Measuring Health Status in Rehabilitation: Psychometric Analysis of Patient Reported Outcome Instruments

A Dissertation

Presented in Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

with a

Major in Education

in the

College of Graduate Studies

University of Idaho

by

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August 2017

Authorization to Submit Dissertation

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Abstract

Assessing practice effectiveness is necessary for evidence-based practice (EBP). Use of EBP allows for more effective health care decisions and provides a process for a clinician to improve the efficacy of clinical practice, while also providing valuable information about treatment effectiveness and patient recovery to important stakeholder groups. Researchers have created patient reported outcome (PRO) instruments to examine specific constructs or symptoms (e.g., pain, functional limitation) to assess patient recovery and treatment effectiveness. However, many of the currently used scales have not be tested using contemporary psychometric analysis techniques to establish factorial validity. The purpose of this dissertation was three-fold: (1) to address the gap in the literature related to the psychometric measurement properties of the Disablement in the Physically Active (DPA) Scale, (2) explore short from versions of the DPA Scale that may be more effective for use in clinical practice and research, and (3) develop and validate a new PRO instrument to assess health status, while providing important summary components for clinicians.

Acknowledgements

I would like to acknowledge the following for their contributions to my professional development and the completion of my dissertation:

Thank you to Dr. Damon Burton for your willingness to join me on this journey. Without your support, I doubt that I would have been able to complete this goal. I am grateful for your efforts to further my development as a scholar and faculty member. You have been a mentor, colleague, and friend. I am better prepared to be the researcher, educator, and mentor I desire to be because of your efforts.

Thank you to Dr. Tony Pickering for being an educator who will not only show you the "rabbit hole," but will join you on the journey to see just how deep it goes. Your efforts allowed me to see that this project was possible. More importantly, your efforts helped me develop the skillset to make it a reality, while simultaneously constructing a new path for my career as a researcher.

Thank you to Dr. Philip Scruggs for your support during my doctoral pursuits. I am grateful for your willingness to listen, offer advice, and support my efforts to better myself as a clinician, scholar, and educator. Thank you for the honest feedback on my development as a scholar and faculty member during this journey.

Thank you to Dr. Amanda Start for your willingness to join this project, for making time to provide feedback on this (or any other research project) I requested over the past few years, and for being an example of a growth mindset. I would also like to thank you for being "first" – you set the stage for doctoral students to know "this" was possible.

Dedication

My dissertation is dedicated to those who made this milestone possible.

To my creator – I pray I do not waste the gift.

To my wife, Jayme – I have no doubt that the best version of myself is a result of you.

To my children, Jarus, Jase, and Taryn – You are blessings in my life.

To my mother, Tina – It may not have been the "doctor" you originally had in mind, but you were right. I am blessed because God chose you.

To my dad, Russ – You are the standard by which I measure my "best" effort in this life.

Thank you – I am grateful beyond words.

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Introduction

Assessing practice effectiveness is a vital component of evidence-based practice (EBP). This process allows for more effective health care decisions to be made given the varied clinical circumstances clinicians face on a daily basis.[1-3] A clinician can improve the efficacy of clinical practice by using this process,[2-4] while also providing valuable information about treatment effectiveness and patient recovery to important stakeholder groups.[2,3] Disease-oriented outcomes (e.g., range of motion) are often used to measure rehabilitation progress,[5] but these measures may fail to assess patient improvement in a manner that is relevant to the patient.[2,3]

To resolve this problem, researchers have created patient reported outcome (PRO) instruments to examine specific constructs or symptoms (e.g., pain, functional limitation) meaningful to patients.[3] These instruments may be used to measure a variety of health concepts[4,6] or may be more focused on a specific disease, body region, or domain.[3] The process is thought to be more effective when a multi-dimensional instrument is utilized.[7-9] To assess a variety of health-related constructs (e.g., functional status, quality of life).[7-10] The Disablement in Physically Active (DPA) Scale is a generic, multi-dimensional PRO designed for physically active populations. The DPA Scale has been recommended for use in clinical practice and research.[11,12]

Analysis of the DPA Scale, however, has indicated the need for further psychometric testing of the instrument.[11,12] The DPA Scale may not effectively assess the originally proposed constructs,[12] which may limit the usefulness of the scale in clinical practice and research. It is important for clinicians to have access to instruments that can be used with a variety of patients, be administered easily, and accurately assess proposed constructs.[3,13] A

scale that assessed health status, while also having summary components (e.g., pain, functional limitations, quality of life), may allow clinicians and researchers to assess individual components of the recovery process, in addition to a higher order construct of health status.[12]

The purpose of this dissertation was three-fold: (1) address the gap in the literature related to the psychometric measurement properties of the DPA Scale, (2) explore short from versions of the DPA Scale that may be more effective for use in clinical practice and research, and (3) develop and validate a new PRO instrument to assess health status, while providing important summary components for clinicians. Thus, in Study 1, we assessed the psychometric properties of the original DPA Scale and explored the potential for short form versions of the scale. In Study 2, we examined the psychometric properties of the newly created DPA Scale Short Form-8 and DPA Scale Short Form-10 to determine if the proposed model fit was maintained in a second sample of physically active participants. Finally, in Study 3, we developed and validated a generic, multi-dimensional PRO instrument assessing health status through the sub-dimensions of functional limitations, disability, quality of life, and pain characteristics.

References:

1) Sackett DL, Rosenburg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. *Br Med J*. 1996;313(7024):71-72.

2) Evans TA, Lam KC. Clinical outcomes assessment in sport rehabilitation. *J Sport Rehabil*. 2011;20:8-16.

3) Nicholas P, Hefford C, Tumilty S. The use of the patient-specific functional scale to measure rehabilitative progress in a physiotherapy setting. *J Man Manip Ther*. 2012;20(3):147-152.

4) Valovich McLeod TC, Snyder AR, Parsons JT, Bay CR, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice, part II: clinical outcomes assessment. *J Athl Train*. 2008;43(4):437–445.

5) Abrams D, Davidson M, Harrick J, Harcourt P, Zylinski M, Clancy J. Monitoring the change: current trends in outcome measure usage in physiotherapy. *Man Ther*. 2006;11(1):46-53.

6) Ware JE Jr, Sherbourne CD. The MOS 36-item short form health survey (SF-36). I. Conceptual frameworks and item selection. *Med Care*. 1992;30(6):473-483.

7) Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med*. 1994;38(1):1–14.

8) Dobrzykowski E. The methodology of outcomes measurement. *J Rehabil Outcomes Meas*. 1997;1(1):8–17.

9) Watts J, Clement D. Conceptual framework for rehabilitation outcomes research. *J Rehabil Outcomes Meas*. 2000;4(2):55–61.

10) Anderson KL, Burckhardt CS. Conceptualization and measurement of quality of life as an outcome variable for health care intervention and research. *J Adv Nurs*. 1999;29(2):298-306.

11) Vela LI, Denegar CR. The disablement in the physically active scale, part II: the psychometric properties of an outcome scale for musculoskeletal injuries. *J Athl Train*. 2010;45(6):630-641.

12) Houston MN, Hoch JM, Van Lunen BL, Hoch MC. The development of summary components for the disablement in the physically active scale in collegiate athletes. *Qual Life Res*. 2015;24(11):2657-2662.

13) Westaway MD, Stratford PW, Binkley JM. The patient-specific functional scale: validation of its use in persons with neck dysfunction. *J Orthop Sports Phys Ther*. 1998;27(5):331-338.

Manuscript 1: Confirmatory Factor Analysis of the Disablement in Physically Active Scale and Preliminary Testing of Short-Form Versions: A Calibration Study.

Evidence-based practice (EBP) involves the development of practice standards based on the collection, appraisal, interpretation, and application of the research literature to guide clinical practice.[1] While evidence is often associated with the published peer-reviewed research literature, the EBP process also includes considering personal clinical expertise and experience, along with the patient's specific situation (e.g., needs, beliefs, circumstance), to make the most appropriate health care decision for a given patient in a specific situation.[2] In clinical practice, this may be accomplished through the systematic collection and assessment of patient outcomes. Patient outcomes may be collected with clinician-derived measures (e.g., strength measurements)[3] or through patient self-report instruments.[4,5] Often, this process is conducted by using patient-reported outcome (PRO) scales that may measure patient, disease, region, or domain-specific constructs regarding the patient's condition.[5-9]

Patient-reported outcome scales may be unidimensional, but many are often designed as multi-dimensional instruments used to measure physical and psychological constructs that capture the injury and recovery process experienced by a patient.[8,10-12] The purpose of PROs is to use patient perception to measure aspects of the injury and recovery process that are meaningful to them.[13] Multi-dimensional PRO instruments are often designed as region specific scales (e.g., Lower Extremity Functional Scale) or generic instruments that are not specific to a location of the body or types of injury.[4,14,15] A common construct measured with the generic instruments is health-related quality of life (HRQoL). Health-related quality of life is valued as a construct because it is thought to encompass the patient's perception of physical, psychological, and social sub-constructs of their health status and recovery.[14,16]

While there are a variety of generic instruments available to assess HRQoL, two of the more commonly utilized generic PROs are the Short-Form 36 (SF-36) and the Short-Form 12 (SF-12).[17] Both instruments, however, do have limitations for use in certain situations. For example, the instruments were not designed for assessing HRQoL following musculoskeletal injury in physically active populations[17-19] and do not adequately distinguish between "causal indicators" (e.g., impairment, mood, etc.) of HRQoL versus being a true assessment of life quality.[20-22] As a result, the Disablement in Physically Active (DPA) Scale was created to measure HRQoL as a unique construct, while also assessing three theorized sub-dimensions of the disablement process: impairment, functional limitations, and disability.[14,15] The DPA Scale is a 16-item instrument, scored on a 1 (no problem) to 5 (severely affected) Likert scale, with a total score floor of 0 and a ceiling of 64 points.[15] The scale has been reported to have acceptable model fit (CMIN/DF = 1.89, GFI = 0.852, TLI = 0.924, CFI = 0.937, RMSEA = 0.085),[15] high test-retest reliability (ICC = .943) and internal consistency (α = .890 - .908),[23] and concurrent validity (-.751 [acute] and -.710 [persistent] relationship with Global Functioning scores).[15] The DPA Scale has also been found to have similar summary components to the SF-36.[24] The design of the scale and the results of early psychometric measurement evaluation have also led to the scale being recommended for use in research and practice.[15,23,24]

However, the development of the DPA Scale does have potential limitations to consider when using the scale in clinical practice and research. The confirmatory factor analysis (CFA) was performed with data from only 125 participants who were all currently suffering from injury (i.e., 43 reporting injury at baseline, 28 after acute injury, and 54 reporting persistent injury), coming from the same geographic regions (5 sites), and of similar

age range (i.e., high school and collegiate athletes).[15] Based on structural equational modeling standards,[25,26] the sample was small and homogenous, suggesting further assessment is needed before the instrument is widely utilized across heterogeneous, physically active populations in clinical practice and research. Overall, the samples used for current psychometric measurement analysis make it difficult to fully assess the fit indices or assume the scale structure would remain sound in more diverse samples.[25,26]

