports\(^{31}\) and suggests using subjective, clinical, and functional criteria when making the return to play decision. A suggestion for further research is to determine if adding isokinetic testing and/or diagnostic testing to functional testing lowers the injury recurrence rate. Best and Garrett\(^{32}\) are in the exploratory stages of determining the value of magnetic resonance imaging (MRI) in predicting injury recovery, but no conclusive evidence exists on its usefulness.

Although there are ideal criteria that are used for RTP guidelines such as being pain free, having full functional range-of-motion and strength, and passing sport-specific conditioning),\(^{31,33-36}\) athletes will frequently “return after meeting some but not all criteria”.\(^{36}\) Orchard et al stated that athletes can typically pass a manual strength test and functional test without pain or obvious limitations, but still have not returned to full strength. With functional testing, the activities are primarily observed and no standard measurement is used. In most cases, athletes are asked to respond to how they feel performing these activities. Their responses may be based on motivation levels, personality traits, and other demographic factors other than impairment, functional limitations, and disability which consequently may increase the probability for reinjury.\(^{21}\)

Looking within the disablement paradigm, it appears that injured athletes associate impairments as their main cause of not fully participating in their sport of choice (a disability). This may infer that impairment and disability are related, but the predictive value of these two concepts is unknown. Meanwhile, functional limitation measures within self-reported outcomes have proven to be predictors of return to participation status or disablement.\(^{8,16}\)
Predictive Values

An important task of a clinician is to predict when an athlete can be expected to return-to-play. Although there is no “foolproof criteria” for accurately estimating recovery time, clinical tests and measures should be capable of providing useful information to the clinician. After performing a “pubmed” search for disablement and athletic injuries four articles were found, two being relevant. These two articles looked at predictors of disablement in athletes with acute ankle sprains. Wilson et al21 looked at joint swelling, range of motion, motor activity score, and self-reported athletic ability to determine the usefulness of impairment and functional limitation measures to assess clinical improvement following acute ankle sprains. Results of their study yielded evidence suggesting that behavioral measures may be as useful as physical measures for assessing treatment responses in athletes with acute ankle sprains. Future studies are needed to identify and assess the usefulness, reliability, and responsiveness of behavioral and physical measures on injured athletes’ disability and the extent to which behavioral measures may predict the number of days lost due to injury.

In the second article, Wilson and Gansneder’s research demonstrated that “measures of activity limitation were the strongest predictors of elapsed time from injury to return to full athletic participation”.8 Clinicians use clinical tests to predict and determine when an athlete can return-to-play, but few studies have looked at short-term and long-term outcomes. Wilson and Gansneder’s research looks at swelling, range-of-motion, observable and self-reported functional ability. They premised their work with the linear model of disablement, therefore believing that no direct path from impairment to disability exists. Their hypothesis is that functional limitation is most closely
associated with disability and thus is the most reasonable measure to predict disability outcome rather than measuring impairments.

In their study, impairment measures (testing range of motion and volumetric displacement) and activity limitation measures consisting of weight-bearing activity scores and self-reported athletic ability were taken 3 days post-injury. They concluded that “although subjects with greater physical impairments generally experienced longer disability periods, clinician-observed and self-reported measures of functional limitation were stronger predictors of disability duration” (difference in return to full participation from the initial date of injury). Their conclusion gives merit to applying Nagi’s disablement model to athletes with acute disabilities. Wilson and Gansneder’s study has touched upon predicting return-to-play and disablement, but their study only investigated acute ankle injuries. Determining predictive values of functional activity measures in a variety of injuries is where future research lies.

Return to play is an important outcome, but it is a uni-dimension measure that does not take into account activities of daily living and quality of life changes. There are few articles which mention the effect of injury on activities of daily living. One article, written by Curl, investigated return to sport following elbow surgery. She noted loss of elbow function has the capability of not only affecting sports participation, but also limiting the ability to perform activities of daily living. Her argument stated that a majority of surgical rehabilitation protocols/return to play guidelines are based on time frames; however, clinicians must focus on the individual, not the time frame, to critically assess the patient through sport-specific functional testing to determine if full function has been restored and the risk of reinjury has been minimized.
Typically, when return to play decisions are made, the cyclic interaction that occurs between impairments, functional limitations, disability, and quality of life are not taken into consideration. Clinicians measure impairments, they may measure functional limitations, and some may measure disability, but quality of life and how these domains affect each other is typically not assessed.\textsuperscript{30-36} Rock and Jones\textsuperscript{37} state that “psychological factors are increasingly being recognized by sports-medicine professionals as important in rehabilitation from sport injury” however, they primarily are studied only in season/career-ending injuries. Conversely, psychological/well-being factors are prevalently discussed in the nursing literature, specifically when associated with terminal diseases where QOL is more salient to the patient.

It can be derived from the lack of literature focusing on the QOL variables in acute musculoskeletal injuries that the variability in day to day or hour to hour QOL variables makes it difficult to capture an injured athlete’s feelings with any precision, leading to large standard errors in measurement.\textsuperscript{17} Because QOL measures illuminate how an injury may truly affect an athlete and his/her psychological readiness to return to participation, it is important to take into consideration how an athlete’s injury can affect him/her not only in the realm of athletics, but outside of it as well, regardless of the change factor in the QOL variables. The incorporation of the DPA as a return to play assessment tool could prove to be beneficial because all four domains are measured and could be taken into account when determining an athlete’s physiological and psychological readiness to return to his/her sport of choice. An area of future research lies in evaluating psychological factors and their effect in sport-injury rehabilitation.\textsuperscript{37}
Because there are no clear cut standards as to when an athlete can return-to-activity, it is imperative that researchers answer the question McFarland poses which is, “What measures are the most predictive of a safe ability to return to play and are predictive of no further injury?” \(^{38}\) Granted there may be some variability among individuals because the decision to return to play should be individualized, a distinct guideline could protect the majority.

**Reinjury**

There are numerous articles \(^{39-42}\) stating high rates of reinjury and discomfort after athletes return-to-participation. If disability, along with impairments and functional limitations are not reduced, a feedback loop occurs which can lead to a new pathology.\(^1\) In applying this portion of the disablement process to an injury, if an injury is not properly treated and an athlete returns to competition before all concepts are addressed, they are more apt to be reinjured or create another feedback loop. It is unrealistic to assume that the elimination of recurrence rates will occur unless an impractical ultraconservative approach was utilized to reduce the rate of recurrence is practical.

A study performed by Beardmore et al\(^{39}\) looked at return-to-play after injury in the New Zealand rugby union. Their results demonstrated that many injured athletes return to training and competition prematurely which resulted in a high incidence of reinjury. Harringe et al\(^{40}\) found similar results with gymnasts who competed in spite of still having symptoms from an injury. Their results yielded that more than half of the gymnasts competed despite having symptoms from an injury, seniors were most likely to compete with symptoms, and fifty-five percent of the gymnasts reported reinjury. These
studies suggest that reducing reinjury requires that adequate recovery and rehabilitation has occurred which could be measured through a standardized RTP assessment.

A majority of the reinjury literature focuses on muscle strains, specifically the hamstrings. Because of the eccentric demand placed on a muscle and “a poorly understood neuromuscular coordination pattern”, reinjury rates tend to be higher for muscle strains than other injuries. There is indirect evidence that deficits in hamstring strength increase the risk of injury recurrence. Interestingly, no correlation has been identified between the size of injury and recurrence rates. Through other researchers’ studies, Crosier highlights the high rate of re-injury in muscle strains:

…re-injuries accounted for 48% of injuries classified as strains…hamstring injuries have the highest recurrence rate of all injuries: 34% of the incidence of new hamstring strains…persistence of a significantly increased risk of recurrence lasted for many weeks after a return to play. The cumulative risk of the recurrence of a hamstring strain for the remainder of the season was 30.6%. Croisier compiled data from these studies and proposed a list of factors that could be associated with recurrent hamstring strains (Figure 2.7) and developed recommendations and a management model of return-to-play for grade II hamstring strains.

**Figure 2.7 Factors Associated With Recurrent Injuries. Reproduced from Croisier.**

![Diagram of factors associated with recurrent injuries](image-url)
Crosier’s recommends that an injured athlete should not return to participation if he/she is still experiencing pain, weakness, or tightness. If pain is present while the athlete is trying to meet the demands of the sport or an aggressive rehabilitation program, neural inhibition can occur resulting in a submaximal contraction of the muscle leading to the resultant factor of reinjury. Accurately diagnosing the extent of injury and beneficial therapy can improve the odds against reinjury, but unfortunately optimal treatment regimens have not been developed through clinical trials. The safe return of an athlete to full participation with minimal risk of reinjury is a difficult decision, but with the use of evidence-based recommendations and/or assessment tools, this process should become more standardized.

**Conclusion**

While disablement frameworks have been in existence for the last 40 years, the recent strides to reach a common language so researchers and clinicians across disciplines can scholastically converse and compare research is to be commended. The recent development of the transient disablement model in the physically active population shows promise when discussing the disablement process that athletes may experience. In athletic training, disablement frameworks are not a required teaching objective, but yet understanding disablement is vital to recognizing the outcomes of a musculoskeletal injury. By appreciating the disablement process, clinicians would be better educated when choosing variables they want to measure. Having a reliable and valid tool that specifically measures the variables a clinician chose is vitally important. Although originally thought of as “soft measures”, self-reported assessment tools have shown their worth when measuring outcomes associated with disablement. The use of the DPA
appears to show the most potential in providing a predictive value when making return to play decisions based on levels of disablement and in assessing treatment interventions of the physically active population.
References


CHAPTER 3

METHODOLOGY
Chapter 3
Methodology

Introduction

An objective assessment tool to assist certified athletic trainers (ATCs) in return to play (RTP) decisions of non-season ending injuries does not exist. Therefore, the purposes of this study were to: 1) identify disablement and demographic variables that best predict RTP status; 2) establish a normative baseline value of the Disability in Physically Active (DPA) tool; 3) identify DPA components that athletes report most affected by injury; 4) determine if the DPA is a sensitive, objective assessment tool that can be incorporated into the RTP decision-making process; 5) estimate the DPA critical value at which athletes RTP. A detailed description of the participants selected, the instrument used, the protocol of survey administration, and methods of data analysis ensues.

Participants

Fourteen Pennsylvania State Athletic Conference (PSAC) universities were invited to participate in this study. Each PSAC university is a member of the National Collegiate Athletic Association (NCAA) Division II athletics. The Division II intercollegiate fall, winter, and spring athletic teams included in this study were: men and women’s cross country, men and women’s soccer, football, women’s volleyball, men and women’s basketball, men and women’s swimming, indoor track, baseball, softball, women’s lacrosse, and outdoor track and field. The decision to exclude Division I field hockey and wrestling was based on competition level variability and possible motivation differences in returning to play.
The invitation to participate in the study was originally sent in May 2006 to each university’s head athletic trainer (HAT) (Appendix A). The HAT was asked to participate in the study and, if interested, to provide names of their institution’s ATCs that cover the participating fall sports. If the HAT did not respond to the researcher’s initial email, attempts to contact via phone or email ensued. Verbal or written agreement from the certified athletic trainer working each sport was obtained prior to data collection. As an enticement for ATCs to participate, a certificate of acknowledgement in the participation of this study was distributed to each ATC. Such activity recognition is included in staff assessment for promotion and tenure.

ATCs from seven universities were willing to participate, ATCs at two universities declined due to professional and personal time constraints, and ATCs from five universities never responded. The Institutional Review Boards of the participating seven universities were contacted regarding the steps required to implement this study. Six universities required the researcher to complete an expedited IRB application while one university only needed an email with a detailed description of the study. The researcher received approval from six of the seven universities. One of the university’s IRB never responded to the IRB application submitted. After multiple attempts to contact this institution’s board, the university was dropped from participation. One other university was eliminated from the study because the ATCs did not have time to gather the athletes’ emails and the researcher could not access the school’s email directory.

The decision to include winter and spring sports occurred soon after receiving IRB approval for the fall teams. The IRBs were contacted regarding stipulations of adding men and women’s basketball, men and women’s indoor and outdoor track and
field, men and women’s swimming, baseball, softball, and women’s lacrosse athletes.

One university never responded despite multiple communication measures and therefore, was eliminated from winter and spring sport data collection only.