Additionally, while meeting some recommended cut points for fit indices[15,27] when assessing scale structure in the original study, other instrument structure concerns remain. For example, stricter fit indices have been recommended for establishing acceptable model fit, such as RMSEA less than or equal to .06[28] and TLI, GFI, and CFI greater than or equal to .95[29] have been recommended for establishing acceptable model fit. Furthermore, the three proposed sub-dimensions of disablement (i.e., impairment, functional limitation, and disability) were highly correlated (above .90),[15] and the high correlational values may indicate the items are not measuring the uniqueness of the sub-dimensions effectively.[26] For example, in a follow-up study of the DPA Scale, analysis produced only two summary components: (1) Physical Summary Component (i.e., Items 1-12 of the impairment, functional limitation, and disability sub-dimensions) and (2) Mental Summary Component (Items 13-16 of the quality of life construct).[24] These findings demonstrate the need for additional testing of the DPA Scale, and its summary components, in a larger sample that better represents the patient population (e.g., different geographic locations, activity levels, etc.).[15, 24, 26]

Further analysis should also be conducted to determine if a more parsimonious version of the scale exists to satisfactorily measure the disablement process based on the proposed items and constructs. Removing items with low construct validity may improve overall

precision and reduce measurement error, without overlooking important patient-reported information on the disablement process.[25,30] In general, more parsimonious and simpler models are preferred,[25] and more concise versions may produce scales with improved validity, precision, and applicability in practice and research.[30-32] Furthermore, given the participation of collegiate athletes from a similar geographic location, the construct validity of the DPA Scale must be assessed across a more diverse sample of the physically active population.[25,26] Thus, further psychometric testing is justified for refining the DPA Scale, and caution should be used when interpreting the findings of the instrument until further assessment has been completed.

Therefore, the purposes of this study were to: (1) assess the model fit of the original DPA Scale using a larger and more diverse sample to examine its psychometric properties, and (2) to explore the potential for a short-form version. The first objective was to use CFA to assess the fit of the originally proposed model of the DPA Scale and assess correlational values among the proposed sub-dimensions of the instrument. The second objective was to use EFA to assess the structural validity of short-form versions of the DPA Scale to identify a model factor structure by eliminating items or factors to help improve model fit of the previously proposed scale. The final objective was to use covariance modeling to assess whether the measurement model extracted from the EFA meets fit indices recommendations necessary for further validation.

Methods

Participants

Following institutional review board approval of this project, participants reviewed and provided informed consent prior to completing the DPA Scale. In the case of minors, the participant provided assent, while the legal guardian provided consent. Participants were recruited from athletic training clinics (n = 22) and outpatient rehabilitation clinics (n = 2) across the United States. Participants were free of chronic pain[15,34] and injuries were classified based on *a priori* definitions for each category into four groups: healthy, acute injury, sub-acute injury, and persistent injury (Table 1). Activity levels of participants were also classified according to *a priori* definitions to create four distinct groups: competitive athlete, recreational athlete, occupational athlete, and activities of daily living (Table 2; Appendix A). A total of 1,592 participants completed the study. The data was dichotomized into two random sub-samples of equal size for use in calibration and validation phases of examination the DPA Scale. The calibration sample (i.e., Sample 1) was used for this study.

Instrumentation

Participants completed packets that included the DPA Scale and demographic information (Appendix B) at an initial intake with the athletic trainer. The DPA Scale was hypothesized to have 4 first-order factors assessed by 16 items. The primary three factors, impairments, functional limitations, and disability, are hypothesized to comprise the second-order construct, disablement. Items 1-4 are designed to tap into the impairment dimension, items 5-9 tap into the functional limitations construct, and items 10-12 comprise the disability construct. Items 13-16 are designed to tap into the construct of quality of life, which covaries

with disablement. Each item was rated on a 1 (“no problem”) to 5 (“severe”) Likert scale. The score for each item is summed, and 16 points is subtracted from the summed total. Scores range from 0 points (i.e., floor) to 64 points (i.e., ceiling).[15]

The athletic trainer working with the participant also collected eight types of demographic information, including: injury category (i.e., persistent, acute, sub-acute, or healthy), patient athletic status (e.g., competitive athlete, recreational athlete), age, sex, sport, general injury location (i.e., lower extremity, spine, and upper extremity), specific injury location (e.g., head/neck, shoulder/arm, ankle/foot, etc.), and type of injury (e.g., arthritis, neuroma, strain, sprain, post-surgery, etc.).

Data Analysis

The DPA Scale responses and demographic information were de-identified and input into Qualtrics by the collecting athletic trainer. Data was downloaded from Qualtrics for data analyses using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) Version 24.0 and Analysis of Moment Structure (AMOS, SPSS, Inc.) Version 24.0. Missing data was treated conservatively and any participant response with a missing value for the DPA Scale was removed from the data set. Any missing demographic data were left as missing values. Data analysis and cleaning were conducted on the univariate distributions of all the variables to verify whether they were normally distributed with low levels of skewness and kurtosis. Multivariate outliers were identified using descriptive statistics and Mahalanobis distance.

Confirmatory factor analysis of the Disablement in the Physically Active Scale. Confirmatory factor analysis (CFA) was conducted using AMOS on the DPA Scale to assess

model fit. Consistent with the original assessment of the scale, the DPA Scale was specified as a 2-factor (1 second-order, 1 first-order) 16-item model[15] to assess model fit. Maximum likelihood estimation (MLE) was used to generate parameter estimates. The likelihood ratio statistic (CMIN or chi-square statistic; χ^2), the χ^2 / degrees of freedom ratio (CMIN/DF), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Bollen's Incremental Fit Index (IFI) were used to assess model fit. Because the χ^2 test is sensitive to sample size, prompting the likelihood of misrepresenting model fit,[27] this test carried less weight in assessing model fit. The fit indices used to assess model fit were set based on the following *a priori* values: GFI ≥ .95,[35] CFI ≥ .95, TLI ≥ .95, RMSEA ≤ .06,[29] and IFI ≥ .95.[27]

Analysis of short-form versions of the Disablement in the Physically Active Scale. To assess construct validity of possible DPA Scale short-form versions, exploratory factor analysis (EFA) was conducted on the 16 items designed to assess the four constructs. Maximum likelihood and principal components extraction methods with oblimin rotation were conducted to assess the underlying dimensional structure of the DPA Scale and ensure results were not a byproduct of extraction method. Factorability of the data was determined by (a) KMO = .80 (recommended > .70) and (b) Bartlett test of Sphericity $p < .001$ (recommended < .05).[36] Following estimation, the measurement model was specified, eliminating items if they: (a) did not have substantial loadings (≥ .50), (b) had simultaneous, substantial cross-loadings (≥ .30), or (c) did not fit conceptually with the other items loading on the factor. Factor dimensions were extracted based on eigenvalue greater than 1.0 or by accounting for more than 5% of variance.[36] Cronbach's alpha was used with an *a priori* value

range of ≥ .70, but ≤ .89, to establish internal consistency of the construct without the factor including more items than necessary to reliably measure the construct.[36]

Covariance modeling, using AMOS and maximum likelihood estimation procedures, was conducted on any proposed short-form versions of the DPA Scale to assess model fit. To assess model fit, the same tasks and criteria utilized for the CFA were applied to this analysis. The measurement model specified within the covariance modeling analysis was consistent with the measurement model extracted from the EFA. Correlational analyses were conducted between the scores on the proposed short form versions of the DPA Scale and the original DPA Scale. Pearson's correlations were estimated to determine if the short form versions explained an acceptable percentage of the variance in responses on the original DPA Scale. An *a priori* correlation value of $r \geq .90$ ($R^2 = .81$) was used to determine if the short form versions explained an acceptable percentage of the variance in DPA Scale scores.[30]

Results

Preliminary Analysis

Within the entire sample (n = 1,592), 100 participants (6%) did not complete the entire DPA Scale and were removed from the data set. A total of 112 (7%) participants reported scores that were identified as univariate (z scores ≥ 3.4) or multivariate outliers (Mahalanobis distance ≥ 33).[37] Participants included both sexes, all injury categories (e.g., acute, persistent), and various injury types (e.g., sprain, strain, etc.). Removal of these participants from the sample resulted in normal data distribution. A total of 1,380 (87%) participants remained, and the sample was randomly split into two even samples (n = 690 for Sample 1a and n = 690 for Sample 2a) for the calibration and validation phases of the study.

Given the substantial number of cases removed from the data cleaning process, it was valuable to ensure the model fit reached was not a result of bias due to participant removal. Thus, an equal and random sample (n = 56) of the participants identified as outliers was added back to each sample (n = 746 for Sample 1b and n = 746 for Sample 2b). An equal and random sample (n = 50) of participants with missing data was also added back to each sample (n = 796 for Sample 1c and n = 796 for Sample 2c). Sample 1a was utilized for the primary analyses in this study. However, the final model findings using Sample 1a were compared against the results generated using Sample 1b and Sample 1c after the final model was produced.

The 690 participant sample (353 males, 330 females, 7 sexes not reported; mean age = 23.1 ± 9.3 years, age range = 11 to 75 years) included competitive athletes (336; 48.7%), recreational athletes (n = 167, 24.2%), occupational athletes (n = 158; 22.9%), and those active in daily life (n = 26, 3.8%). Participants reported participating in a variety of primary sports (Table 3). The majority of responses (n = 427; 62%) were collected at collegiate (Division I = 67, 9.7%; Division II = 126, 18.3%; Division III = 32, 4.6%; NAIA = 63, 9.0%; Junior College = 44, 6.4%) and high school (n = 96; 13.9%) athletic training clinics, but a large portion of the sample (n = 263; 38%) was collected in two out-patient clinics. The sample included those with persistent injury (n = 220, 31.9%), acute injury (n = 144, 20.9%), sub-acute injury (n = 199, 28.8%), and healthy (n = 127; 18.4%) status. A variety of injury locations (Table 3) and types were reported (Table 4).

Scale Structure of the Disablement in the Physically Active Scale

The correlations between the sub dimensions of the disablement construct were high (Impairment and Functional Limitations, r = .95; Functional Limitations and Disability, r =

.97; Impairments and Disability, r = .89). Because of the high correlations, as was done in the original assessment of the DPA Scale,[15] a hierarchical CFA was used to assess the scale structure of the originally published model. The initial analysis revealed fit indices approaching acceptable levels (CFI = .938, GFI = .903, TLI = .926, RMSEA .082, IFI = .938). As was the case in the initial analysis of the scale,[15] the modification indices indicated the model fit could be improved if the error covariance between v5 (Item 5) and v9 (Item 9) and v8 (Item 8) and v12 (Item 12) were freed to covary. Because this study was assessing the findings of the original analysis, these specifications were accepted, and the final DPA Scale measurement model ($\chi 2$ [98] = 420.849, CMIN/DF = 4.29, $p \leq .001$) was estimated using the confirmatory approach for the original DPA scale. For the final model, the CFI (.957) and IFI (.957) fit indices were above the recommended levels. The GFI (.929), TLI (.947), and RMSEA (.069) approached recommend levels (Figure 1).

Scale Structure of the Short-Form Versions of the Disablement in the Physically Active Scale

Exploratory factor analysis results. A two-factor structure emerged from the EFA on the DPA Scale items. The first factor represented a "physical" summary component (Items 1-12), while the second factor represented a "mental" summary component (Items 13-16). The total variance accounted for by the items in the two factors was 60%, with the physical summary component accounting for 49% of the variance (eigenvalue = 7.86; $\alpha = .945$), and the mental summary component accounting for 11% of the variance (eigenvalue = 1.73; $\alpha = .852$). The 16 item, two factor solution could be reduced to an 8 item instrument with a shortened physical summary component (Items 1, 2, 3, and 5) and the mental summary component (Items 13-16; Table 6). The factors within the shortened version accounted for a

similar proportion of the variance (total = 61%; physical summary = 44%; mental summary = 17%). Cronbach's alpha was acceptable for the "physical" summary factor (α = .850) and the "mental" summary factor (α = .852).

A three-factor solution could also be specified from the EFA (Table 7). The first factor represented "impairment" (Items 1-3), the second factor represented "quality of life" (Items 13-16), and the third factor represented "functional limitations" (Items 4, 5, and 9). The total variance accounted for by the three factor solution was 74%, with "Impairment" accounting for 48%, "quality of life" accounting for 19%, and "functional limitations" accounting for 7%. The items comprising the three-factor solution had strong Cronbach's alpha levels across dimensions, with "impairment" (α = .837), "functional limitations" (α = .840), and "quality of life" (α = .852) having acceptable internal consistency. The items in each scale, along with original and revised dimension labels, are provided in Table 8.

Covariance modeling results. Initial fit for the covariance model of the 2-factor, 8-item (i.e., DPA Scale Short Form-8; DPA SF-8) solution indicated excellent fit ($\chi 2$ [19] = 36.949, CMIN/DF = 1.945, $p \leq .008$), with fit indices exceeding recommended levels (CFI = .993, GFI = .987, TLI = .990, RMSEA .037, IFI = .993; Figure 2). All factor loadings were significant ($p \leq .001$) and modification indices did not suggest model fit could be substantially improved with the specification of a covariance between error terms.

Initial covariance modeling of the DPA Scale Short Form-10 (DPA SF-10) indicated the correlations between impairment and functional limitations constructs were high (r = .83), but were acceptable for functional limitations and quality of life (r = .26) and impairment and quality of life (r = .45) dimensions. Because of the high correlations, a second-order model was used to assess the scale structure of the DPA SF-10. The initial analysis revealed fit

indices exceeded the recommended levels ($\chi 2$ [32] = 60.911, CMIN/DF = 1.903, $p \leq .002$, CFI = .992, GFI = .983, TLI = .989, RMSEA .036, IFI = .992). The modification indices indicated the model fit could be slightly improved if the error covariance between v5 and v9 were freed to covary. Because improvement was nonsignificant and all factor loadings were significant ($p \leq .001$), the DPA SF-10 measurement model without this modification was accepted (Figure 3). A comparison of the final model solutions for the DPA Scale, DPA SF-10, and DPA SF-8 across all of the samples (1a, 1b, and 1c) is provided in Table 9.

Scale correlation results. The correlation between participant cumulative scores on the DPA Scale and the DPA SF-8 was high ($r = .94$, $p \leq .001$, $R^2 = .88$). The correlation between participant cumulative scores on the DPA Scale and the DPA SF-10 was also high ($r = .97$, $p \leq .001$, $R^2 = .94$). The correlation between cumulative scores on the DPA SF-10 and DPA SF-8 was also high ($r = .98$, $p \leq .001$, $R^2 = .96$). Group mean scores on the three versions of the scale are provided in Table 10.

Discussion

The first purpose of the study was to assess the scale structure the DPA Scale using a larger and more diverse physically active sample to examine its psychometric properties. Another purpose was to use EFA to assess the structural validity of short-form versions of the DPA Scale and to use covariance modeling to examine whether the measurement model extracted through EFA met fit indices recommendations necessary for further validation. We used contemporary psychometric analysis methods to assess the model fit of DPA Scale and short form versions.[25-27] The calibration sample used in this study provided a more physically active participant pool than had previously been utilized for psychometric analysis of the DPA

Scale. The results suggest the DPA Scale, along with the DPA SF-8 and DPA SF-10, are valid and reliable multidimensional PRO instruments.

Confirmatory Factor Analysis of the DPA Scale

The CFA findings were similar to the results of the original study[15] of the DPA Scale: (1) the sub-dimensions of the disablement construct were highly correlated ($r \geq .89$), (2) model fit was improved by allowing error terms of items 8 and 12 and 5 and 9 freedom to covary, and (3) the scale met some, but not all, of the strict fit indices recommendations.[27-29,35] The results supported the DPA Scale having reasonable fit to justify its use in clinical practice and research. However, the high correlation values between sub-dimensions of the higher-order disablement construct made it difficult to conclude that the items for these sub-dimensions are tapping into unique constructs.[25,26] While it is useful to have an instrument that measures multiple constructs of disablement,[10,11,15] the DPA Scale was designed to avoid the World Health Organization model where the distinction between the constructs was unclear.[15,38] The results of our study indicated the constructs are either measuring much of the same phenomenon or the items are being interpreted similarly by participants given the high correlational findings. The results suggest the instrument may be improved by condensing the scale into a more parsimonious instrument.[25] Another option would be to re-word items or provide fewer over-lapping examples that may lead to participants not being able to make distinctions between items designed to measure different constructs.[39]

Psychometric Analysis of the Short Form Versions of the DPA Scale

The short-form versions produced from the analysis reflect the initial design of the DPA Scale in that the instrument was hypothesized to measure constructs assessing physical

(i.e., disablement) and mental health (i.e., QOL) dimensions. Our EFA findings support previous research on the summary components of the DPA Scale.[24] However, our results also indicated further modification could improve the internal consistency of the constructs, while also potentially improving scale structure and reducing response burden by creating a more parsimonious instrument.[25,36]

Creating a more parsimonious model primarily occurred by removing items that had higher cross loadings, those that did not account for a substantial portion of the variance, or those which inflated Cronbach's alpha levels.[25,36] This process led to the removal of Items 6, 7, 8, 10, 11, and 12 for both of the short form versions. Additionally, Item 4, which was originally hypothesized to be an item addressing impairment, factored better in the functional limitations construct when examining the data. We felt the item could be interpreted in that fashion by a patient and could theoretically fit with assessing functional limitations. These changes resulted in a mild decrease in the correlation between the functional limitations and impairment dimensions, while also resulting in the loss of all of the items from the proposed disability construct. However, the disability construct had a high correlation with the other sub-constructs and was not supported by our EFA analysis or previous EFA analysis.[24] The changes resulted in a more parsimonious model with improved model precision as both the DPA SF-8 and DPA SF-10 had excellent model fit, with both scales exceeding the strictest fit indices recommendations on all of the measured indices.[27-29,35]

The DPA SF-8 and SF-10 accomplished the following: (1) accounted for more than 90% of the variance in participant scores on the original DPA Scale within this sample, (2) improved scale structure and model fit, (3) provided summary components that can be scored as unique constructs, and (4) demonstrated a more parsimonious scale with reduced response

burden on patients which may lead to more efficient self-administration.[25,30,36] The DPA SF-8 also addressed the issue of high correlations between the sub-dimensions of the higher order construct 'disability,' while both short form versions addressed redundancy of items measuring the constructs based on improved internal cosnsitency.[36]

The summary components created in the DPA SF-10 and DPA SF-8 also provide additional benefits to practitioners. The new versions offer feasible and efficient tools to measure important health related constructs within the physically active by calculating scores for the summary dimensions,[24] which may relieve burden on clinicians who feel it is difficult using multiple instruments[5,40,41] or that instruments take too long to complete.[42,43] The new versions allow clinicians to measure physical status, using either a one- or two-dimension instrument, while also simultaneously assessing QOL as a unique construct. The concise scales have the potential to reduce barriers to practice implementation.

While our sample is the largest and most diverse sample (e.g., included adolescent athletes, national sample, non-competitive athletes) used to examine the DPA Scale, it does have limitations. First, it is a cross-sectional sample that did not have long-term follow-up to fully assess reliability or responsiveness (i.e., minimal clinically important difference) of the Short Form versions of the DPA Scale. Additionally, the majority of the sample was below the age of 25. Thus, it may be valuable to study the new versions in an older population. Therefore, more work must be done to assess the validity of the short-form versions, such as a CFA and longitudinal invariance testing. Additionally, the summary components of the DPA SF-8 and DPA SF-10 need to be compared to other scales (e.g., numeric pain rating scale, patient specific functional scale) to determine the validity of the summary dimensions. Finally, invariance testing should eventually be conducted to ensure that different groups

(e.g., gender, age, injury type, etc.) do not interpret items differently, which may suggest item bias because groups may respond differently to items indicating more of a construct (e.g., pain) is present due to item wording versus actual presence of the symptom.

Conclusion

A CFA analysis of the original DPA Scale resulted in similar findings to the original assessment of the instrument. Initial examination indicates the DPA SF-8 and DPA SF-10 are plausible alternatives to the DPA Scale for measuring disablement in the physically active. The original scale item pool was reduced by approximately 40-50%, but the short forms still accounting for a substantial portion of the variance in participant responses on the DPA Scale. While the changes may not be viewed as substantial, the short form versions improved measurement properties and may result in more efficient clinical use because the new scales reduce burdens for both patients and clinicians. Additionally, the short forms still provide an overview of health status, and offer insight into the constructs related to physical function and quality of life in the physically active. Further analysis, using more strict analysis techniques (i.e., CFA), is needed before the scale structure of the DPA SF-8 and DPA SF-10 are accepted for research and practice.

References

1) Hurley WL, Denegar CR, Hertel J. *Research Methods: A Framework for Evidence-based Clinical Practice*. 1st ed. Baltimore, MD: Lippincott Williams & Wilkins; 2011.

2) Sackett DL, Rosenburg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. *Br Med J*. 1996;313(7024):71-72.

3) Abrams D, Davidson M, Harrick J, Harcourt P, Zylinski M, Clancy J. Monitoring the change: current trends in outcome measure usage in physiotherapy. *Man Ther*. 2006; 11(1):46-53.

4) Valovich McLeod TC, Snyder AR, Parsons JT, Bay CR, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice, part II: clinical outcomes assessment. *J Athl Train*. 2008;43(4):437–445.

5) Nicholas P, Hefford C, Tumilty S. The use of the patient-specific functional scale to measure rehabilitative progress in a physiotherapy setting. *J Man Manip Ther*. 2012;20(3):147-152.