One thousand, one hundred and five athletes from five institutions were contacted to participate in the initial baseline survey. In the fall, 632 athletes from 20 teams and 5 universities participated. The twenty participating teams included three men’s and women’s cross country teams, four football teams, four women’s soccer teams, three men’s soccer teams, and three volleyball teams. In the winter, 341 athletes from 19 teams at 4 universities were initially contacted. There were four women’s basketball teams, three men’s basketball teams, four men and women’s indoor track teams, three women’s swimming teams, and one men’s swimming team. In the spring, 132 athletes from 9 teams at 4 universities were initially contacted. This number excluded outdoor track athletes because these athletes also competed in indoor track. The team breakdown included two women’s lacrosse teams, three softball teams, four men and women’s outdoor track teams, and two baseball teams.

**Instruments**

All athletes on the participating teams were asked to complete an online, web-based DPA survey to obtain baseline measurements and were also asked to self-report relevant demographic information (Appendix B). The DPA is a multidimensional, self-reported scale which measures impairment, functional limitation, disability, and quality of life following a musculoskeletal injury. The DPA was created using the underpinning theory of the Institute of Medicine’s (IOM) disablement paradigm. The DPA utilizes a five point scale ranging from “no problem” to the problem “severely limits” the
participant. There are eleven specific categories rated which correlate to one of the four concepts in the IOM disablement theory. The specific categories included on the DPA scale are: pain, motion, muscular functioning, stability, changing directions, daily actions, maintaining positions, skill performance, overall fitness, participation in activities, and well-being. Two categories, skill performance and participation in activities, have two subset questions while the well-being category has four subset questions. Therefore, there were a total of sixteen questions on the DPA.

Previous work performed by Vela\(^1\) assessed the validity and reliability of the paper-based DPA measure. In Vela’s\(^1\) research, the reliability of the overall DPA instrument in injured participants one day following injury (N = 28) was .908, using the Cronbach alpha score. Item-total correlation was not below .20, indicating that no item in the scale, if dropped, significantly altered the relationships among other items. Intraclass correlations (ICC) were all above 0.75. For all participants the ICC value of the DPA was 0.969. The ICC found for injured participants was 0.943 while the ICC for injury-free participants was 0.961. The mean, standard deviation, range, and floor effects for the baseline uninjured, injured, and return-to-play were calculated and are shown in Table 3.1.\(^1\) Due to the 1-5 ranking on the survey instrument for the 16 DPA questions, a range from 16-80 exists; however, Vela subtracted 16 points from all totals so the range would be from 0-64. This change occurred on the basis of making the statistics easier to maneuver by the statistician and to increase reader understanding of the scores.\(^1\) The researcher will do the same to keep scores standardized and increase comparability with Vela’s prior research.
Table 3.1 Disability in Physically Active Scale Results. Reproduced from Vela

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<tr>
<td>Baseline</td>
<td>Uninjured (n=271)</td>
<td>3.68</td>
<td>5.65</td>
<td>0-34</td>
<td>40.6%</td>
</tr>
<tr>
<td></td>
<td>Injured (n=97)</td>
<td>21.82</td>
<td>13.31</td>
<td>0-52</td>
<td>5.2%</td>
</tr>
<tr>
<td>Acute injury</td>
<td>Return to play(n=25)</td>
<td>9.04</td>
<td>7.00</td>
<td>0-23</td>
<td>17.9%</td>
</tr>
</tbody>
</table>

Demographic Questions

Specific demographic questions (Appendix B) were added to the survey by the researcher to determine if there were other variables that may affect return-to-participation in injured athletes. The baseline survey asked the athlete’s age, gender, sport, current academic standing (freshman through graduate student), and if he/she currently had an injury in which he/she was not cleared for full participation. If athletes were under the age of 18 or older than 25 they were excluded from the study. The researcher wanted to focus on the traditional college-aged athlete and did not want to include minors due to the need for parental consent measures. Athletes were also excluded from the study if they had an injury in which they were not cleared to fully participate in activity at the time they completed the baseline survey.

Once an athlete became injured, demographic questions asked included: in what sport did the athlete participate, if the injury occurred during a game/meet, practice, or conditioning, if the athlete held a starting position at the time of injury, what position he/she was playing when injured (if applicable), and how many student clubs/organizations the athlete was involved in outside of his/her sport. Research shows that the more the athlete self-identifies with being an athlete, the more motivated he/she will be to return-to-participation. Hence, if a participant is not a starter or is involved in many different clubs/organizations he/she is less likely to self-identify as an athlete and
will not be as motivated to return-to-participation. The questions regarding sport, when the injury occurred, and position played were used to track differences between and within these variables regarding injury rates and return-to-play status; however, due to the small sample size differences were not determined.

Lastly, injured athletes were asked to classify their injury as mild, moderate, or severe, and how long they were out of competition. These questions were to provide a gauge on an athlete’s perception of injury severity and record time away from competition. The time out of competition was used in developing the receiver operating characteristic (ROC) curve to determine the critical value of the DPA. The ROC curves plot sensitivity against the false positive error rate. The upper left corner represents the ideal and the critical value is taken from the point closest to the upper left corner of the ROC. 8

Web-based surveys

Electronic administration of the DPA permitted inclusion of athletes from multiple institutions without requiring staff members to collect information form the athletes. This mechanism also allowed the information provided by the athletes to remain confidential between the participants and the investigator. Web-based data acquisition is also cost-effective, provides for rapid responses, reduces the number of incomplete questions in comparison to postal or fax surveys, and permits electronic transmission into a database for analysis. 10 The accessibility of computers make web-based survey administration convenient for college students.
Surveymonkey (www.surveymonkey.com), a website used only for survey data was used for this study. Surveymonkey is user-friendly and allows researchers to design their own survey with various options for formatting of questions and appearance. Surveymonkey provides easy accessibility to the raw data. The questions and answer options were identical to the paper-based DPA.

The reliability and validity of web-based surveys is preserved when adapted from paper-based surveys.\textsuperscript{9,11-12} Research findings demonstrate that responses to questions do not differ significantly from web-based surveys to paper-based surveys.\textsuperscript{13} Internal consistency reliability using Cronbach alpha has also been determined to be nearly identical for multi-item instruments.\textsuperscript{11}

List-based samples of high-coverage populations were employed in this study. Student surveys at higher education institutions are a typical example of list-based surveys. Unfortunately, low response is a concern in these surveys.\textsuperscript{14} Low response rates can threaten the validity of surveys by increasing non-response bias\textsuperscript{15,16}. The results of research on response rates of mail surveys versus email surveys have varied.\textsuperscript{13-17} Most research states that email surveys have a lower response rate than paper surveys. Despite efforts to make the Internet version of their survey participant friendly and using a population that had easy access to the Internet, email surveys had response rates 31% lower than a postal survey during initial contact.\textsuperscript{15} Response rates from 60%-80% of a sample is considered excellent.\textsuperscript{17} Response rates to Internet-based surveys varied greatly from 11%-94%. In summary, literature on web-based surveys suggests that more research needs to be completed to look at why participation rates are lower than paper surveys and what can be done to increase the rates.\textsuperscript{14}
Study Protocol

A roster from each teams’ webpage was collected by the researcher. An alphabetical roster, in database format, was emailed to the teams’ ATC for roster additions or deletions, along with inclusion of each athlete’s email address, if possible. If the ATC did not include the athlete’s email address upon return of the spreadsheet to the researcher, the researcher searched the university’s database and recorded the athletes’ email addresses in the spreadsheet. After the researcher received the roster database back, a code was issued to each athlete. The athletes’ code and email address, but not their name, was entered into the web-based survey database. Rather then sending the ATC a database with the athlete’s code and not their name, the researcher sent a spreadsheet with the athlete’s name to make the process of injury tracking easier for the ATC. This spreadsheet was kept on a USB drive to which only the researcher had access. The researcher also kept a binder which converted the athletes’ names into their respective codes in a locked cabinet. As for the web database, only the researcher knew the identity of the athletes, enhancing anonymity and confidentiality of the athletes’ responses to the survey. Also, all completed surveys were password protected.

Standard protocol of survey administration is to: 1) provide an invitation and cover letter detailing the purpose of the study via email a few days prior to receiving the survey; 2) send an email with a link to the Internet survey; 3) send a reminder email with a link to the survey within a few days to 6 weeks based on urgency of data; and 4) send out another email reminder with a link to the survey. The researcher used this standard protocol to contact the athletes once receiving IRB approval and consent from the university’s ATCs.
The fall athletes from three of the fourteen PSAC universities were emailed information regarding the study during the 2nd week of preseason. IRB approval from an additional two universities was not received until the first week of classes. This provided a range of 15 days from when the first round of baseline surveys were sent to when the second round was distributed to the last two participating universities.

The athletes were originally contacted via email because response rates are shown to be higher when respondents are contacted through the same medium the survey is conducted (Appendix C). Within 3 days of receiving the informative email regarding the study, the athletes were sent information regarding implied consent form along with a hyperlink to the DPA survey (Appendix D). The two universities whose IRB approvals were received later were sent the consent form and survey link two days after receiving the informative email. Regardless of when the baseline survey link was emailed to the athlete, if the researcher did not receive a response within four days, a reminder email (Appendix E) was sent to the athlete by the researcher through SurveyMonkey. Because response rates were low, all athletes who did not respond to the survey were emailed a third time at the beginning of the fall academic semester. If the athletes did not respond after the third invitation, they were not contacted again. All athletes had the option to decline to participate in the survey. This was indicated on the list management portion of SurveyMonkey.

The winter athletes from four of the PSAC conference universities were emailed by October 1st and asked to complete the DPA measurement and demographic information. The same protocol was used in recording the athletes’ information in the web-based database and contacting them to participate in the study. The only difference
was that these athletes were already involved in the academic semester, so each athlete was initially emailed to participate, reminded approximately 4 days later, and then once again after a week had passed since the last reminder.

Spring athletes were contacted mid-February to complete the initial survey. The identical protocol was again used in contacting the athletes. The number of athletes who completed the survey in the spring was a small number, but the researcher continued to use the indoor track athletes who completed the survey in the winter when collecting spring data for outdoor track athletes.

Originally, the spreadsheet (Table 3.2), which included only the athletes who completed the baseline survey, was emailed to each ATC every other day. A month into data collection, the researcher ran into slow response rates from the cooperating ATCs. The turnover appeared to be too quick for the participating ATCs. Therefore, the frequency of emailing the spreadsheets to the ATCs changed to once every third day. The change in frequency from every other day to once every two days did not affect the timeframe in which athletes would be contacted to fill out the injury DPA survey.

<table>
<thead>
<tr>
<th>Injured Athlete (Code)</th>
<th>Injury Site</th>
<th>Return to Play (Check once athlete meets this status)</th>
<th>Reinjured (Check if athlete is reinjured with the same previous injury)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joe Smith</td>
<td>Left Quad – 9/17</td>
<td>X – 9/27</td>
<td></td>
</tr>
</tbody>
</table>

The Surveymonkey database contains a list management section. Within this section, each athlete’s email address was listed along with their code. Once an athlete met the injured criteria (being limited from physical activity for two consecutive days) or returned to full participation, the researcher would refer to her binder that converted the athletes’ names into their respective codes. The researcher then used Surveymonkey’s list
management section to email the appropriate survey hyperlink to the injured or returning to play athlete (Appendix E). The athlete was instructed to complete the DPA measure within 48 hours. The researcher checked the web-based database to see if the athlete had completed the survey. If “no response” was found beside the athlete’s code within 48 hours, a reminder was issued via email by the researcher. Once an athlete had completed the study (consisting of completing the survey three separate times), he/she was no longer an eligible participant in the study. If the athlete was reinjured with the same injury, he/she was excluded as a potential participant, but the cooperating ATC was asked to inform the researcher of reinjury, as marked in Table 3.2.

Data Analysis

Only subjects who participated and completed in all three surveys were included in the post-injury and RTP data analysis. Raw data were extracted from the Surveymonkev site and entered into Statistical Package for the Social Sciences (SPSS) version 14.0 for Windows. Frequency distributions, descriptive statistics, independent t-tests, one-way analysis of variance (ANOVA), factor analysis, multiple linear regression, and receiver operator characteristic (ROC) curves were generated through SPSS.