6) Kane RL. Looking for physical therapy outcomes. *Phys Ther*. 1994;74(5):425–429.

7) Kane RL. Approaching the outcomes question. *J Rehabil Outcomes Meas*. 1999;3(1):50–58.

8) Dobrzykowski E. The methodology of outcomes measurement. *J Rehabil Outcomes Meas*. 1997;1(1):8–17.

9) Streiner DL, Norman GR. *Health Measurement Scales*. 3rd ed. Oxford, United Kingdom: Oxford University Press; 2003:14–60.

10) Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med*. 1994;38(1):1–14.

11) Jette AM. Outcomes research: shifting the dominant research paradigm in physical therapy. *Phys Ther*. 1995;75(11):965–970.

12) Watts J, Clement D. Conceptual framework for rehabilitation outcomes research. *J Rehabil Outcomes Meas*. 2000;4(2):55–61.

13) Snyder AR, Parsons JT, Valovich-McLeod TC, Bay R, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice, part I: disablement models. *J Athl Train. 2008*;43(4):428–436.

14) Vela LI, Denegar CR. Transient disablement in the physically active with musculoskeletal injuries, part 1: a descriptive model. J Athl Train. 2010; 45(6):615-629.

15) Vela LI, Denegar CR. The disablement in the physically active scale, part II: the psychometric properties of an outcome scale for musculoskeletal injuries. *J Athl Train*. 2010;45(6):630-641.

16) Parsons JT, Snyder AR. Health-related quality of life as a primary clinical outcome in sport rehabilitation. *J Sport Rehabil*. 2011;20(1):17–36.

17) Jenkinson C. *Measuring Health and Medical Outcomes*. Vol 215. London, United Kingdom: UCL Press Ltd; 1994:89–110.

18) McAllister DR, Motamedi AR, Hame SL, Shapiro MS, Dorey FJ. Quality of life assessment in elite collegiate athletes. *Am J Sports Med*. 2001;29(6):806–810.

19) Campbell H, Rivero-Arias O, Johnston K, Gray A, Fairbank J, Frost H. Responsiveness of objective, disease-specific, and generic outcome measures in patients with chronic low back pain: an assessment for improving, stable, and deteriorating patients. *Spine*. 2006;31(7):815–822.

20) Anderson KL, Burckhardt CS. Conceptualization and measurement of quality of life as an outcome variable for health care intervention and research. *J Adv Nurs*. 1999;29(2):298-306.

21) Smith KW, Avis NE, Assmann SF. Distinguishing between quality of life and health status in quality of life research: a meta-analysis. *Qual Life Res*. 1999;8(5):447-459.

22) Revicki DA, Osoba D, Fairclough D, Barofsky I, Berzon R, Leidy NK, Rothman M. Recommendations on health-related quality of life research to support labeling and promotional claims in the United States. *Qual Life Res*. 2000;9(8):887-900.

23) Hoch JM, Druvenga B, Ferguson BA, Houston MA, Hoch MC. Patient-reported outcomes in male and female collegiate soccer players during an athletic season. *J Athl Train*. 2015;50(9):930-936.

24) Houston MN, Hoch JM, Van Lunen BL, Hoch MC. The development of summary components for the disablement in the physically active scale in collegiate athletes. *Qual Life Res*. 2015;24(11):2657-2662.

25) Kline RB. *Principles and Practice of Structural Equation Modeling*. 4th ed. New York, NY: The Guilford Press, 2016.

26) Brown TA. *Confirmatory Factor Analysis for Applied Research*. 2nd ed. New York, NY: The Guilford Press, 2015.

27) Byrne BM. *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming*. 3rd ed. New York, NY: Routledge, 2016.

28) MacCullum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structural modeling. *Psychological Methods*. 1996;1:130-149.

29) Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structural analysis: conventional criteria versus new alternatives. *Structural Equation Modeling*. 1999;6:1-55.

30) Ware J Jr, Kosinski M, Keller SD. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care*. 1996;34(3):220-233.

31) Ware JE Jr. The status of health assessment1994. *Annu Rev Public Health*. 1995;16:327-354.

32) Ware JE, Kosinski M, Bayliss MS, McHorney CA, Rogers WH, Raczek A. Comparison of methods for the scoring and statistical analysis of SF-36 health profile and summary measures: summary of results from the Medical Outcomes Study. *Med Care*. 1995;33(4 Suppl):AS264-279.

33) Nunnally JC, Berstein IR. *Psychometric Theory*. 3rd ed. New York, NY: McGraw-Hill, 1994.

34) Strong J, Unruh AM, Wright A, Baxter GD. *Pain: A Textbook for Therapists*. Edinburgh, Scotland: Churchill Livingstone; 2002;425-433.

35) Jöreskog KG, Sörbom D. *LISREL 8: Structural Equation Modeling with the SIMPLIS Command Language*. Chicago, IL: Scientific Software International; 1993.

36) Leech NL, Barret KC, Morgan GA. *IBM SPSS for Intermediate Statistics: Use and Interpretation*. 5th ed. New York, NY: Routledge;2015.

37) Tabchnick BG, Fidell LS. *Using Multivariate Statistics*. 4th ed. Needham Heights, MA: Allyn & Bacon;2001.

38) Whiteneck G. Conceptual models of disability: past, present, and future. In: Field M, Jette A, Martin L, eds. *Workshop on Disability in America: A New Look - Summary and Background Papers.* https://www.nap.edu/catalog/11579/workshop-on-disability-in-america-a-new-look-summary-and. Accessed June 8, 2017.

39) Dillman DA, Smyth JD, Christian LM. *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design*. 4th ed. Hoboken, NY: Wiley;2014.

40) Westaway MD, Stratford PW, Binkley JM. The patient-specific functional scale: validation of its use in persons with neck dysfunction. *J Orthop Sports Phys Ther*. 1998;27(5):331-338.

41) Jolles BM, Buchbinder R, Beaton DE. A study compared nine patient-specific indices for musculoskeletal disorders. *J Clin Epidemiol*. 2005;58(8):791-801.

42) Huijbregts MP, Myers AM, Kay TM, Gavin TS. Systematic outcome measurement in clinical practice: challenges experienced by physiotherapist. *Physiother Can*. 2002;54(1):25-31.

43) Kay TM, Myers AM, Huijbregts MP. How far have we come since 1991? A comparative survey of physiotherapists use of outcome measures. *Physiother Can*. 2001;53(4):268-275.

Table 1. Participant Inclusion and Exclusion Criteria for Physical Activity and Injury.

	Criterion	Definition[15]
Inclusion	Physically Active, and	"An individual who engages in athletic, recreational, or occupational activities that require physical skills and who uses strength, power, endurance, speed, flexibility, range of motion, or agility at least 3 days per week."[15]
	Healthy, or	Free from musculoskeletal injury and fully able to participate in sport or activity.
	Acute Injury, or	A musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (0-72 hours post-injury).
	Sub-Acute Injury, or	A musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (3 days to 1 month post-injury).
	Persistent Injury	"A musculoskeletal injury that has been symptomatic for at least 1 month."[15]
Exclusion	Chronic Pain	"Pain that consistently does not get any better with routine treatment or non-narcotic medication."[15]

Table 2. Participant Athletic Status Definitions

Status	Definition
Competitive Athlete	"A participant who engages in a sport activity that requires at least 1 pre-participation examination, regular attendance at scheduled practices and/or conditioning sessions, and a coach who leads practices and/or competitions."[15]
Recreational Athlete	"Participants who meet the criteria for physical activity and participate in sport, but do not meet the criteria for competitive status."[15]
Occupational Athlete	Participants who meet the criteria for physical activity for occupation or recreation, but do not meet the criteria for competitive or recreational athlete.
Physically Active in Activities of Daily Living	Participants who do not meet the criteria for any "athlete" category, but who are physically active through their daily activities.

Table 3. Participant Reported Primary Sport Activity.

Sport	Frequency	Percentage
Baseball	41	5.9
Basketball	54	7.8
Cheerleading	9	1.3
Cross-Country	23	3.3
Football	73	10.6
Gymnastics	1	0.1
Racquet Sports	7	1.0
Recreational Running	49	7.1
Soccer	78	11.3
Softball	9	1.3
Swimming/Diving	10	1.4
Track and Field	32	4.6
Volleyball	24	3.5
Water Polo	6	0.9
Other	262	38
Not Reported	12	1.7

Table 4. Injury Locations for Participants as Reported by Clinician.

Injury Location	Frequency	Percentage
Head/Neck	27	3.9
Shoulder/Arm	82	11.9
Elbow/Forearm	8	1.2
Wrist/Hand	21	3.0
Trunk/Thoracic Spine	16	2.3
Low Back/Pelvis	68	9.9
Hip/Thigh	63	9.1
Knee/Leg	157	22.8
Ankle/Foot	120	17.4
Other	9	1.3
Not Reported	119	17.2

Table 5. Injury Type for Participants as Reported by Clinician.

Injury Type	Frequency	Percentage
Arthritis	5	0.7
Dislocation/Subluxation	27	3.9
Disc Pathology	23	3.3
Fracture	9	1.3
Meniscal/Labral Lesion	29	4.2
Neuroma	2	0.3
Post-Surgery	14	2.0
Sprain	158	22.9
Strain	133	19.3
Stress Fracture	26	3.8
Tendinopathy	68	9.9
Other	80	11.6
Not Reported	116	16.8

Table 6. Exploratory Factor Analysis Pattern Matrix Loadings for the DPA SF-8.

	Maximum Likelihood		**Principal Components**	
Item	Physical Summary Component	Mental Summary Component	Physical Summary Component	Mental Summary Component
Item 2. Motion	.878		.882	
Item 1. Pain	.785		.843	
Item 3. Muscular Functioning	.738		.821	
Item 5. Changing Directions	.677		.782	
Item 16. Well Being – Mood, etc.		.827		.851
Item 13. Well Being – Increased stress, etc.		.780		.839
Item 15. Well Being – Decreased Engery		.775		.839
Item 14. Well Being – Altered relationships		.736		.829
Eigenvalue	3.90	1.71	1.71	3.93
% of Variance	43.95	16.58	21.40	48.79
Cronbach's alpha	.850	.852		

Table 7. Exploratory Factor Analysis Pattern Matrix Loadings for the DPA SF-10.

	Maximum Likelihood			**Principal Components**		
Item	Impairment	Quality of Life	Functional Limitations	Impairment	Quality of Life	Functional Limitations
Item 2. Motion	.876			.836		
Item 1. Pain	.781			.886		
Item 3. Muscular Functioning	.663			.819		
Item 16. Well Being – Mood, etc.		.831			.849	
Item 13. Well Being – Increased stress, etc.		.780			.830	
Item 15. Well Being – Decreased Energy		.770			.836	
Item 14. Well Being – altered relationships		.727			.829	
Item 9. Skill – Coordination, etc.			.857			-.892
Item 5. Changing Directions			.826			-.853
Item 4. Stability			.643			-.826
Eigenvalue	4.82	1.88	.689	4.89	1.88	.689
% of Variance	44.52	15.09	3.45	48.19	18.79	6.89
Cronbach's alpha	.837	.850	.840			

Table 8. Original and Revised Construct Labels for the Disablement in the Physically Active Short Forms.

Item (Number and Phrasing from Original DPA Scale)	DPA Scale Dimensions	DPA SF-8 Dimensions	DPA SF-10 Dimensions
2. Do I have impaired motion (Ex. decreased range/ease of motion, flexibility, and/or increased stiffness)	IMP	PSC	IMP
1. Do I have pain?	IMP	PSC	IMP
3. Do I have impaired muscle function? (Ex. decreased strength, power, endurance, and/or increased fatigue).	IMP	PSC	IMP
16. Do I have difficulties with the following…Changes in my mood and/or increased frustration	QOL	MSC	QOL
13. Do I have difficulties with the following…Increased uncertainty, stress, pressure, and/or anxiety.	QOL	MSC	QOL
15. Do I have difficulties with the following…Decreased overall energy	QOL	MSC	QOL
14. Do I have difficulties with the following…Altered relationships with team, friends, and/or colleagues	QOL	MSC	QOL
9. Do I have difficulties with performing skills that are required for physical activity? (Ex. coordination, agility, precision, & balance)	FL	*	FL
5. Do I have difficulty with changing directions in activity (Ex. Twisting, turning, starting/stopping, cutting, pivoting)	FL	PSC	FL
4. Do I have impaired stability? (the injured area feels loose, gives out, or gives way).	IMP	*	FL
DPA = Disablement in the Physically Active; SF = Short form; IMP = Impairments; FL = Functional limitations; QOL = Quality of life; PSC = Physical summary component; MSC = Mental summary component; * = not included in scale.			

Table 9. Comparison of Covariance Modeling Fit Indices by Instrument and Sample.

	Sample	n	GFI	CFI	TLI	IFI	RMSEA
DPA Scale	1a	690 (353 males, 330 females, 7 not reported; mean age = 23.1 ± 9.3 years)	.929	.957	.947	.957	.069
	1b	746 (377 males, 362 females, 7 not reported; mean age = 23.15 ± 9.3 years)	.944	.963	.955	.963	.060
	1c	796 (402 males, 386 females, 8 not reported; mean age = 23.16 ± 9.4 years)	-	.962	.947	.962	.060
DPA SF-10	1a	690 (353 males, 330 females, 7 not reported; mean age = 23.1 ± 9.3 years)	.987	.993	.990	.993	.037
	1b	746 (377 males, 362 females, 7 not reported; mean age = 23.15 ± 9.3 years)	.988	.996	.994	.996	.024
	1c	796 (402 males, 386 females, 8 not reported; mean age = 23.16 ± 9.4 years)	-	.994	.990	.994	.028
DPA SF-8	1a	690 (353 males, 330 females, 7 not reported; mean age = 23.1 ± 9.3 years)	.983	.992	.989	.992	.036
	1b	746 (377 males, 362 females, 7 not reported; mean age = 23.15 ± 9.3 years)	.992	.998	.997	.998	.017
	1c	796 (402 males, 386 females, 8 not reported; mean age = 23.16 ± 9.4 years)	-	.996	.993	.996	.025
DPA = Disablement in the Physically Active; SF = Short Form; GFI = Goodness of Fit Index (GFI); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation							

Table 10. Group Mean Scores on the DPA Scale, DPA SF-10, and DPA SF-8 in Participants with and without Injury at Intake.

Scale	Group	Mean ± SD	Range
DPA Scale	Persistent Injury	27. 28 ± 11.94	3-55
	Acute Injury	28.1 ± 11.16	3-50
	Sub-Acute Injury	26.25 ± 10.41	2-41
	Healthy	4.92 ± 6.17	0-32
DPA SF-10	Persistent Injury	15.31 ± 7.11	2-34
	Acute Injury	15.76 ± 6.44	1-31
	Sub-Acute Injury	14.55 ± 6.22	2-32
	Healthy	3.34 ± 4.0	0-16
DPA SF-8	Persistent Injury	11.91 ± 5.56	1-27
	Acute Injury	12.13 ± 5.10	0-26
	Sub-Acute Injury	11.24 ± 5.05	0-28
	Healthy	2.90 ± 3.40	0-12
DPA = Disablement in the Physically Active; SF = Short Form.			

Figure 1. The Disablement in Physically Active Scale hierarchical confirmatory factor analysis measurement model with standardized loadings for Sample 1a (n = 690). Chi Sq = Chi Square ($\chi 2$), CMIN/DF = the $\chi 2$ / degrees of freedom ratio; GFI = Goodness of Fit Index (GFI); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation, df = degrees of freedom, p = alpha level.

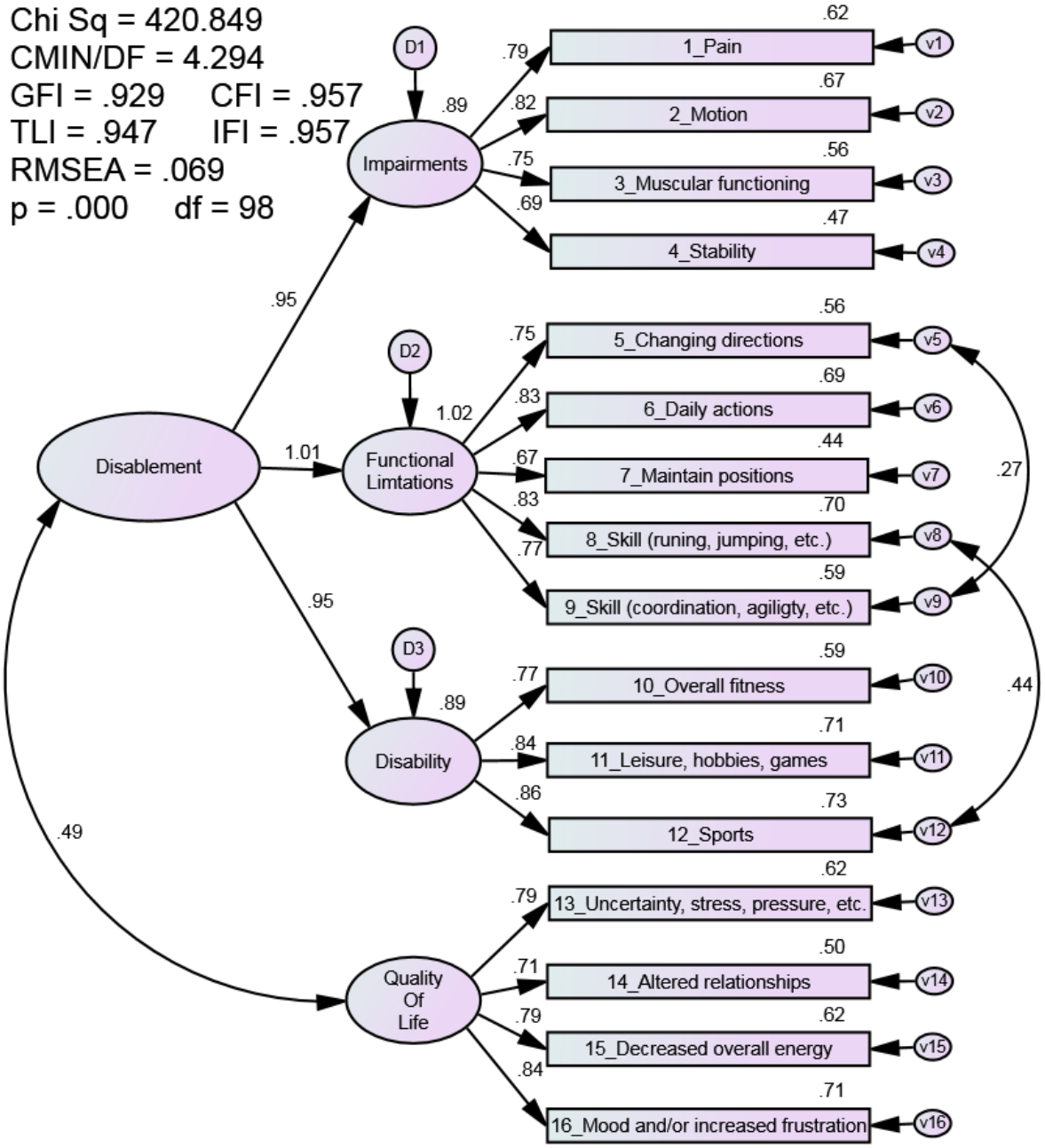


Figure 2. The Disablement in Physically Active Scale 8-Item Short Form covariance model with loadings. Chi Sq = Chi Square ($\chi 2$), CMIN/DF = the $\chi 2$ / degrees of freedom ratio; GFI = Goodness of Fit Index (GFI); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation, df = degrees of freedom, p = alpha level.