The first research question of the study addresses which variables are the best predictors of RTP. The number of days between the second and third survey was used as the days to recovery or the criterion/dependent variable. The predictors in the model were the DPA item responses and demographic variables. To analyze which variables were the best predictors of RTP, multiple linear regression was calculated. However, prior to performing regression analysis, a factor analysis was completed. The factor analysis identified factors that explained the variation among DPA variables. Specifically, the
factor analysis determined appropriate disablement groupings of the 16 DPA variables. The factors identified were also entered multiple linear regression with RTP as the criteria.

Through multiple regression, different statistical models were completed to identify the best predictors of RTP. First, only DPA item reposes were entered. Next, only the demographic variables were entered. Then only the statistically significant variables from the first analysis and all demographic variables were entered. Finally, factors identified through factor analysis of the DPA responses were entered into a regression analysis.

To address the issue of normative values for the DPA at baseline, the mean scores of this study and Vela’s\(^1\) were compared. Vela’s\(^1\) factor analysis results were also compared. To identify the DPA components that athletes reported affected them the most, mean values from baseline, post-injury and RTP surveys were compared. To assess significant effects between demographic variables, DPA measures, and the number of days to RTP, independent t-tests and ANOVAs were performed. Internal consistency of the DPA in injured subjects was assessed through an item analysis.\(^{19}\) The item analysis identified whether the individual items within each of the theoretical concepts (impairment, functional limitations, disability, and QOL) actually measured the same underlying construct.

Instrument sensitivity to detect change in an athlete’s status post-injury and upon returning to play was assessed by calculating effect sizes. To estimate the critical DPA value at which athletes RTP, a ROC curve was generated by identifying those athletes that returned to play in \(n\) days or less versus those who hadn’t and compared this to those
who had a total score between \(a-b\) and \(c-d\) on the significant DPA predictors discovered through the multiple regression analysis (Table 3.3). From the ROC curve, a minimal clinically important difference (MCID) of the DPA was estimated. Such a value may assist clinicians with RTP decision by quantifying the self-reported health status.

Table 3.3 Instrument Sensitivity

<table>
<thead>
<tr>
<th>Predictive components sum</th>
<th>RTP</th>
<th>Did not RTP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RTP*</td>
<td>Did not RTP**</td>
</tr>
<tr>
<td>0-6 points</td>
<td>8</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>7-12 points</td>
<td>4</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

\* = RTP ≤8 days, \** = RTP >8 days
References


CHAPTER 4

DATA ANALYSIS
Chapter 4

Data Analysis

Introduction

Due to a lack of established objective criteria, there currently is no consensus when an athlete can or should return to participation (RTP) following a non-season ending musculoskeletal injury. RTP decisions are generally based upon restoration of strength, range of motion, and performance during functional activity testing. Unfortunately, there is little evidence to support these methods and a gold standard for RTP has yet to be established. The purposes of this study were: 1.) determine what disablement and demographic variables best predict RTP status in a sample of intercollegiate athletes; 2.) establish a normative baseline value of the Disability in Physically Active (DPA) scale; 3.) identify those DPA components the athletes report most affected by injury; 4.) determine the sensitivity of the Disability in Physically Active (DPA) measure; 5.) estimate the DPA critical value at which athletes RTP.

Baseline data from eligible participants were analyzed. Baseline, time of injury, and time of RTP measurements for those that sustained injuries were also analyzed. Baseline measurements reveal the normal condition for individuals actively participating in sport. The score self-reported at the time of injury reveals the impact of the injury on the athlete. Lastly, DPA values at RTP provide means to estimate self-reported recovery.

This chapter is arranged in order of the purposes outlined above. Descriptive data, summaries of data analyses, and discussion of the results are included in each subsection.
Data from Vela’s research\(^3\) are included in the analysis of baseline data to increase the sample size. Delimitation and limitations to the study are also presented followed by a conclusion of the data analysis.

**Population**

E-mail addresses were collected from 1105 athletes participating in the Pennsylvania State Athletic Conference (PSAC). Three hundred thirty-six (30.4%) completed the baseline survey. Twenty-two athletes (2%) declined to participate in the survey and 743 athletes (67.2%) did not respond. In the fall, 13 athletes out of 632 (2%) declined to participate while 160 (25.3%) completed the baseline survey. For winter sports, seven athletes out of 341 (2%) declined to participate while 137 (40%) completed the baseline measure. In the spring, there were 40 athletes (30.3%) who completed the survey out of the 132 originally contacted and two athletes (1.5%) declined to participate.

Additionally, four emails (.4%) were returned to sender with invalid email addresses. Data from 35 respondents (10.4%) were excluded (6 due to age restrictions (<17 or >25), 17 due to a pre-existing injury when baseline data were collected, and 12 due to incomplete surveys. Thus, data from 301 participants (27.2%) were included in the initial baseline data analysis.

There were five universities from the PSAC represented in this study. One hundred and sixty-three (54%) of the 301 participants were athletes at the researcher’s institution. These athletes were more likely to be familiar with the researcher’s name on the email and more likely to be encouraged to participate by their coaches and athletics department staff. Of the 301 participants, there were 134 males (44.5%) and 167 females (55.5%) with a mean age of 19.44 (\(SD = 1.28\)). There were 110 freshmen (36.5%), 76
sophomores (25.3%), 67 juniors (22.3%), 46 seniors (15.3%), and 2 graduate students (.66%) included in the data analysis of the 301 respondents. A reason for this distribution is that overall, participation in intercollegiate athletics decreases with age. More than 50% (N=168) participated in indoor/outdoor track (which did not include the overlap of the cross country athletes), soccer, or football (Table 4.1). It was expected that football and track would have more participants due to their larger roster size.

<table>
<thead>
<tr>
<th>Sport</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Country</td>
<td>25</td>
<td>8.3</td>
</tr>
<tr>
<td>Football</td>
<td>43</td>
<td>14.2</td>
</tr>
<tr>
<td>Soccer</td>
<td>56</td>
<td>18.6</td>
</tr>
<tr>
<td>Volleyball</td>
<td>18</td>
<td>6.0</td>
</tr>
<tr>
<td>Basketball</td>
<td>33</td>
<td>11.0</td>
</tr>
<tr>
<td>Indoor/Outdoor Track</td>
<td>69</td>
<td>22.9</td>
</tr>
<tr>
<td>Swimming</td>
<td>22</td>
<td>7.3</td>
</tr>
<tr>
<td>Baseball</td>
<td>8</td>
<td>2.7</td>
</tr>
<tr>
<td>Lacrosse</td>
<td>15</td>
<td>5.0</td>
</tr>
<tr>
<td>Softball</td>
<td>12</td>
<td>4.0</td>
</tr>
<tr>
<td>Total</td>
<td>301</td>
<td>100</td>
</tr>
</tbody>
</table>

Sixty-one (20.6%) sustained an injury, defined as missing a day of competition or two practices. Of the sixty-one, 45 (73.8%) completed the injury survey. Sixteen (26.2%) did not respond to the initial email or the two follow-up emails the researcher sent with the link to the post-injury survey. Of the 45 participants who sustained an injury, 31 (68.9%) followed through with completing the return-to-play DPA survey. Fourteen participants (31.1%) were lost from injury to RTP and twenty-one participants (46.7%) were lost altogether. Of these twenty-one participants, two quit their team before returning to play, one participant violated the law and went to prison, one sustained a season-ending injury, five did not respond to follow-up emails to complete the RTP survey, eleven did not have three complete surveys. Data from one athlete was excluded.
because of an extended absence from competition. Therefore, data from 24 injured athletes were available for RTP analysis.

Out of the 24 injured participants, ten different teams were represented from two institutions. Sixty-seven percent (N = 16) of the participants either participated in football, indoor track, or soccer. Twenty-three participants (95.8%) were from the researcher’s institution. The gender of the participants were equally split (12 females and 12 males) with the average age of 19.9 ± 1.3 years old. There were 12 freshmen and sophomores, and 12 juniors, seniors, or graduate students.

Five out of the 24 athletes sustained non-season ending, non-musculoskeletal injuries (2 suffered concussions and 3 received eye injuries). The distribution of injury location can be seen in Table 4.2. A majority of the injuries, 75% (N = 18), were classified as either sprains or strains by the participating ATCs. Seventy-one percent of the subjects classified their injury as mild, 21% as moderate, while 8% classified their injury as severe.

<table>
<thead>
<tr>
<th>Injury location</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/face/neck</td>
<td>7</td>
</tr>
<tr>
<td>Shoulder/arm</td>
<td>1</td>
</tr>
<tr>
<td>Forearm/wrist/hand</td>
<td>1</td>
</tr>
<tr>
<td>Trunk/low back</td>
<td>0</td>
</tr>
<tr>
<td>Hip/thigh</td>
<td>8</td>
</tr>
<tr>
<td>Knee</td>
<td>0</td>
</tr>
<tr>
<td>Lower leg</td>
<td>0</td>
</tr>
<tr>
<td>Foot/ankle</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>
Scale Inventory

The DPA measure was constructed by Vela\textsuperscript{3} and included 16 components addressing the four theoretical constructs of the disablement model; impairment, functional limitations, disability, and quality of life.\textsuperscript{5-6} The factor groupings which emerged in this study were used in determining which theoretical construct groupings were predictors of RTP.

Vela\textsuperscript{3} performed a qualitative study which classified the 16 DPA items into the four theoretical constructs and later performed a factor analysis on the injured subjects’ data to validate inclusion of all 16 items on the DPA measure. Three distinct factors emerged which were related to the constructs of the disablement models. The first factor, labeled impairo-disability by Vela\textsuperscript{3}, contained 3 impairment components (pain, muscular performance, motion) and 3 disability components (participation in leisure activities and sport of preference, and overall fitness). The second factor, functional limitations, included all five functional limitation items (daily actions, skill performance one and two, changing directions, and maintaining positions) and one impairment component (stability). The last factor, quality of life, contained all four well-being items (increased anxiety, altered relationships, decreased overall energy, and changes in mood).

In this study, the dimensionality of the 16 item DPA scale was analyzed using maximum likelihood factor analysis on the difference in RTP scores and injury scores from the 24 injured participants. Three criteria were used to determine the number of factors to rotate: the scree tests, the interpretability of the factor solution, and the disablement model’s multidimensional theoretical constructs.\textsuperscript{7}
The factor analysis confirmed that the DPA is a multidimensional instrument. However, in this study five factors emerged from the factor analysis compared to Vela’s three emergent factors.\textsuperscript{5-6} The five factors which emerged were perceived disablement, functional disability, quality of life, impaire-limitations, and fitness. Based on the scree plot, five factors were rotated using a Varimax rotation procedure. Tables 4.3 and 4.4 illustrate the breakdown of the five factors from this study’s initial factor analysis.

<table>
<thead>
<tr>
<th>Table 4.3 Factor Analysis Using Injury Scores – RTP Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>Pain</td>
</tr>
<tr>
<td>Motion</td>
</tr>
<tr>
<td>Muscle function</td>
</tr>
<tr>
<td>Stability</td>
</tr>
<tr>
<td>Changing directions</td>
</tr>
<tr>
<td>Daily actions</td>
</tr>
<tr>
<td>Maintaining positions</td>
</tr>
<tr>
<td>Skill performance 1</td>
</tr>
<tr>
<td>Skill performance 2</td>
</tr>
<tr>
<td>Fitness</td>
</tr>
<tr>
<td>Leisure activities</td>
</tr>
<tr>
<td>Sport activities</td>
</tr>
<tr>
<td>Uncertainty/stress</td>
</tr>
<tr>
<td>Relationships</td>
</tr>
<tr>
<td>Energy</td>
</tr>
<tr>
<td>Mood</td>
</tr>
</tbody>
</table>
### Table 4.4 Factor Analysis for the DPA Scale (N=24)

<table>
<thead>
<tr>
<th>Item</th>
<th>Domain</th>
<th>Eigenvalue</th>
<th>Perceiveddisablement</th>
<th>Functional-disability</th>
<th>QOL</th>
<th>Impairment-limitations</th>
<th>Fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability</td>
<td>IMP</td>
<td>6.836</td>
<td>.887</td>
<td>.553</td>
<td></td>
<td>.507</td>
<td></td>
</tr>
<tr>
<td>Daily actions</td>
<td>FL</td>
<td></td>
<td>.631</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td>IMP</td>
<td>.586</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintaining positions</td>
<td>FL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participation in sport of choice</td>
<td>DIS</td>
<td>1.613</td>
<td></td>
<td></td>
<td></td>
<td>.899</td>
<td></td>
</tr>
<tr>
<td>Participation in leisure</td>
<td>DIS</td>
<td></td>
<td>.662</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill performance 1</td>
<td>FL</td>
<td></td>
<td>.496</td>
<td>.528</td>
<td>.573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill performance 2</td>
<td>FL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncertainty/Stress</td>
<td>QOL</td>
<td>1.126</td>
<td></td>
<td></td>
<td>.893</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mood</td>
<td>QOL</td>
<td></td>
<td></td>
<td></td>
<td>.838</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>QOL</td>
<td></td>
<td></td>
<td></td>
<td>.548</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationships</td>
<td>QOL</td>
<td></td>
<td></td>
<td></td>
<td>.474</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changing directions</td>
<td>FL</td>
<td>.973</td>
<td></td>
<td></td>
<td>.796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motion</td>
<td>IMP</td>
<td></td>
<td></td>
<td></td>
<td>.713</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscular performance</td>
<td>IMP</td>
<td></td>
<td></td>
<td></td>
<td>.605</td>
<td></td>
<td>.602</td>
</tr>
<tr>
<td>Fitness</td>
<td>DIS</td>
<td>.731</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The first factor, labeled perceived disablement, included two functional limitation components, daily actions and maintaining positions, and two impairment components, stability and pain. Functional measures are shown to be strong contributors to disablement. Pain may be perceived by athletes as the key component associated with disablement and therefore, fit well into this grouping. Athletes may relate pain with the inability to perform functional and/or daily activities. Stability, also an impairment, could be perceived by athletes as a functional limitation because limited stability could affect actions related to activities the athlete may be unable to perform. The results of the factor analysis in this study demonstrates that functional limitations and impairments account
for more variability in DPA scores than in Vela’s study where impairments and disability accounted for the most variability.

The second factor was labeled functional-disability and included two out of the three disability components and two functional limitations. Disability items separated into two different factors (two and five) unlike Vela’s groupings which coupled with impairments into the impairo-disability grouping. The grouping in this study included participating in their sport of choice, leisure activities, and skill performance. Functional limitations tend to be more salient for an injured athlete because they have more of a direct link and impact to disability.10

The third factor, labeled quality of life, consisted of the four well-being components. The quality of life factor included the same items in both factor analyses. Because of the interest in the psychological well-being of the athlete, the quality of life factor provides a more holistic assessment of the injured athlete and should be considered in the return to play decision making process.

The fourth factor was labeled impairo-limitations and included two impairments (motion and muscular performance) and one functional limitation component (changing directions). This grouping is sensible in that athletes relate impaired motion with the inability to twist, turn, pivot, cut (all examples of changing directions) and having limited motion may decrease the ability of full muscle functioning.

The fifth factor included one disability component, fitness. It should be noted however that in this study most injuries were minor and participants returned to play fairly quickly. Thus, their fitness levels may not have been affected.
Identifying Predictors

Four multiple linear regression analysis were conducted to identify those DPA and demographic variables that best predict the number of days to RTP. Regression was conducted with ungrouped DPA variables, demographical variables, significant DPA variables combined with demographic variables, and theoretically grouped DPA items. The dependent variable was the score on the DPA at RTP subtracted from the score on the DPA post-injury. The criterion for a variable to remain in the regression model was $p=.05^{11}$.

The initial analysis (Table 4.5) included the 16 DPA variables and yielded a $R^2 = .773$ and an adjusted $R^2$ of .255 ($F = 1.492, p = .306$). The large difference in the $R^2$ and adjusted $R^2$ could be attributed to the adjustment for the number of items in the model that occurs when calculating adjusted $R^2$, typically due to a small sample. After removing the least significant variables and rerunning the regression until a significant predictive model was discovered, three components of the DPA ($F = 8.924, p = .001$), motion ($p < .001$), muscle function ($p = .002$), and skill performance 2 (coordination, agility, precision, balance) ($p = .016$) explained significant portions of variance in days to RTP (Table 4.6). These variables combined account for 57.2% of the variance in the number of days to RTP ($R^2 = .572$ and $R^2$ adjusted = .508), which confirms the impact of a small sample size. Further analysis must bear this small sample into account.
### Table 4.5 Initial Analysis With All DPA Variables Included

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
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<td>Motion</td>
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<td></td>
<td>Muscular functioning</td>
<td>4.122</td>
<td>1.635</td>
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<tr>
<td></td>
<td>Stability</td>
<td>-1.905</td>
<td>2.046</td>
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<td></td>
<td>Changing directions</td>
<td>-1.041</td>
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<td></td>
<td>Daily actions</td>
<td>1.060</td>
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<td></td>
<td>Maintaining positions</td>
<td>1.891</td>
<td>2.171</td>
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<tr>
<td></td>
<td>Skill performance 1</td>
<td>.002</td>
<td>2.505</td>
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<td></td>
<td>Skill performance 2</td>
<td>3.477</td>
<td>2.117</td>
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<td></td>
<td>Overall fitness</td>
<td>1.082</td>
<td>1.511</td>
</tr>
<tr>
<td></td>
<td>Leisure activities</td>
<td>-2.448</td>
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</tr>
<tr>
<td></td>
<td>Sport of preference</td>
<td>.093</td>
<td>2.192</td>
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<tr>
<td></td>
<td>Uncertainty/stress</td>
<td>2.375</td>
<td>2.479</td>
</tr>
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<td></td>
<td>Relationships</td>
<td>-0.833</td>
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<td></td>
<td>Energy</td>
<td>.060</td>
<td>1.739</td>
</tr>
<tr>
<td></td>
<td>Mood</td>
<td>-2.656</td>
<td>2.303</td>
</tr>
</tbody>
</table>

* Dependent Variable: Days to RTP

### Table 4.6 Significant Predictive Model Using DPA Variables Only

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
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<tr>
<td>1</td>
<td>(Constant)</td>
<td>6.657</td>
<td>1.250</td>
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<td></td>
<td>Motion</td>
<td>-4.675</td>
<td>.929</td>
</tr>
<tr>
<td></td>
<td>Muscular functioning</td>
<td>2.898</td>
<td>.835</td>
</tr>
<tr>
<td></td>
<td>Skill performance 2</td>
<td>1.995</td>
<td>.761</td>
</tr>
</tbody>
</table>

* Dependent Variable: Days to RTP

The second regression analysis explored the variance in days to RTP explained by demographic variables. The variables of sport, gender, age, academic status, starter status, and involvement in clubs were included. None of the demographic variables were significant predictors of RTP ($R^2 = .237$ and adjusted $R^2 = -.032$; $p = .530$).
The third regression analysis was performed using the three significant predictive variables from the DPA and all the demographic variables. This analysis (Table 4.7) yielded a $R^2 = .695$ and an adjusted $R^2$ of $.500$ ($p = .017$). Age, academic status, and starter status added in combination with DPA scores of motion and muscle function (Table 4.8), to account for 66.2% of the variance in days to RTP.

Table 4.7 Regression Model with Significant DPA Variables and All Demographic Variables

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>56.344</td>
<td>1.760</td>
<td>.100</td>
</tr>
<tr>
<td>Sport</td>
<td>-.266</td>
<td>-.520</td>
<td>.611</td>
</tr>
<tr>
<td>Gender</td>
<td>1.219</td>
<td>.565</td>
<td>.581</td>
</tr>
<tr>
<td>Age</td>
<td>-2.774</td>
<td>-1.555</td>
<td>.142</td>
</tr>
<tr>
<td>Status</td>
<td>2.810</td>
<td>1.460</td>
<td>.166</td>
</tr>
<tr>
<td>Starter</td>
<td>-1.688</td>
<td>-1.216</td>
<td>.244</td>
</tr>
<tr>
<td>Clubs</td>
<td>.467</td>
<td>.390</td>
<td>.702</td>
</tr>
<tr>
<td>Motion</td>
<td>-4.270</td>
<td>-3.939</td>
<td>.001</td>
</tr>
<tr>
<td>Muscle function</td>
<td>3.376</td>
<td>3.636</td>
<td>.003</td>
</tr>
<tr>
<td>Skill performance 2</td>
<td>1.048</td>
<td>1.138</td>
<td>.274</td>
</tr>
</tbody>
</table>

a Dependent Variable: Days to RTP

Table 4.8 Regression Model Including Significant DPA and Demographic Variables

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>75.706</td>
<td>2.998</td>
<td>.008</td>
</tr>
<tr>
<td>Age</td>
<td>-3.743</td>
<td>-2.580</td>
<td>.019</td>
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<tr>
<td>Status</td>
<td>3.787</td>
<td>2.468</td>
<td>.024</td>
</tr>
<tr>
<td>Starter</td>
<td>-2.254</td>
<td>-2.191</td>
<td>.042</td>
</tr>
<tr>
<td>Motion</td>
<td>-3.390</td>
<td>-4.567</td>
<td>.000</td>
</tr>
<tr>
<td>Muscle function</td>
<td>3.375</td>
<td>.861</td>
<td>.001</td>
</tr>
</tbody>
</table>

a Dependent Variable: Days to RTP
The fourth regression analysis included the average score for each factor identified through the factor analysis (perceived disablement, functional-disability, QOL, and impaire-limitations). The model revealed no significant grouped predictors. This result demonstrates that there is not one theoretical construct which is a better predictor of returning to play than another. To possibly find a disablement construct that reveals significant RTP predictive power, additional participants and rerunning the regressions are necessary.

Discussion of the Identifying Predictors

Mattacola and Dwyer\textsuperscript{12} made previous attempts of determining RTP using physiological measures such as ROM and strength. The impact of psychological measures, including fear of movement and reinjury, on RTP were investigated by a variety of researchers.\textsuperscript{13-17} Tripp et al\textsuperscript{15} and McCarty et al\textsuperscript{17} allege that impairments, specifically motion and strength, have an influence on returning to participation which align with the predictive power and elevated scores in impaired motion and muscle performance of the subjects in this study. Wilson and Gansneder\textsuperscript{9} specifically investigated the predictive power of disablement theoretical constructs on RTP. Their inclusion of functional limitations explained 33\% of additional variance in days to RTP. In this study, the results revealed that two impairment measures and one functional limitation measure, were most predictive of days to RTP. Functional limitations have been reported to be better clinical predictors of disablement than impairments.\textsuperscript{8-9} However, clinicians focus more on measuring impairments to determine RTP status than functional limitations.
A variety of personal characteristics, situational characteristics, and psychological variables can influence injury and RTP. This study revealed age, academic status, and starter status as predictors of RTP. Infusing Chickering and Reisser’s psychosocial development theory, freshmen and sophomores lag behind juniors and seniors developmentally. Unfortunately, freshmen and sophomores are typically in the development stage of building meaningful relationships. They may lack sufficient social support for dealing with their injury; hence it may take this population longer to RTP than upperclassmen. The other variable is starter status. This study reinforces work by Wrisberg and Fisher which stated that feelings of anxiety may be present for athletes who are starters because they feel as if they may not be able to reclaim their starting position. They also state that when an injured athlete observes a teammate excelling at his/her position, they may return to participation before being ready.

**DPA Scores**

On the DPA (see Appendix B), each subject was presented with 16 questions which he/she scored from 1 “does not effect” to 5 “severely effects”. The researcher recoded the data so the range of scores was from 0-4 for each question. The maximum score on the DPA is 64 and the minimum is 0. The average baseline score was 8.39 points ($SD = 9.52$) with a range from 0-51 (see Table 4.9). At baseline, 23.9% (N = 72) of the 301 subjects had a total score of 0. A floor and/or ceiling effect was not reached.
Table 4.9 Survey Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline of all athletes (N=301)</td>
<td>8.39</td>
<td>9.52</td>
<td>0-51</td>
</tr>
<tr>
<td>Baseline of fall athletes (N=141)</td>
<td>7.67</td>
<td>9.09</td>
<td>0-42</td>
</tr>
<tr>
<td>Baseline of winter athletes (N=125)</td>
<td>8.35</td>
<td>9.63</td>
<td>0-51</td>
</tr>
<tr>
<td>Baseline of spring athletes (N=35)</td>
<td>11.40</td>
<td>10.50</td>
<td>0-51</td>
</tr>
<tr>
<td>Baseline of athletes who became injured (N=24)</td>
<td>9.67</td>
<td>10.35</td>
<td>0-38</td>
</tr>
<tr>
<td>Post-injury of all athletes (N=45)</td>
<td>24.73</td>
<td>12.02</td>
<td>0-53</td>
</tr>
<tr>
<td>Post-injury of final participating athletes (N=24)</td>
<td>25.71</td>
<td>14.00</td>
<td>6-53</td>
</tr>
<tr>
<td>RTP (N=24)</td>
<td>13.58</td>
<td>14.07</td>
<td>0-53</td>
</tr>
</tbody>
</table>

Differences in the baseline scores of the athletes at the researcher’s institution versus the other four universities in the PSAC were analyzed. The baseline average scores were $7.49 \ (SD = 8.90)$ and $9.45 \ (SD = 10.14)$, respectively. Baseline means from the fall, winter, and spring were also similar (Table 4.9) although spring athletes presented higher (3.05-3.73) baseline scores.