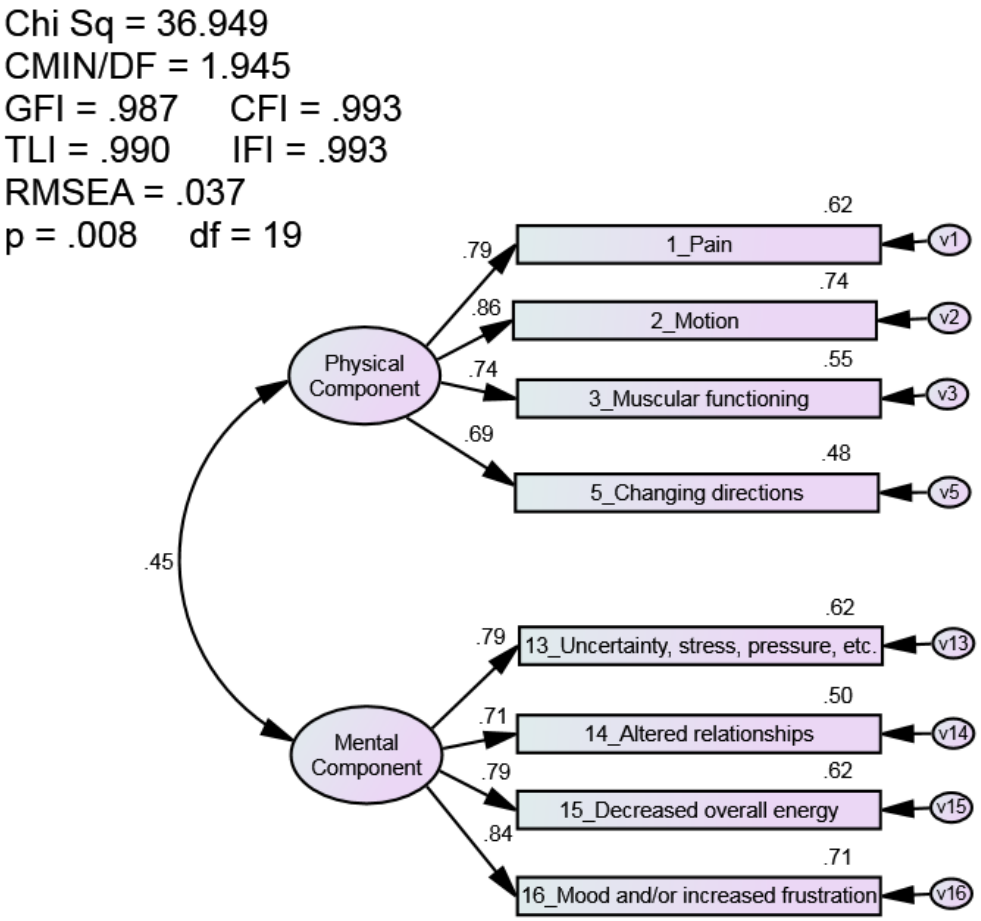
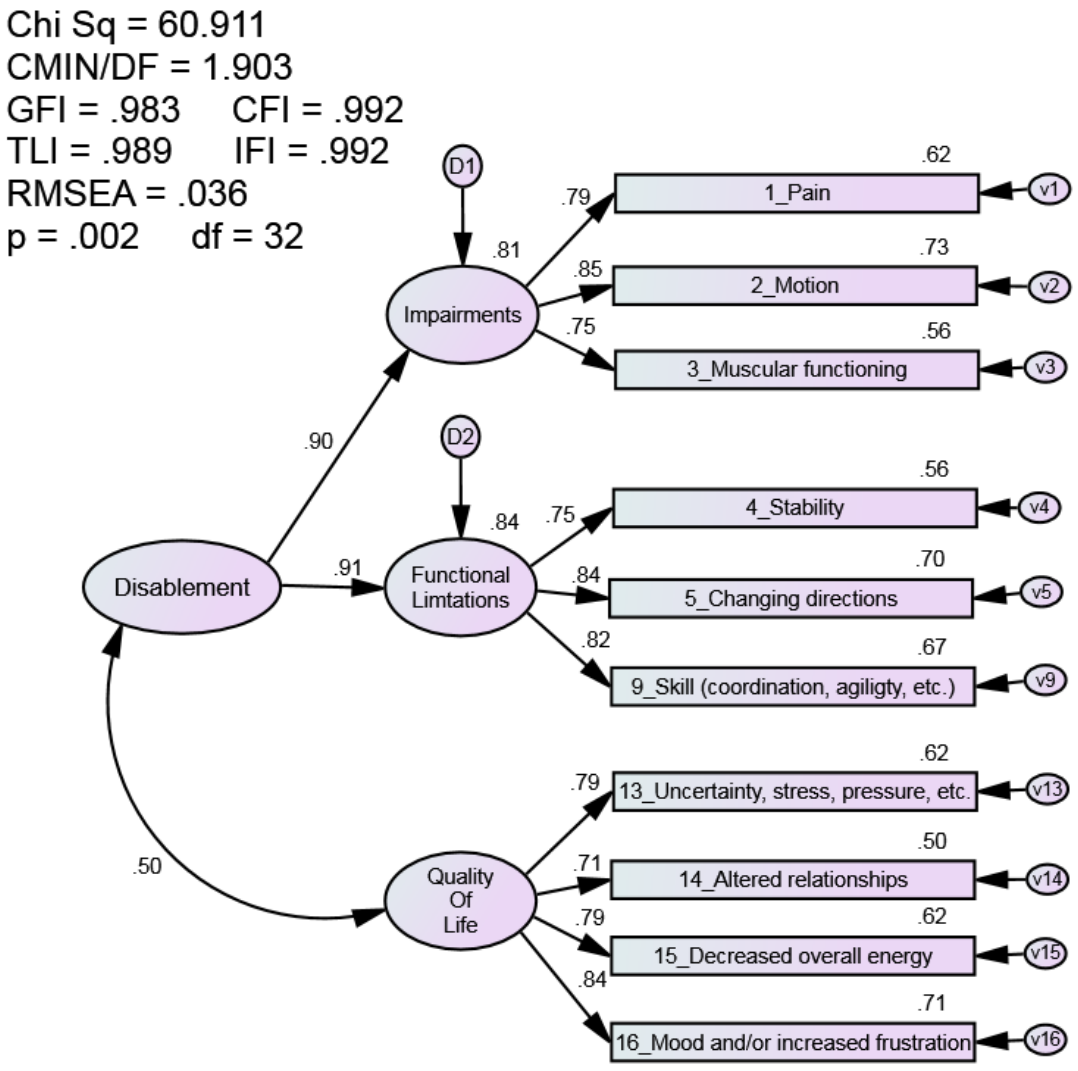


Figure 3. The Disablement in Physically Active Scale 10-item short form hierarchical covariance model with standardized loadings. Chi Sq = Chi Square ($\chi 2$), CMIN/DF = the $\chi 2$ / degrees of freedom ratio; GFI = Goodness of Fit Index (GFI); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation, df = degrees of freedom, p = alpha level.



Manuscript 2: Confirmatory Factor Analysis of the Disablement in Physically Active Scale Short Form-10 and Short Form-8: A Validation Study.

Following injury, patients experience a recovery process that involves physiological, psychological, and social factors. Assessing the patient's full experience is a vital component in determining if the patient has returned to pre-injury status, as well as assessing treatment effectiveness.[1,2] Patient recovery is often assessed using clinician- and patient-reported outcome measures.[3-6] While clinician-reported measures, such as range of motion measurements, are valuable for assessing treatment effectiveness or improvements in physical impairments,[7] these measures often fail to assess multi-dimensional changes in health status that are meaningful to the patient.[1]

Evaluating health status from the perspective of the patient often involves utilizing a multi-dimensional instrument to assess underlying dimensions of the recovery process.[8,9] Health related quality of life (HRQOL) is thought to be a valuable construct to measure within a multi-dimensional instrument because it is thought to encompass the physical, psychological, and social dimensions a patient experiences during the recovery process.[10,11] Using HRQOL instruments to assess patient improvement, however, is not without issue. First, HRQOL is truly only one dimension of the recovery process and should be distinguished from other related constructs (e.g., impairment).[10] Second, quality of life (QOL) is a broad construct related to one's mental well-being. By itself, it is not a complete measurement of health status.[12-16] Furthermore, QOL has often been measured by causal indicators (e.g., functional status, symptomology, etc.) of health status used as indirect measures of one's life satisfaction, which is not a true assessment of QOL.[12-16] Finally, most HRQOL instruments are not designed to be used in physically active populations or after

musculoskeletal injuries. These limitations are problematic for many clinical circumstances where the instruments are currently used.[10,14,15,17]

The Disablement in Physically Active (DPA) Scale, in contrast, was designed to assess HRQoL as a unique construct, while also assessing disability through the sub-dimensions of impairment, functional limitations, and disability, in physically active populations following musculoskeletal injury.[17] The DPA Scale has been recommended for use in research and practice for a number of reasons. Initial development and analysis of the scale indicated it was reliable, valid, and could be used to track patient improvement in a physically active population.[17] Subsequent analysis indicated the DPA Scale was reliable and useful for tracking recovery from injury throughout an athletic season.[18] The DPA Scale was also recommended because it was found to have similar summary components to the Short Form-36, a commonly used HRQoL scale. Furthermore, because the scale was brief and designed for the physically active populations, unlike many generic patient reported outcome scales, it was believed to be a psychometrically sound instrument for this population.[19]

Despite positive early psychometric findings and recommendations, further analysis of the DPA Scale is needed. Early testing of the DPA Scale involved relatively small samples of homogenous participants (e.g., male and female collegiate soccer players) from similar geographic locations.[17-19] Additionally, the fit indices assessing scale structure did not meet many of the recommended standards for psychometric measurement analysis.[20-22] It is important to assess the validity of the instrument in a more heterogeneous sample that is representative of the populations the scale will be utilized with in patient care before an instrument is adopted for use in clinical practice and research.[23,24] Furthermore, three of the sub-dimensions of the DPA Scale (i.e., impairment, functional limitation, and disability) were

found to be highly correlated ($r \geq .90$)[17] and subsequent analysis revealed only two summary components: Physical Summary Component (i.e., Items 1-12 comprising impairment, functional limitation, and disability subscales) and Mental Summary Component (Items 13-16 of the quality of life construct).[19] By reducing the number of items or altering the design of the items, it may be possible to make the DPA Scale more concise and produce a more parsimonious scale with improved validity, precision, and applicability for clinical practice and research.[13,24-26]

Follow-up testing of the DPA Scale in a larger, more diverse physically active population in the previous study revealed the scale could be shortened to an 8-item and 10-item instrument with improved construct validity and model fit. Exploratory factor analysis (EFA) and covariance modeling techniques revealed a more parsimonious model meeting stricter requirements for assessing model fit, without losing a significant amount of the variance accounted for in participants' responses. However, further psychometric analysis is needed to assess, refine, and validate potential short-form versions of the DPA Scale.[22-24] Our initial findings identified items which demonstrated sound model fit for two shorter versions of the scale, but Kline[24] recommends establishing construct validity in a separate participant sample through a confirmatory factor analysis (CFA). The CFA approach is used because it is a more rigorous statistical test. The process allows for the refinement of a proposed instrument, while also allowing more rigorous testing of the psychometric properties of the instrument.[23,24,27] Ultimately, the process allows the identification of a more parsimonious and psychometrically sound instrument to use in clinical practice and research.[23,24]

The DPA Scale Short Form-10 (DPA SF-10) and DPA Short Form-8 (DPA SF-8) were revised versions of the previously developed DPA Scale. The new versions were created

following EFA and covariance modeling of the DPA Scale in a large sample of physically active individuals who more closely represented a national sample. However, before the DPA SF-10 and DPA SF-8 are implemented into clinical practice and research, further psychometric testing is needed to establish the factorial validity of the proposed scales. Therefore, the purpose of this study was to assess the psychometric properties of the newly proposed short form versions of the DPA Scale to examine whether model fit was maintained in a second sample of physically active participants.

Methods

Participants

Upon institutional review board approval of this research project, participants reviewed and provided informed consent prior to survey completion. When applicable, minors provided assent and their legal guardian provided consent prior to participation. Recruiting participants occurred at 20 athletic training clinics and two outpatient rehabilitation clinics across the United States. Participants who were physically active were included in the study, while those with chronic pain were excluded from the study participation (Table 1).[17,28] Participants were also grouped by pre-defined physical activity categories to establish an athletic status classification: competitive athlete, recreational athlete, occupational athlete, and activities of daily living (Table 2). In total, 1,592 participants completed the study; however, the full sample was not utilized for analysis in this study. Data from the entire sample was cleaned and randomly dichotomized into two random sub-samples of equal size for use in calibration (Sample 1) and validation (Sample 2) phases of the study. The validation sample (i.e., Sample 2) was used for this study (n = 690).