Due to the limited number of responses, the researcher combined Vela’s population with those in this study as an exercise to see if similarities existed between the two baseline population scores and to determine a normative baseline based on a larger population. The populations in both studies were similar, although not completely identical. In both studies a majority of the subjects were situated around a university setting, but competition levels were slightly different. With some limitations, Vela’s baseline score was 3.68 points (Table 4.10). When filtering Vela’s data, 87 subjects classified themselves as competitive and not recreational. The baseline mean of these subjects was 8.35 points which is similar to the 8.39 mean of the 301 participants in this study which made it reasonable to combine the results of both studies baseline scores. This results in a normative baseline value of 3-8.4 points or 6 points ±2, for physically active individuals.
Table 4.10 Survey Results from Vela

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (N=271)</td>
<td>3.68</td>
<td>5.65</td>
<td>0-34</td>
</tr>
<tr>
<td>Baseline of competitive (N=87)</td>
<td>8.35</td>
<td>12.29</td>
<td>0-47</td>
</tr>
<tr>
<td>Baseline of competitive with no current or persistent injury (N=61)</td>
<td>2.83</td>
<td>5.67</td>
<td>0-34</td>
</tr>
<tr>
<td>Baseline of recreational with no current or persistent injury (N=210)</td>
<td>3.93</td>
<td>5.64</td>
<td>0-26</td>
</tr>
<tr>
<td>Baseline of subjects with current or persistent injury (N=79)</td>
<td>22.17</td>
<td>12.84</td>
<td>0-52</td>
</tr>
<tr>
<td>RTP of acute injury (N=25)</td>
<td>9.04</td>
<td>7.00</td>
<td>0-23</td>
</tr>
</tbody>
</table>

Vela’s subjects who reported an acute or persistent injury (N = 79) had a mean DPA score of 22.17, which is 2.6 points lower than the post-injury DPA scores recorded in this study (Table 4.9 and Table 4.10). As shown in Table 4.9, the 24 participating subjects sustaining an injury had a baseline score of 9.67 (SD = 10.35), a mean injury score of 25.71 (SD = 14.00) and a RTP mean score of 13.58 (SD = 14.07). As expected, baseline scores had the lowest mean with an average increase of 16 points once a subject was injured. Upon return to full participation, DPA scores were lower, but not to the baseline mean. The change in scores had a similar trend to those reported by Vela. Vela’s change in scores from baseline to injured status were greater than those in this study. She reported a 36 point change from baseline to injury. The difference in the Vela’s point change and the change in this study could be attributed to Vela’s subjects completing the survey within 24 hours after injury compared to around three days post-injury in this study. The mean DPA reported by Vela at 3 days post-injury was 31.36. Thus, at day 3 post-injury, athletes in the Vela study reported DPA scores closer to those found in this study. No matter the differences in the two studies, a common factor is that baseline scores were reported as the lowest with an increase in scores post-injury, followed by a decrease in score during RTP. Although differences were found between
baseline and injury and injury and RTP scores (Table 4.11), the large standard deviations reflect considerable dispersion. Future research should investigate the qualitative nature of the dispersion in scores.

Table 4.11 Individual DPA Scores and Days to RTP

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline score</th>
<th>Injury score</th>
<th>RTP score</th>
<th># Days to RTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1**</td>
<td>9</td>
<td>13</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>2**</td>
<td>11</td>
<td>13</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>3*</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>30</td>
<td>34</td>
<td>25</td>
</tr>
<tr>
<td>5*</td>
<td>2</td>
<td>13</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>6**</td>
<td>20</td>
<td>35</td>
<td>18</td>
<td>10</td>
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<tr>
<td>7</td>
<td>18</td>
<td>29</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>35</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
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<tr>
<td>24</td>
<td>16</td>
<td>43</td>
<td>19</td>
<td>9</td>
</tr>
</tbody>
</table>

* Subjects who reported identical baseline and RTP scores  
** Subjects who reported lower RTP scores than baseline scores

DPA Components

Mean baseline scores of the 16 DPA components ranged from .23-1.09 (0-4 scale). The DPA component with the highest baseline mean score for all participants was “do I have pain” (1.09) while the component with the lowest baseline mean score was “do I have difficulty with participating in activities, specifically leisure activities” (.23).
For the 24 participants that sustained an injury, the components with the highest baseline means were “do I have pain” ($1.25, \text{SD} = 1.11$) and “do I have difficulty maintaining the same position for a long period of time” ($1.13, \text{SD} = 1.12$). Based on the wording of the DPA, these scores correspond to the DPA component not affecting or only slightly affecting the respondent.

Two of the components with the highest mean injury scores were “do I have difficulty participating in activities, specifically my sport of preference” ($2.54, \text{SD} = 1.38$) and “do I have difficulties with performing skills that are required for activity, specifically running, jumping, kicking, throwing, and catching” ($2.42, \text{SD} = 1.28$). These components would be salient in an athlete who cannot participate in their sport due to injury. The component demonstrating the least response to injury was the question “do I have difficulty with altered relationships with team, friends, and/or colleagues” ($0.46, \text{SD} = 0.83$).

Lastly, the component with the highest RTP mean score was “do I have impaired motion” ($1.33, \text{SD} = 1.40$). The components with the lowest mean score were “do I have difficulty with altered relationships with team, friends, and/or colleagues” ($0.375, \text{SD} = 0.77$) and “do I have difficulties with decreased overall energy” ($0.375, \text{SD} = 0.82$). Caution and interpretation needs to be used with these results due to a standard deviation which is larger than the mean.

**Internal Consistency of the DPA**

The internal consistency of the overall DPA instrument in the injured subjects ($N = 24$) resulted in a Cronbach alpha score of 0.928. Typically, scores that range from .70-.90 are considered acceptable and scores above .90 may indicate that the scale is only
measuring a single construct.³ Cronbach alpha scores were assessed three separate ways.

The initial analysis assessed the 16 DPA items, the second analysis used Nagi’s construct groupings, and the last analysis utilized the groupings discovered in the factor analysis of this study.

The first analysis was conducted on the 16 items hypothesized to assess disablement. As shown in Table 4.12, each of the 16 items were correlated with the total injury score on the DPA. All the correlations were greater than .430 which demonstrated that no item should be dropped from the scale.

Table 4.12 Item-Total Statistics of the Injured Athletes (N=24)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean/Standard Deviation</th>
<th>Item-Total Correlation</th>
<th>Cronbach’s Alpha if Item Deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>2.04±1.00</td>
<td>.528</td>
<td>.926</td>
</tr>
<tr>
<td>Motion</td>
<td>1.67±1.31</td>
<td>.631</td>
<td>.924</td>
</tr>
<tr>
<td>Muscle Performance</td>
<td>2.00±1.06</td>
<td>.550</td>
<td>.926</td>
</tr>
<tr>
<td>Stability</td>
<td>1.25±1.26</td>
<td>.696</td>
<td>.922</td>
</tr>
<tr>
<td>Changing Directions</td>
<td>1.62±1.41</td>
<td>.721</td>
<td>.921</td>
</tr>
<tr>
<td>Daily Actions</td>
<td>1.75±1.22</td>
<td>.746</td>
<td>.921</td>
</tr>
<tr>
<td>Maintaining Positions</td>
<td>1.21±1.25</td>
<td>.805</td>
<td>.919</td>
</tr>
<tr>
<td>Skill Performance 1</td>
<td>2.42±1.28</td>
<td>.823</td>
<td>.918</td>
</tr>
<tr>
<td>Skill Performance 2</td>
<td>1.80±1.47</td>
<td>.704</td>
<td>.922</td>
</tr>
<tr>
<td>Overall Fitness</td>
<td>1.37±1.24</td>
<td>.492</td>
<td>.927</td>
</tr>
<tr>
<td>Leisure Activities</td>
<td>2.04±1.40</td>
<td>.631</td>
<td>.924</td>
</tr>
<tr>
<td>Sport Activities</td>
<td>2.54±1.38</td>
<td>.647</td>
<td>.923</td>
</tr>
<tr>
<td>Stress/Uncertainty</td>
<td>1.04±1.30</td>
<td>.713</td>
<td>.921</td>
</tr>
<tr>
<td>Relationships</td>
<td>.46±0.83</td>
<td>.434</td>
<td>.928</td>
</tr>
<tr>
<td>Energy</td>
<td>1.04±1.16</td>
<td>.432</td>
<td>.929</td>
</tr>
<tr>
<td>Mood</td>
<td>1.46±1.44</td>
<td>.690</td>
<td>.922</td>
</tr>
</tbody>
</table>

The second analysis was based upon Nagi’s disablement theoretical constructs of impairments, functional limitations, disability, and quality of life.³⁵⁻⁶ The final analysis was completed using the grouping which occurred during the factor analysis for this study, which differed from Nagi’s⁵⁻⁶ theoretical construct grouping used in the second
analysis. All of these groupings, but perceived disablement/functional limitations, had a higher Cronbach alpha in the third analysis than the second.

Fifteen of the 16 survey questions serve as reasonably reliable measures of the four theoretical constructs which aligns with the factor analysis and demonstrates that the DPA is a good instrument. Fitness could be dropped from this survey with no significant differences in results, if the DPA is used only for intercollegiate athletes sustaining non-season ending acute injuries.

**Demographic Variables**

Demographic questions asked in the baseline survey included gender, sport, age, and academic status. For those who became injured, additional demographic questions included starter/non-starter status, club involvement, self-reported severity classification, and an estimated time he/she was out of competition.

Wrisberg and Fisher\(^{19}\) believed playing status and injury severity play a role in rehabilitation outcomes, including readiness to return to sport. McCarty et al\(^{17}\) suggested that factors such as age, academic status, and type of sport should be taken into consideration when determining when an athlete is ready to return to competition. The inclusion of club involvement was based on self-identity research. Ryska\(^{10}\) stated, “…an individual with a strong athletic identity would be more likely to interpret sport-related events in terms of how they impact his or her athletic functioning than would an individual who is less committed to the athletic role”. In this study, however, age, academic status, club involvement, and type of sport did not affect DPA scores or the number of days to RTP. As demonstrated in Table 4.13, significance was revealed between gender and baseline scores (N = 301), starter status and injury score, starter
status and RTP score, self-reported severity classification and days to RTP, and self-reported out-of-competition dates and days to RTP.

Table 4.13 Significant Findings with Demographic Variables

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Baseline score</th>
<th>Injury score</th>
<th>RTP score</th>
<th>RTP days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (N=301)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p = .020</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starter status (N=24)</td>
<td></td>
<td>p = .023</td>
<td>p = .033</td>
<td></td>
</tr>
<tr>
<td>p = .023</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severity (N=24)</td>
<td>p &lt; .001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-of-competition (N=24)</td>
<td>p = .005</td>
<td></td>
<td></td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>p = .005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Starters reported a higher injury total mean (30.0; $SD = 14.0$, N = 16) than non-starters (12.25; $SD = 1.5$, N = 4) ($t = 2.48$, $p = .023$). All non-starters self-reported a mild injury while starters self-reported reported mild (N = 9), moderate (N = 5), and severe (N = 2) injuries. The self-reporting of moderate and severe injuries from the starters could possibly explain the difference in injury total means between starters and non-starters.

Starters also return to play with a higher average DPA score (17.75, $SD = 14.63$) than non-starters (0.5, $SD = 1.0$) ($t = 2.31$, $p = .033$). Athletes sustaining moderate and severe injuries represented four different sports. Starters may feel more pressure internally and from their coaches, teammates, parents and media to RTP faster than non-starters. The average number of days to RTP between starters (10.56 days, $SD = 6.19$) and non-starters (9.5 days, $SD = 5.0$) was not significantly different ($p = .755$). According to the results of previous research$^{21-22}$, returning to participation may be a priority in those individuals who are starters and highly self-identify with being an athlete. If athletic identity is salient and central to the individual’s self-concept, research indicates relationships will be influenced which indirectly relates to coping abilities which can enhance the ability to RTP.$^{10,23}$
Upon observation of the injury severity estimates, participants who classified their injury as severe reported the highest injury total mean of 33.0 ($SD = 24.04$) while those classifying their injury as moderate reported a mean of 31.8 ($SD = 11.37$). Although a linear relationship is present, the relationship between severity and DPA scores was not significant which is most likely due to an N of 2 within the severe classification. There was a significant correlation ($r = .709, p < .001$) between severity and the number of days it took an athlete to RTP. As expected, athletes rating their injury as severe had the highest RTP mean at 19.50 days ($SD = 2.12$) while athletes rating their injury as mild had the lowest RTP mean of 7.53 ($SD = 3.14$). The change in scores from baseline to injury between those out of competition the shortest and the longest amount of time was consistent at 12 points. The time a subject was out of competition and their RTP scores was significant ($F = 5.88, p = .005$).

Vela$^3$ reported that of the 25 acutely injured athletes in her study, 7 returned in two weeks or less, 11 returned between 2 weeks to a month, 4 between 1-3 months, and 3 between 3-6 months. In this study, 19 athletes return in two weeks or less, 5 returned between 2 weeks to a month, and 1 returned between 1-3 months and was subsequently removed from the study’s analysis. These athletes are highly competitive and have a drive to RTP as soon as possible. Vela’s study$^3$ included intercollegiate athletes, but also included high school athletes, intramural/club athletes, and patients from a clinic which may have a lower level of competitive drive. However, it must be noted that competitive drive was not measured in either study.
### Table 4.14 Out of Competition

<table>
<thead>
<tr>
<th>Days to Return</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 week</td>
<td>10</td>
<td>42</td>
</tr>
<tr>
<td>1-2 weeks</td>
<td>11</td>
<td>46</td>
</tr>
<tr>
<td>2-3 weeks</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3-4 weeks</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>4-6 weeks</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>6-8 weeks</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Over 2 months</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Instrument Sensitivity**

Responsiveness is related to the last two research questions, the first having to deal with instrument sensitivity. Responsiveness is measured to detect changes or differences over time which are clinically meaningful for people experiencing disablement. A measurement instrument is considered responsive when a measurement change is detected in patients whose health status is known to have changed. Responsiveness is an important measurement characteristic when assessing the usefulness of a self-reported disability scale like the DPA.

For this study the mean change in score divided by the standard deviation of baseline scores was used to calculate effect sizes. Although the sample met the assumption that the test variable is normally distributed in the population, a commonly accepted value for a moderate sample size is 30 and the sample size used in this effect size calculation was 24. Effect sizes were calculated from the paired sample t test, which are shown in Table 4.15. According to Green and Salkind, values of .2, .5, and .8 are interpreted as small, medium, and large effect sizes, respectively. The effect size was small between baseline and RTP scores. Baseline to injury scores and injury to RTP scores demonstrated large effect sizes. These results demonstrate that the DPA is
sensitive to change in disablement levels of the physically active population, specifically from baseline to injury and then from injury to RTP status.

**Table 4.15 DPA Effect Size**

<table>
<thead>
<tr>
<th>Surveys</th>
<th>X1-X2</th>
<th>ES</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline to RTP</td>
<td>-3.92</td>
<td>-0.38</td>
<td>Small</td>
</tr>
<tr>
<td>Baseline to Injury</td>
<td>-16.04</td>
<td>-1.55</td>
<td>Large</td>
</tr>
<tr>
<td>Injury to RTP</td>
<td>12.125</td>
<td>1.25</td>
<td>Large</td>
</tr>
</tbody>
</table>

**Critical Value**

Responsiveness was also measured by creating a receiver operating characteristic (ROC) curve, which was used to establish the critical value for RTP. ROC curves synthesize the sensitivity and specificity information to differentiate between patients who have reported a change versus those who have not or have been stable. To create the ROC curve, the DPA scores and the days to RTP were used to calculate the plots.

Sensitivity and specificity values of the DPA were 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 (RTP in 8 days or less) versus those who had not. Twelve subjects returned to play in 8 days or less. Sensitivity was .667 and specificity was .417 (Table 4.16). Each point change was used to plot an ROC curve where the Y-axis represented the sensitivity values and X-axis represented the specificity values.
In order to have a robust model, more subjects are needed. The minimal clinical important difference (MCID) value was determined by choosing the point on the ROC curve that is nearest the upper left corner, demonstrating the optimal trade off between sensitivity and specificity.\textsuperscript{25,28} Ideally, a perfect distinction of a clinically significant change would be an area of 1.0 under the curve. An area represented by 0.5 or less indicates that the instrument does not discriminate between change in a patient’s status.\textsuperscript{25} The area under the curve in this study was .675. Based on the data, the MCID value is 6.5 (sensitivity = .667, 1-specificity = .381) for returning to play in 8 days or less (Figure 4.3).

### Table 4.16 Sensitivity and Specificity of the DPA

<table>
<thead>
<tr>
<th>Predictive components sum</th>
<th>RTP</th>
<th>Did not RTP**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RTP*</td>
<td>Did not RTP**</td>
</tr>
<tr>
<td>0-6 points</td>
<td>8</td>
<td>a</td>
</tr>
<tr>
<td>7-12 points</td>
<td>4</td>
<td>c</td>
</tr>
</tbody>
</table>

* = RTP ≤8 days, ** = RTP >8 days
Discussion of Limitations

The major limitation to this study was the small sample size. To rectify the small sample size, the population pool could be expanded to include all NCAA divisions and sports. Another major limitation to the study was the low response rate which contributed to the small sample size. Only speculation can be made regarding the low response rate of the participants. Confidentiality concerns with respect to Internet security could be one explanation. Viruses and spam are also prevalent in computer usage which might have increased the likelihood of a participant to delete an email from an unknown sender. Access to computers could also be a limiting factor at some institutions.

Conclusions

Once an athlete is injured, one of the common questions an ATC hears from the athlete, teammates, coaches, and/or parents is when can he/she return to participation. According to Anderson et al., 29 “there are no foolproof criteria for accurately estimating
recovery time” because they vary due to injury severity, prior injury, effectiveness of rehabilitation, motivation levels of the athlete, and the demands of the sport. Clinicians traditionally have minimized the importance of self-reported assessment tools. By instituting a simple objective assessment tool like the DPA, clinicians could gauge the level of disablement an athlete is experiencing. To return to the first research question, the DPA components of impaired motion, muscle function, and the ability to perform skills such as coordination, agility, precision, and balance proved to be predictors of RTP. When the DPA components were combined with the demographic variables, impaired motion, muscle function, age, academic status, and starter status proved to be significant predictors of the number of days it takes an athlete to RTP following injury. Grouping of the disablement constructs proved to be a useless exercise and not necessary.

Through the incorporation of Vela’s baseline data with the data from this study (N = 572), a normative average of 6 ±2 was established for the baseline DPA. The next research question investigated which DPA components affected the participants’ the most during baseline, injury, and RTP. During baseline, pain was the component with the highest average score followed by an increased change in mood. Difficulty participating in the athlete’s sport of preference and performing the skills of running, kicking, jumping, throwing, and catching received the highest scores post-injury. Lastly, when returning to play, the highest scored component was impaired motion.

The DPA proved to be a responsive instrument that demonstrated change in athletes’ status, specifically from baseline to injury and injury to RTP. Based on these
two large effect sizes and the significant differences in means reported in the paired samples t-test, the DPA could be implemented as an objective assessment tool for the RTP decision making process. The last research question was to determine the critical value of the DPA upon returning to participation. The critical value of the DPA was calculated by a ROC curve and determined to be 6.5.

The DPA, even with the limitations presented, appears to be a valid tool to determine disablement. This can only be confirmed with further research that includes using larger numbers of participants in similar studies.
References


CHAPTER 5

CONCLUSION
Chapter 5

Conclusion

Introduction

Physiological functions are at the core of determining when an injured athlete should RTP. Clinicians base a majority of their RTP decisions on the outcomes of impairments and functional limitations. Meanwhile, the amount of disability incurred by the athlete and his/her psychological well-being is ignored. Literature\textsuperscript{1-4} suggests that psychological factors play a role in injury occurrence, the healing process, and rehabilitation outcomes. One of the purposes of this study was to determine which Disability in Physically Active (DPA) variables, individually and grouped within their respective theoretical constructs, predict return to play (RTP).

Besides finding which DPA variables are strong predictors of RTP, other purposes of this study were to determine which demographic variables were strong predictors of RTP, determine a normative baseline value for the DPA, assess which DPA components affect participants the most during baseline, injury, and RTP, determine which demographic variables have a significant affect on baseline, injury, and RTP scores along with the number of days to RTP, determine whether the DPA is a sensitive, objective assessment tool for ATCs to implement when making RTP decisions, and establish a critical value for returning to play. This chapter includes a summary, the findings of the research questions, and recommendations for future research.
Summary

The participants (N = 301) were student-athletes representing 5 Pennsylvania State Athletic Conference (PSAC) institutions and 11 sports (baseball, basketball, cross country, football, indoor track and field, outdoor track and field, soccer, softball, swimming, women’s lacrosse and women’s volleyball) competing at the NCAA Division II level. Participants completed a web-based baseline measure of the DPA scale. Scores ranged from 0-51 with a mean of 8.39. Upon acute injury, participants (N = 45) completed the DPA scale for a second time. The average score was 24.73 with a range from 0-53. When the athletes (N = 31) returned to play, they completed the DPA for a final time. A total of 24 participants completed all three DPA scales and were used in the data analysis. For the final 24 participants, their baseline mean was 9.67, injury mean was 25.71 and the RTP mean was 13.58.

Slightly different disablement construct groupings than Vela\textsuperscript{5} and Nagi\textsuperscript{6-7} were discovered through a factor analysis. Stability, daily actions, pain, and maintaining positions fell within the perceived disablement grouping. The functional disability grouping consisted of participation in leisure activities and sport of preference along with the ability to perform skills such as running, kicking, and balance. The quality of life grouping included the well-being variables of uncertainty, mood, energy, and relationships. The impairo-limitation grouping included changing directions, motion, and muscular performance. Lastly, the component of overall fitness did not fit into any specific group which questions its inclusion in the DPA measure.

Results indicated three significant DPA predictors of RTP. The significant predictors were motion, muscular functioning, and the ability to perform the skills of
coordination, agility, precision, and balance. Results also indicated that age, academic
class status, and starter status were demographic predictors of RTP when included with
the significant DPA predictors. When demographic variables were grouped without the
DPA variables, no variables were significant predictors of RTP. Also, when the DPA
variables were grouped by disablement theoretical constructs no significant predictors of
RTP were discovered.

When combining Vela’s baseline data with this study, the normative value of the
baseline DPA was established to be 6 points \( \pm 2 \). When investigating the DPA
components, “do I have pain” received the highest average on the baseline DPA. On the
post-injury DPA survey, difficulty participating in the athlete’s sport of preference and
experiencing difficulty performing skills required for activity received the highest scores.
Upon returning to play, the component with the highest mean was “do I have impaired
motion”.

Six significant findings were discovered through analysis of the demographic
variables. Males reported lower baseline scores (6.97) than females (9.53). Starter status
was associated with higher injury \( (p = 0.023) \) and RTP \( (p = 0.033) \) DPA scores. Starters
reported a higher injury DPA (30.0) and RTP DPA (17.75) than non-starters (12.25 and
0.5). Self-reported injury severity was associated \( (p = 0.001) \) to the number of days to
RTP. If subjects rated their injury as severe, they had a higher RTP mean (19.5 days)
compared to those who rated their injury as mild (7.5 days). The self-reported out-of-
competition variable was significantly correlated to RTP scores \( (p = 0.05) \). Lastly, the
amount of time the subjects stated they were out-of-competition was associated to the
actual number of days they did not participate ($p < .001$), which demonstrated that the subjects self-reported honestly.