Instrumentation

The survey packet included the DPA Scale and a demographic information questionnaire completed at an initial visit with an athletic trainer. The DPA Scale is a patient-reported outcome (PRO) scale thought to have four factors assessed by 16 items. The first three constructs, impairments, functional limitations, and disability, are first-order factors of the higher-order construct, disablement. Items 1- 4 are designed to tap into the impairment dimension, items 5 – 9 the functional limitations construct, and items 10-12 the disability construct. Items 13-16 are designed to tap into the construct of quality of life, which is hypothesized to covary with the disablement construct. Participants rate each item on a 1 ("no problem") to 5 ("severe") Likert scale. The score provided for each item are added together, with 16 points being subtracted from the summed total to produce a final score. Participant total scores may range from 0 points (i.e., floor) to 64 points.[17]

The athletic trainer also collected de-identified participant demographic information, including: injury category (i.e., persistent, acute, sub-acute, or healthy), patient athletic status (e.g., competitive athlete, recreational athlete), age, sex, sport, general injury location (i.e., lower extremity, spine, and upper extremity), specific injury location (e.g., head/neck, shoulder/arm, ankle/foot, etc.), and type of injury (e.g., arthritis, neuroma, strain, sprain, post-surgery, etc.). The collected DPA Scale data and demographic information was input into Qualtrics (Provo, UT) by the collecting athletic trainer.

Data Analysis

Data was downloaded from Qualtrics for data analyses. The Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) Version 24.0 and Analysis of Moment Structure (AMOS, SPSS, Inc.) Version 24.0 was used for data analysis. Missing data was

treated conservatively, and any participant response with a missing value for the DPA Scale were removed from the data set. Missing demographic data, however, was left as missing values. Data cleaning included assessment of the univariate distributions of all the variables to verify normal distribution with low levels of skewness and kurtosis. Assessment of multivariate outliers was identified using Mahalanobis distance.

Confirmatory factor analysis (CFA) was conducted using AMOS to assess model fit of the DPA SF-10 and DPA SF-8. Analyses were conducted using a maximum likelihood estimation (MLE) to generate parameter estimates. The fit indexes used to assess model fit were the likelihood ratio statistic (CMIN or chi-square statistic; $\chi 2$), the $\chi 2$ / degrees of freedom ratio (CMIN/DF), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Bollen's Incremental Fit Index (IFI). Because the CMIN test is sensitive to sample size and may indicate unnecessary scale changes to improve model fit,[22] this test was superseded by the other indices in assessing model fit. The fit indices cutoff points for determining good model fit were assessed using standard *a priori* values: GFI $\geq$ .95,[29] CFI $\geq$ .95, TLI $\geq$ .95,[21] RMSEA $\leq$ .06,[21,22] and IFI $\geq$ .95.[22] To further assess validity of the short form versions of the DPA Scale, the cumulative score on the DPA SF-10 and DPA SF-8 were correlated with the scores of the DPA Scale. An *a priori* correlation value of r $\geq$ .90 (R^2 =.81) was used to determine if the short form versions explained an acceptable percentage of the variance in DPA Scale scores on the original instrument.[26]

Results

Preliminary Analysis

Of the 1,592 participants who completed the DPA Scale, 100 participants (6%) had missing data and were removed from the data set. Additionally, 12 participants (7%) reported scores that exceeded the recommended threshold for univariate z scores (3.3) or multivariate outliers for this analysis (Mahalanobis distance ≥ 33)[30], and these participants were not included in the primary analysis. Qualitative assessment indicated the participants identified as outliers included a relatively equal number of males and females, as well as participants classified with various injury categories (e.g., acute, persistent) and types. The removal of these participants resulted in normal data distribution and allowed for all fit indices to be calculated. The remaining 1,380 participant (87%) responses were randomly split into two even samples (n = 690 for each sample). Sample 2, the validation sample, was then utilized for the primary analyses in this study.

Because of the number of cases removed, we wanted to ensure that the final model solutions were not significantly impacted by the data cleaning process. Thus, we analyzed the final model solutions with the outliers and missing cases returned to the sample. First, an equal and random selection (n = 56) of the participants identified as outliers was put back into to each sample (n = 746 for Sample 1b and n = 746 for Sample 2b). Then, an equal and random number (n = 50) of participants with missing data were added back to each sample (n = 796 for Sample 1c and n = 796 for Sample 2c). Sample 2a was utilized for the primary analyses of this study, while Sample 2b and Sample 2c were used to check final model results.

Sample 2a consisted of 351 males, 337 females, and 2 without a sex reported. The sample (mean age = 22.9 ± 9.3 years, age range = 8 to 74 years) included participants

classified into all four activity statuses who reported participating in a variety of primary sports (Table 3). A total of 338 (49%) participants were classified as competitive athletes, 176 (26%) were recreational athletes, 164 (24%) were occupational athletes, and the remaining 12 (1%) were classified as physically active through activities of daily living. Participants were classified as being healthy (n = 122; 18%) or suffering from persistent injury (n = 219, 32%), acute injury (n = 156, 22%), or sub-acute injury (n = 193, 28%) when they completed the DPA Scale. For those suffering from injury, a variety of injury locations (Table 4) and types (Table 5) were reported by their treating clinicians. The majority of responses from participants were collected in the traditional athletic training setting (n = 442; 64%) at collegiate (Division I = 64, 9.3%; Division II = 123, 17.8%; Division III = 40, 5.8%; NAIA = 68, 9.0%; Junior College = 46, 6.7%) and high school (n = 101; 14.6%) athletic training clinics. A total of 248 (46%) responses were collected from participants seeking care in an out-patient clinic setting.

Confirmatory Factor Analysis Results

The fit for the CFA of the DPA SF-8 indicated excellent fit ($\chi 2$ [19] = 29.459, CMIN/DF = 1.550, $p \geq .059$) because all of the assessed fit indices exceeded the recommended levels (CFI = .996, GFI = .989, TLI = .994, RMSEA = .028, IFI = .996; Figure 1). The factor loadings were all significant ($p \leq .001$), and model fit could not be substantially improved with the specification of a covariance between error terms.

Initial analysis of the covariance model of the DPA SF-10 indicated the correlation between the impairment and functional limitations constructs was high (r = .86). The correlations between the functional limitations and quality of life (r = .44) and impairment and quality of life (r = .44) constructs were acceptable. A hierarchical CFA revealed fit

indices exceeded the recommended levels ($\chi 2$ [32] = 81.163, CMIN/DF = 2.563, $p \leq .001$, CFI = .986, GFI = .975, TLI = .980, RMSEA .047, IFI = .986). All factor loadings were significant ($p \leq .001$), and modification indices did not indicate the model fit could be significantly improved if error covariances between items were freed to covary (Figure 2). A comparison of all final model solutions for the DPA SF-10 and DPA SF-8 across all of the samples (2a, 2b, and 2c) did not reveal substantial differences in model fit across the fit indices (Table 6). Group mean scores on the three versions of the DPA scale are provided in Table 7.

Correlational Results

The correlation values between participant scores on the DPA Scale, the DPA SF-8, and the DPA SF-10 were high. Scores on the DPA SF-8 highly correlated with the DPA Scale scores at $r = .94$ ($p \leq .001$, $R^2 = .88$) level, while the scores on the DPA SF-10 correlated with the scores on the DPA Scale at $r = .97$ ($p \leq .001$, $R^2 = .94$). The correlation between scores on the DPA SF-10 and DPA SF-8 was also high ($r = .98$, $p \leq .001$, $R^2 = .96$).

Discussion

The purpose of this study was to assess the psychometric properties of DPA SF-8 and DPA SF-10 using a CFA approach in a large sample of physically active participants. We used a CFA approach to more rigorously test the psychometric properties of the instruments to make a recommendation for implementation of the instruments in clinical practice in research.[24] The results suggest the DPA SF-8 and DPA SF-10 are valid and reliable multidimensional PRO instruments with excellent psychometric measurement properties.

Psychometric Analysis of the DPA SF-8

The CFA of the DPA SF-8 indicated the model was an acceptable approximation of the data and the overall model fit exceeded the fit indices recommendations.[20-22,29] The DPA SF-8 narrowed the breadth of the information collected by the DPA scale. However, the correlation value ($r = .94$, $R^2 = .88$) suggested the eight-item version accounted for an acceptable amount of variance in participant responses on the original DPA Scale when comparing cumulative scores, while also improving the precision of the instrument given the model fit. Furthermore, the DPA SF-8 allows for the collection of summative dimension scores for physical and mental health statuses as unique constructs. Because it has been argued that QOL and disablement are unique constructs,[14-17] it is important to be able to score the constructs separately to determine patient health status and help guide decisions in clinical care to match interventions to the specific dimensional impairment a patient is experiencing.[19]

Psychometric Analysis of the DPA SF-10

The DPA SF-10 also demonstrated model fit exceeding the strictest recommendations.[20-22,29] This version of the instrument more closely resembles the original design of the DPA Scale,[17] maintaining a unique quality of life construct and a second order disablement construct, but the disablement construct now contains only two sub-dimensions (i.e., impairment and functional limitations) with improved measurement precision. The cumulative scores on the DPA SF-10 also maintained a high correlation ($r = .97$, $R^2 = .94$) with scores on the DPA Scale, indicating the vast majority of the variance in participant responses in the DPA Scale total scores were also accounted for in this short form version. The DPA SF-10 also allows for the scoring of the dimensions (i.e., disablement and QOL) as unique constructs. This is valuable because the scores can provide greater insight into the

patient's experience, while also potentially reducing response burden for a patient and barriers to implementation for the clinician.[2,19]

Implementation in Clinical Practice and Research

Choosing between the short form versions depends on the lens one uses to assess the instruments. It has been argued that measuring complex constructs, such as health status or disablement, requires an instrument designed to measure multiple sub-constructs that comprise the higher order construct.[10,17,31,32] However, it can also be argued that the sub-constructs should be unique dimensions without substantial overlap to provide both a more parsimonious and psychometrically-sound instrument, as well as the most precise measures for clinical practice and research (Kline, 2016; Brown, 2015).[23,24]

The DPA SF-10 improves the precision of the original instrument given the fit indices results. This version does not fully reduce the potential issues of overlap between the impairment and functional limitations sub-constructs, but it does maintain the higher order "disablement" construct as a separate construct from the QOL construct. The DPA SF-8 resolves this issue while still providing excellent model fit, but it does not account for as much variance in DPA Scale responses as the DPA SF-10 does. The DPA SF-8 may not provide as rich an understanding of a patient's physical health status as might be gained from the DPA SF-10. Both instruments provide the opportunity for scoring of individual constructs[19] and for measuring QOL as a unique component of the injury process that is not traditionally captured by the dimensions designed to assess physical health status.[15,17] Both instruments have measurement properties indicating the scales are valid measures of these constructs in physically active populations, which has not been the case with other instruments, such as the Short Form-36.[33] The reduced length and increased precision of the

short form versions of the DPA Scale may remove barriers for clinicians and patients to utilize the instrument efficiently in practice.[2,34-37] For research purposes, the SF-10 may be the more valuable instrument for collecting a broader portrayal of a patient's condition, while the SF-8 may be more efficient for clinical practice to provide objective values for physical and mental health status as it relates to a patient's injury/condition.