Large effect sizes were discovered between baseline to injury and injury to RTP. This result demonstrates that the DPA is responsive to changes in disablement levels of the physically active population, leading the researcher to believe that the DPA is a sensitive and valid objective assessment tool which should be implemented when clinicians are faced with making RTP decisions. The critical value of the DPA when returning to play within 8 days or less was determined to be 6.5 points. This demonstrates that if an athlete scores 6.5 points or less on the post-injury sum of the three predictive DPA components he/she is more likely to return to play $\leq 8$ days.

**Conclusions**

The following conclusions are based on the findings of the study:

1. Impairments and functional limitations were predictors of RTP. However, none of the theoretical construct groupings were significant predictors of RTP, but three individual variables within the impairment and functional limitation constructs were significant predictors of RTP. Motion, muscular functioning, and performing the skills of coordination, agility, precision, and balance were discovered as significant predictors of RTP. According to Nagi’s$^{6-7}$ disablement model, motion and muscular functioning are considered to be impairments while skill performance is a functional limitation. The predictive power of motion and muscular functioning align with the results of previous researchers.$^{8-9}$

Typically, once impairments resolve and athletes experience minimal limitations with functional activities they will return to play, regardless of their levels of disability
and quality-of-life (QOL). This study demonstrated that disability and QOL measures are not predictors of RTP. However, out of nine impairment and functional limitation components, only three DPA items were significant predictors of RTP. The researcher was surprised that pain, changing directions, and performing the skills of running, jumping, kicking, throwing, and catching did not have a predictive power to determine RTP. Pain is a salient characteristic in acute injuries, but many competitive athletes are coached to play through pain. This mindset could explain why pain was not a predictive variable. Changing directions and skill performance would be expected to directly affect athletes’ ability to perform at pre-injury status, but as shown in this study these variables do not predict RTP.

2. Among the demographic variables, age, academic class standing, and starter status were significant predictors of RTP when included with the three predictive DPA variables, but only increased the variance by an additional 9%. Without including the predictive DPA variables into the regression, no demographic variables predicted RTP. The researcher believed that academic class standing and starter status would be strong predictors of RTP. Specifically, being either a junior or senior starter would demonstrate a quicker RTP rate.

The belief of junior or senior status being a strong predictor of RTP was based on the fact that they tend to be more developmentally and emotionally mature, have formed strong relationships with others and have a solid support network to cope with their injury than freshmen and sophomores. Solid coping skills have shown to help an athlete RTP at a quicker rate.
The researcher expected that starter status would be a predictor of RTP because starters tend to self-identify with being an athlete.\textsuperscript{1,4} Being a starter may provide more motivation to RTP at a faster rate. This population of starters would also be more worried about an athlete taking over his/her starting position or may feel more peer pressure to RTP as fast as possible.\textsuperscript{13-14}

3. The normative value of the baseline DPA instrument in healthy competitive athletes was determined to be 6 points $\pm$ 2. The researcher hypothesized that a normative value for the DPA at baseline would be 3.7 $\pm$ 6, which was based on Vela’s previous results.\textsuperscript{5}

4. Athletes are most likely to report pain during completion of the baseline DPA score. After injury, athletes are most likely to experience difficulty with performing skills of running, kicking, throwing, and catching which directly affect their ability to perform their sport of preferences. Upon return to participation, athletes are most likely to report impaired motion. Based on modified disablement theories,\textsuperscript{5,15-16} the researcher was surprised that QOL scores were typically reported as the least affected component.

5. It was hypothesized that the DPA measure would be an objective assessment tool that was sensitive to post-injury change in the physically active population. The DPA was found through the factor analysis and effect size calculations to be a multi-dimensional assessment measure that is sensitive to change in health status. The DPA demonstrated sensitivity to change between baseline and injury and injury to RTP. Large effect sizes were noted between these times of administration of the DPA.

6. The critical value of the DPA when returning to play in 8 days or less was determined to be 6.5. The critical value was expected to be approximately nine. This
expectation was based on previous research results by Vela showing a summative DPA mean for acute injuries as 9.04 with a standard deviation of 7. To attain the critical value of 6.5, the sum of the three predictive DPA variables of motion, muscular functioning, and performing the skills of coordination, agility, precision, and balance, were used. This critical value demonstrates when an athlete has experienced a clinically significant change.

**Recommendations for Future Study**

The following are recommendations for future research based on the findings, limitations, and delimitations of the present study:

1. The major limitation to this study was the small injured population. To gain a larger injured population there needs to be more subjects completing the baseline survey. To increase the baseline population an increase in response rate needs to occur. A face-to-face invitation to complete the survey rather than an email invitation is suggested, specifically with baseline survey completion. If possible, completion of the DPA could be incorporated into each teams’ pre-season schedule, as is orthopedic screening in many institutions. Another way to increase the baseline population is to incorporate more schools and sports. The present study was restricted to universities in the state system of Pennsylvania that compete at the NCAA Division II level. Hopefully, by increasing the baseline population an increase in the injured sample will ensue.

By having more injured subjects, the researcher believes the possibility of finding specific trends and significant differences between demographic variables and total scores would have elucidated. With a small sample, an inflation in correlations and
regression coefficients occur. In order to have accurate correlations and regression coefficients, the study needs to have five times the amount of subjects than variables. In this study, a population of at least 80 injured athletes would need to be present (if including DPA variables only).

2. By increasing the population, future research can branch out and investigate a variety of areas. With more injured subjects, the researcher believes specific trends and significant differences between demographic variables and the DPA could be exposed. A normative value of the DPA following an acute non-season ending injury could also be determined since a normative value of the baseline DPA was established in this study. A larger population could lead to more robust models that hold more substantial power.

3. Since this study established a normative value for baseline, future research should focus on the implications of baseline measures which are above normative values. Questions regarding the increased likelihood of becoming injured and why baseline measures are above normative values could be explored.

4. A qualitative component could be added to this study to look at who reports higher than normative baseline scores and why. The qualitative research could provide insight to the large dispersion in scores.

5. Future researchers should investigate the risk of reinjury if an athlete returns to play in \( \leq 8 \) days when they have an elevated critical value score. With a larger sample, additional critical values can be determined for multiple RTP dates. Recurrence rates (i.e. – hamstring strains 30.6%, ankle sprain 15%) have the potential to decrease if useful tools exist to aid in the RTP decision-making process. The researcher believes the DPA
has this potential; however, a larger sample size needs to be used to assess reinjury rates. With a large sample, researchers could investigate which DPA components are elevated when an athlete RTP and becomes reinjured.

6. Variables not explored in this study, but could be used in future research on RTP predictors are previous injury history and fear avoidance. Maddison and Prapavessis\textsuperscript{19} found previous injury was correlated with the number of days it took to RTP. An increase in anxiety, fear of reinjury, and/or altered efficacy to perform to previous level may emerge if the athlete is not ready to RTP.

Research has demonstrated that when pain is experienced and signals fear of reinjury, an athlete may experience apprehension in returning to full participation. This specific fear leads to a decrease in physical performance and reluctance in engaging in activities.\textsuperscript{20} In this study and Tripp et al\textsuperscript{9}, pain was not shown to have a significant impact on whether the individuals engaged in their sport of preference or not, but further investigation is warranted.

7. Future researchers should also explore psychological variables such as coping ability, anger, anxiety, depression, and their impact on predicting injury and predictive value to RTP. Researchers have investigated whether psychosocial variables play a role in predicting vulnerability or resiliency to injury.\textsuperscript{4,12,19,21} In fact, athletes with high stress levels “were two to five times more likely to sustain an injury than athletes with low life stress”.\textsuperscript{19} Although the current study was not specifically looking at predictors of injury, well-being baseline scores could be looked at in future research with a larger sample to see if athletes who reported high stress levels were more likely to be injured.
Previous research states that recovery from injury often depends on the athlete’s primary feelings upon injury which commonly includes frustration, alienation, anger, and sadness.\textsuperscript{12-13,21,23} If these feelings are left unattended, an athlete can show signs of depression, social isolation and withdrawal. If an injured athlete has not formed meaningful relationships that assist in the coping process prior to injury, anxiety and stress levels are likely to increase. Researchers suggest problematic psychosocial factors such as maladaptive coping skills, high levels of anxiety and stress may prolong rehabilitation for injured athletes.\textsuperscript{12,19,22} Leddy et al\textsuperscript{21} stated that levels of depression, anxiety, and self-esteem were not significantly different between pretest and post-injury scores, although mood scores were slightly elevated. Other research demonstrates that high athletic identity along with injury severity and low social support increases emotional/depressive symptoms following an injury where the athlete is out of competition for a minimum of 3 weeks. Three weeks was utilized as a cut-off point because they believe a shorter period of time would not significantly affect emotional/well-being components.\textsuperscript{24} This could be a plausible explanation as to why the well-being components were not a predictor of RTP in this study and were one of the lowest scored components when an athlete was injured.

Quality of life variables might be more predictive of RTP when dealing with persistent/chronic injuries, however the one case in this study was excluded from final data analysis. Future studies could investigate the impact of severe and persistent/chronic injuries to see if quality of life scores yield a significant predictive value to RTP.
References


Appendix A

*Invitation Letter to Certified Athletic Trainers*
PSAC ATC Research Information Invitation

My name is Jody Preische and I am a certified athletic trainer at Lock Haven University. I am contacting you to ask for your assistance in a research project as part of my doctoral program at Penn State University. My research is looking at predictors of return-to-play (RTP). Secondarily, I am validating whether the use of the Disability in the Physically Active (DPA) scale can be used as a meaningful measure for RTP guidelines. For this project I would like to collect data from all PSAC schools and your participation is vital. I consulted with a fellow PSAC ATC, Yvette Ingram, and we believe the time commitment involved will be minimal and manageable.

In general, I will need your assistance for the following procedures:

1. Updating rosters and filling in email addresses of your athletes on a spreadsheet that I email you.
2. Filling in a database, I provide, when you have any athletes who:
   a.) meet the injured criteria
   b.) return to full participation
   c.) become reinjured with the same injury

A more detailed explanation of the procedures involved in this study are described below. The areas in bold are the areas where I will need your assistance:

1. I will email you an excel spreadsheet with your team’s roster at the beginning of the team’s season. The following teams will be invited to participate: men and women’s cross country, football, volleyball, men and women’s soccer, men and women’s basketball, indoor and outdoor track, swimming, women’s lacrosse, softball, and baseball. I will need you to make updates to the roster. I will also need you to add their email address, if possible, on the spreadsheet and send this back to me.
2. I will contact your athletes via email during preseason informing them of my research and asking them to fill out an online survey which asks questions regarding their levels of impairment, functional limitations, disablement, and quality of life. This enables me to obtain your athletes’ baseline measures. There are no associated risks involved for your athlete. Your encouragement of the athletes’ participation is greatly appreciated.
3. Once pre-season begins, I will email you a roster spreadsheet (only including athletes who filled out the baseline survey) every two days that looks like this:

<table>
<thead>
<tr>
<th>Date</th>
<th>Sport</th>
<th>Athlete</th>
<th>Injury</th>
<th>Return to play</th>
<th>Reinjured</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/16/06</td>
<td>Football</td>
<td>Joe Smith</td>
<td>Ankle sprain</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

I will ask that once an athlete is injured (misses 2 days of practice or a competition) you fill in the chart by typing in the athlete’s injury and then send it back to me. I will proceed to email the athlete and ask him/her to fill out the online survey again. When an athlete returns to full participation it can be marked with an x on the chart. Full participation is considered when an athlete can participate in all drills at practice and/or can compete in a competition. The
athlete will again be emailed by me when they return to full participation and will be asked to complete the online survey one last time. Once they have filled out the survey three separate times they are no longer eligible to participate in this study. However, **I ask that if your athlete becomes reinjured (with the same injury) you inform me on the database so I can keep track of reinjury rates.**

So in review, I need your assistance with:

1. Updating rosters and filling in email addresses of your athletes
2. Filling in the database I provide every other day and emailing it back to me when you have athletes who:
   a.) meet the injured criteria
   b.) return to full participation
   c.) become reinjured with the same injury
3. If you have no athletes meeting the above criteria I ask that you hit the reply message and send me the database back. This allows for accurate data tracking.

At the beginning of the study each athlete will be emailed information regarding the research. They will also be informed that their participation is voluntary and all information they provide will be confidential.

To recognize your participation in this study I will produce a certificate of participation that you can use as tenure/promotion research credit document. I welcome any questions, concerns, and/ or points of clarification. Feel free to contact me at jrp260@psu.edu or 570-484-2704.

Sincerely,
Jody Preische, ATC
Appendix B

Disability in Physically Active Survey and Demographic Questions
Baseline Demographic Questions (for Spring Athletes)

What intercollegiate sport are you participating in?
O Baseball
O Lacrosse
O Outdoor Track and Field
O Softball

I am a:
O Male
O Female

How old are you?

What is your current academic class standing?
O Freshman
O Sophomore
O Junior
O Senior
O Graduate Student

Do you currently have an injury in which you are not cleared for full athletic participation?
O Yes
O No
Post-Injury Demographic Questions (for Spring Athletes)

Which intercollegiate sport were you involved in when you were injured?
O Baseball
O Lacrosse
O Outdoor Track and Field
O Softball

The injury occurred during
O Practice
O Game/Meet
O Conditioning

If the injury occurred during practice or competition, what position were you playing?

If you are an outdoor track and field athlete and were injured during practice or competition, what event were you involved in?

Were you a first-team player (starter) when you were injured?
O Yes
O No
O Not applicable

Not including your sport involvement, how many on-campus clubs/organizations are you currently involved in?
O 0
O 1
O 2
O 3
O 4 or more
Return-to-Play Demographic Questions (for Spring Athletes)

Which intercollegiate sport were you involved in when you were injured?
O Baseball
O Lacrosse
O Outdoor Track and Field
O Softball

Would you classify your injury as being:
O mild
O moderate
O severe

How long were you out of competition?
O less than one week
O 1-2 weeks
O 2-3 weeks
O 3-4 weeks
O 4-6 weeks
O 6-8 weeks
O over 2 months
**DPA Survey for Baseline, Injury, and Return to Participation**  
**Adapted from Vela ©2005**

Instructions: Please answer each statement with one response by choosing 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

### Pain

<table>
<thead>
<tr>
<th>“Do I have pain?”</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Motion – “Do I have impaired motion?”

<table>
<thead>
<tr>
<th>Ex. decreased range/ease of motion, flexibility, and/or increased stiffness</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Muscular Functioning – “Do I have impaired muscle function?”

<table>
<thead>
<tr>
<th>Ex. decreased strength, power, endurance, and/or increased fatigue</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Stability – “Do I have impaired stability?”

<table>
<thead>
<tr>
<th>Ex. the injured area Feels loose, gives out, or gives way</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Changing Directions – “Do I have difficulty with changing directions in activity?”

<table>
<thead>
<tr>
<th>Ex. twisting, turning, starting/stoping, cutting, pivoting</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### Daily Actions – “Do I have difficulty with daily actions that I would normally do?”

<table>
<thead>
<tr>
<th>Action Description</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. walking, squatting, getting up, lifting, carrying, bending over, reaching, and going up/down stairs</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Maintaining Positions – “Do I have difficulty maintaining the same position for a long period of time?”

<table>
<thead>
<tr>
<th>Position Description</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. standing, sitting, Keeping the arm overhead, or sleeping</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Skill Performance – “Do I have difficulties with performing skills that are required for physical activity?”

1. Ex. running, jumping, kicking, throwing, & catching
2. Ex. coordination, agility, precision & balance

<table>
<thead>
<tr>
<th>Skill Description</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Overall Fitness – “Do I have difficulty maintaining my fitness level?”

<table>
<thead>
<tr>
<th>Fitness Element</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. condition, weight lifting &amp; cardiovascular endurance</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
</tbody>
</table>

### Participation in Activities – “Do I have difficulty with participating in activities?”

1. Ex. participating in leisure activities, hobbies, and games
2. Ex. participating in my sport(s) of preference

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>No problem</th>
<th>Does not affect</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Well-Being – “Do I have difficulties with the following…?”</td>
<td>No problem</td>
<td>Does not affect</td>
<td>Slight</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
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<td>--------</td>
</tr>
<tr>
<td>1.) increased uncertainty, stress, pressure, and/or anxiety</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2.) altered relationships with team, friends, and/or colleagues</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>3.) Decreased overall energy</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>4.) Changes in my mood and/or increased frustration</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
Appendix C

Recruitment Letter to Athletes
Dear NCAA Athlete:

You have been invited to participate in research of NCAA Division II intercollegiate athletes participating within the Pennsylvania State Athletic Conference. The purpose of this research is to determine the best predictors of return-to-play in intercollegiate sports after sustaining an athletic injury.

Your participation in this study will take approximately 20 minutes. You will be asked to complete an online web-based survey so the researcher can gain baseline measurements. This should take approximately 10 minutes to complete. If you become injured you will be contacted through email to complete the survey at two separate times, each time taking a total of 5 minutes. You will be provided with a brief overview of the research and a consent form within the next few days via email. If you agree to participate in the study a link will be provided on the consent form which will take you to the web-based survey. The consent form will be sent to you via email within the next 24 hours.

Your participation in this research is confidential. Only the person in charge of the research will be able to connect you with the dataset. To ensure your privacy, all information you complete will be assigned a code number rather than your name. Although your athletic trainer knows of your potential participation in this study, he/she will not have access to any of the surveys you complete. All completed surveys will be secured in a password protected file. In the event of a publication or presentation resulting from the research, no personally identifiable information will be shared.

You are invited to make any inquiries concerning this study. Please contact Jody Preische at jrp260@psu.edu or 570-484-2704 (office) with questions or concerns about this study.

Sincerely,
Jody Preische, ATC
Doctoral Candidate at The Pennsylvania State University
Appendix D

Informed Consent Form
1. Purpose of the Study: The purpose of this research is to determine what factors are key determinants in returning to activity after a sports-related injury.

2. Procedures to be followed:
   Step 1: You will be asked to fill out a web-based survey which asks about how well you function in physical activity and daily activities. There will also be a section which will ask questions regarding your age, sport position, starter/non-starter role, academic class standing, and involvement in other college activities.

   Step 2: If you suffer an injury during your season, your athletic trainer will contact the primary investigator via email. You will then be contacted via email and asked to complete the web-based survey.

   Step 3: Upon returning to full participation in your sport, your athletic trainer will notify the primary investigator via email. You will again be notified via email and asked to complete the survey one last time.

3. Duration: Your participation in this study will take approximately 10 minutes to complete the baseline survey. If you become injured you will be contacted through email to complete the survey at two separate times, each time taking a total of 5 minutes.

4. Statement of Confidentiality: Your participation in this research is confidential. Only the investigator will have access to personal identifiers and to any information that can be associated with your identity. To ensure your privacy all information you complete will be assigned a code number rather than your name. 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. Your confidentiality will be kept to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the Internet by any third parties. All completed surveys will be password protected. In the event of publication of the research, no personally identifying information will be disclosed.

5. **Right to Ask Questions:** Please contact Jody Preische at jrp260@psu.edu or 570-484-2704 (office) with questions or concerns about this study.

6. **Voluntary Participation:** Your participation is completely voluntary and you can withdraw from the study at any time by notifying Ms. Preische with no adverse consequences. You have the opportunity to refuse to answer any questions that you choose.

In order to participate in this study, you must be between the ages of 18-25 to agree to participate in this research study. If you consent to participate in this research study and to the terms above, please place an x beside accept. If you do not want to participate in this research, please place an x beside decline. Completion and return of the survey implies your consent to participate in this research. Please print off this form to keep for your records.

**Accept**

Please proceed to [SurveyLink] if you accept the terms of this research.

**Decline**

Please note: If you decline, please click the link below, and you will be automatically removed from our mailing list. http://www.surveymonkey.com/optout.aspx
Appendix E

Emails to Athletes
Follow-up Emails

Email sent as a 2\textsuperscript{nd} follow-up to initial baseline survey

Dear Athlete,
This email serves as a reminder to fill out the survey at [SurveyLink] regarding return to play predictors for PSAC athletes. This survey has taken an average of 90 seconds for your peer athletes to complete. The results of the survey will hopefully assist your certified athletic trainer in the future. Your participation is important. If you have already completed this survey, please disregard this email. Thank you for your assistance in this research project.

Jody Preische, MEd., ATC
The Pennsylvania State University
Department of Kinesiology
146 Recreation Hall
University Park, PA 16802
jrp260@psu.edu
570-484-2704

Email sent to athletes who become injured

Dear Athlete,
Your athletic trainer has notified me that you have sustained an injury. Please fill out the survey at [SurveyLink], which is similar to the survey you completed at the beginning of the season. Your participation in this study will assist certified athletic trainers in providing better care in the future. Your timely completion of this survey is necessary. If possible, please complete this survey within the next 48 hours.

As a reminder, your participation in this study is strictly voluntary. You may withdraw from this study at any time. Also, privacy and confidentiality to your data will be maintained throughout this study. Your confidentiality will be kept to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the Internet by any third parties. If you have any questions or concerns regarding this research, please feel free to contact me, Jody Preische, at either jrp260@psu.edu or at 570-484-2704 (office). Thank you for your assistance. Best wishes for a healthy and timely recovery.

Sincerely,
Jody Preische
Primary Investigator
Pennsylvania State University
Email sent as a follow-up reminder to an athlete who sustained an injury

Dear Athlete,
This email serves as a reminder to fill out the survey located at [SurveyLink]. This survey is vital to this research, which hopes to determine what factors are key determinants in returning to activity after sports-related injuries. Your timely completion of this survey is necessary. If possible, please complete this survey within the next 24 hours. Your participation is important. Thank you for your assistance in this research project. Best wishes for a healthy and timely recovery.

Sincerely,
Jody Preische
Primary Investigator
Pennsylvania State University

Email sent to athletes who return to play

Dear Athlete,
Thank you for filling out my survey when you were injured. To continue with my study I need your assistance one last time. Your athletic trainer has notified me that you have returned to full athletic participation following injury. I would appreciate it if you would fill out the survey at [SurveyLink] for a final time. This third survey is vital to this research, which hopes to determine what factors are key determinants in returning to activity after sports-related injuries. Your timely completion of this survey is necessary. If possible, please complete this survey within the next 48 hours.

As a reminder, your participation in this study is strictly voluntary. You may withdraw from this study at any time. Also, privacy and confidentiality to your data will be maintained throughout this study. Your confidentiality will be kept to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the Internet by any third parties. If you have any questions or concerns regarding this research, please feel free to contact me, Jody Preische, at either jrp260@psu.edu or at 570-484-2704 (office). Thank you for your assistance. Congratulations on your recovery and good luck in your athletic endeavors.

Sincerely,
Jody Preische
Primary Investigator
Pennsylvania State University
Vita
Jody R. Preische

EDUCATION
2002-2007 The Pennsylvania State University, University Park, PA
PhD: Kinesiology with a specialization in Athletic Training
Minor: Higher Education
1995-1997 Valdosta State University, Valdosta, GA
MED: Health and Physical Education
1990-1995 Salisbury University, Salisbury, MD
BS: Physical Education with an emphasis in Athletic Training and K-12 Education

CERTIFICATIONS
National Athletic Trainers Association
Pennsylvania Athletic Training Licensure
Maryland K-12 Physical Education Teaching Certification

CAREER EXPERIENCE
2006-present Lock Haven University, Lock Haven, PA
Clinical Coordinator of Athletic Training Education Program
2004-present Lock Haven University, Lock Haven, PA
Instructor in the Department of Health Science; Assistant Athletic Trainer
2002-2004 Pennsylvania State University, University Park, PA
Teaching Assistant in the Department of Education Theory and Policy
2000-2002 Chowan College, Murfreesboro, NC
Director of Athletic Training Education; Senior Woman Administrator
1998-2002 Chowan College, Murfreesboro, NC
Instructor in the Department of Health and Physical Education; Assistant Athletic Trainer
1997-1998 Wicomico High School, Salisbury, MD
Head Athletic Trainer; Physical Education Teacher
1997-1998 Salisbury State University, Salisbury, MD
Clinical Supervisor; Adjunct Instructor
1995-1997 Valdosta State University, Valdosta, GA
Graduate Assistant

SCHOLARLY ACTIVITY
Preische, JR, Wagner EB. Ophthalmoplegic Migraine, Cranial Nerve Palsy, Amblyopia: Differential Diagnosis of an Eye Injury to a Female Collegiate Soccer Player. Accepted for presentation at the National Athletic Trainers Association Convention, June 2007.