Instrument Scoring

The DPA Scale was originally created to be scored by summing a patient's scores on all of the items to produce a cumulative "disablement" score.[17] However, we would argue against a cumulative score because the QOL and disablement are unique constructs and it should not be assumed that a summary score of two unique constructs provides an accurate portrayal of health status when it is defined as disablement.[14-17] The results of our study, along with previous findings,[17,19] suggest that the QOL and disablement constructs are unique. In short, the two constructs are not measuring the same phenomenon and should not be summed together as a disablement score. It may be more effective, and more in line with psychometric analyses of the scales, to use summative scores for each individual construct (e.g., score for disablement and a score for QOL) versus a cumulative score. Examining the individual construct scores likely provides a better and more accurate portrayal of a patient's health status as it relates to using these scales to measure the proposed constructs.[19]

Limitations

While the results of this study are positive for supporting the use of the DPA SF-10 and DPA SF-8 in clinical practice and research, the study does have limitations. First, the cross-sectional design of the study did not allow for follow-up analysis of participant

responses on the scale. Thus, the responsiveness and test-retest reliability of the new versions of the scale could not be assessed. Furthermore, invariance testing of the instruments has not been conducted which does not allow for conclusions to be made regarding different groups (e.g., males and females, age groups, injury type, etc.) interpreting items differently which may introduce bias making it difficult to assess group differences using the scales. Additionally, further study should be done to compare the summary components of the scale to other commonly used instruments (e.g., patient specific functional scale) to determine if the summary component scores can be used to replace the other instruments, which would further reduce barriers for implementation among patients and clinicians.

Conclusion

The CFA analysis of the DPA SF-8 and DPA SF-10 confirmed that the shortened versions are psychometrically sound alternatives to the DPA Scale. The new versions account for a substantial portion the variance in participant cumulative scores on the DPA Scale, while also having improved scale structure and measurement precision. Both of the short form versions provide the opportunity to score the different measured constructs, while still measuring quality of life as a unique construct separate from physical health status. The abbreviated versions may also relieve patient response burden and reduce potential clinician barriers for implementation to practice. Further study is still needed to establish the responsiveness of the scale, determine measurement invariance, and construct validity in research and practice.

References

1) Evans TA, Lam KC. Clinical outcomes assessment in sport rehabilitation. *J Sport Rehabil*. 2011;20:8-16.

2) Nicholas P, Hefford C, Tumilty S. The use of the patient-specific functional scale to measure rehabilitative progress in a physiotherapy setting. *J Man Manip Ther*. 2012;20(3):147-152.

3) Kane RL. Looking for physical therapy outcomes. *Phys Ther*. 1994;74(5):425–429.

4) Dobrzykowski E. The methodology of outcomes measurement. *J Rehabil Outcomes Meas*. 1997;1(1):8–17.

5) Kane RL. Approaching the outcomes question. *J Rehabil Outcomes Meas*. 1999;3(1):50–58.

6) Streiner DL, Norman GR. *Health Measurement Scales*. 3rd ed. Oxford, United Kingdom: Oxford University Press; 2003:14–60.

7) Abrams D, Davidson M, Harrick J, Harcourt P, Zylinski M, Clancy J. Monitoring the change: current trends in outcome measure usage in physiotherapy. *Man Ther*. 2006; 11(1):46-53.

8) Ware JE Jr, Sherbourne CD. The MOS 36-item short form health survey (SF-36). I. Conceptual frameworks and item selection. *Med Care*. 1992; 30(6):473-483.

9) Valovich McLeod TC, Snyder AR, Parsons JT, Bay CR, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice, part II: clinical outcomes assessment. *J Athl Train*. 2008;43(4):437–445.

10) Vela LI, Denegar CR. Transient disablement in the physically active with musculoskeletal injuries, part 1: a descriptive model. J Athl Train. 2010; 45(6):615-629.

11) Parsons JT, Snyder AR. Health-related quality of life as a primary clinical outcome in sport rehabilitation. *J Sport Rehabil*. 2011;20(1):17–36.

12) Ware JE Jr. The status of health assessment1994. *Annu Rev Public Health*. 1995;16:327-354.

13) Ware JE, Kosinski M, Bayliss MS, McHorney CA, Rogers WH, Raczek A. Comparison of methods for the scoring and statistical analysis of SF-36 health profile

and summary measures: summary of results from the Medical Outcomes Study. *Med Care*. 1995;33(4 Suppl):AS264-279.

14) Anderson KL, Burckhardt CS. Conceptualization and measurement of quality of life as an outcome variable for health care intervention and research. *J Adv Nurs*. 1999;29(2):298-306.

15) Smith KW, Avis NE, Assmann SF. Distinguishing between quality of life and health status in quality of life research: a meta-analysis. *Qual Life Res*. 1999;8(5):447-459.

16) Revicki DA, Osoba D, Fairclough D, Barofsky I, Berzon R, Leidy NK, Rothman M. Recommendations on health-related quality of life research to support labeling and promotional claims in the United States. *Qual Life Res*. 2000;9(8):887-900.

17) Vela LI, Denegar CR. The disablement in the physically active scale, part II: the psychometric properties of an outcome scale for musculoskeletal injuries. *J Athl Train*. 2010;45(6):630-641.

18) Hoch JM, Druvenga B, Ferguson BA, Houston MA, Hoch MC. Patient-reported outcomes in male and female collegiate soccer players during an athletic season. *J Athl Train*. 2015;50(9):930-936.

19) Houston MN, Hoch JM, Van Lunen BL, Hoch MC. The development of summary components for the disablement in the physically active scale in collegiate athletes. *Qual Life Res*. 2015;24(11):2657-2662.

20) MacCullum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structural modeling. *Psychological Methods*. 1996;1:130-149.

21) Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structural analysis: conventional criteria versus new alternatives. *Structural Equation Modeling*. 1999;6:1-55.

22) Byrne BM. *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming*. 3rd ed. New York, NY: Routledge, 2016.

23) Brown TA. *Confirmatory Factor Analysis for Applied Research*. 2nd ed. New York, NY: The Guilford Press, 2015.

24) Kline RB. *Principles and Practice of Structural Equation Modeling*. 4th ed. New York, NY: The Guilford Press, 2016.

25) Nunnally JC, Berstein IR. *Psychometric Theory*. 3rd ed. New York, NY: McGraw-Hill, 1994.

26) Ware J Jr, Kosinski M, Keller SD. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care*. 1996;34(3):220-233.

27) Tenenbaum G, Eklund RC, Kamata A. *Measurement in sport and exercise psychology* Vol. 2. Champaign, IL: Human Kinetics;2012.

28) Strong J, Unruh AM, Wright A, Baxter GD. *Pain: A Textbook for Therapists*. Edinburgh, Scotland: Churchill Livingstone; 2002;425-433.

29) Jöreskog KG, Sörbom D. *LISREL 8: Structural Equation Modeling with the SIMPLIS Command Language*. Chicago, IL: Scientific Software International; 1993.

30) Tabchnick BG, Fidell LS. *Using Multivariate Statistics*. 4th ed. Needham Heights, MA: Allyn & Bacon;2001.

31) Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med*. 1994;38(1):1–14.

32) Jette AM. Outcomes research: shifting the dominant research paradigm in physical therapy. *Phys Ther*. 1995;75(11):965–970.

33) McAllister DR, Motamedi AR, Hame SL, Shapiro MS, Dorey FJ. Quality of life assessment in elite collegiate athletes. *Am J Sports Med*. 2001;29(6):806–810.

34) Westaway MD, Stratford PW, Binkley JM. The patient-specific functional scale: validation of its use in persons with neck dysfunction. *J Orthop Sports Phys Ther*. 1998;27(5):331-338.

35) Jolles BM, Buchbinder R, Beaton DE. A study compared nine patient-specific indices for musculoskeletal disorders. *J Clin Epidemiol*. 2005;58(8):791-801.

36) Huijbregts MP, Myers AM, Kay TM, Gavin TS. Systematic outcome measurement in clinical practice: challenges experienced by physiotherapist. *Physiother Can*. 2002;54(1):25-31.

37) Kay TM, Myers AM, Huijbregts MP. How far have we come since 1991? A comparative survey of physiotherapists use of outcome measures. *Physiother Can*. 2001;53(4):268-275.

Table 1. Study Inclusion and Exclusion Criteria for Participant Activity Level, Injury, and Pain Type.

	Criterion	Definition[15]
Inclusion	Physically Active, and	"An individual who engages in athletic, recreational, or occupational activities that require physical skills and who uses strength, power, endurance, speed, flexibility, range of motion, or agility at least 3 days per week."[15]
	Healthy, or	Free from musculoskeletal injury and fully able to participate in sport or activity.
	Acute Injury, or	A musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (0-72 hours post-injury).
	Sub-Acute Injury, or	A musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (3 days to 1 month post-injury).
	Persistent Injury	"A musculoskeletal injury that has been symptomatic for at least 1 month."[15]
Exclusion	Chronic Pain	"Pain that consistently does not get any better with routine treatment or non-narcotic medication."[15]

Table 2. Definitions for Participant Athletic Status Stratification.

Status	Definition
Competitive Athlete	"A participant who engages in a sport activity that requires at least 1 pre-participation examination, regular attendance at scheduled practices and/or conditioning sessions, and a coach who leads practices and/or competitions."[15]
Recreational Athlete	"Participants who meet the criteria for physical activity and participate in sport, but do not meet the criteria for competitive status."[15]
Occupational Athlete	Participants who meet the criteria for physical activity for occupation or recreation, but do not meet the criteria for competitive or recreational athlete.
Physically Active in Activities of Daily Living	Participants who do not meet the criteria for any "athlete" category, but who are physically active through their daily activities.

Table 3. Primary Sport Activity as Reported by Participant.

Sport	Frequency	Percentage
Baseball	32	4.6
Basketball	62	9.0
Cheerleading	7	1.0
Cross-Country	12	1.7
Football	77	11.2
Gymnastics	1	0.1
Racquet Sports	10	1.4
Recreational Running	55	8.0
Soccer	80	11.6
Softball	18	2.6
Swimming/Diving	9	1.3
Track and Field	28	4.1
Volleyball	20	2.9
Water Polo	4	0.6
Other	218	31.6
Not Reported	57	8.3

Table 4. Clinician Reported Injury Locations for Participants.

Injury Location	Number	Percentage
Head/Neck	36	5.2
Shoulder/Arm	64	9.3
Elbow/Forearm	12	1.7
Wrist/Hand	15	2.2
Trunk/Thoracic Spine	24	3.5
Low Back/Pelvis	61	8.8
Hip/Thigh	73	10.6
Knee/Leg	155	22.5
Ankle/Foot	129	18.7
Other	5	0.7
Not Reported	116	16.8

Table 5. Type of Injury Suffered as Reported by the Clinician.

Injury Type	Frequency	Percentage
Arthritis	10	1.4
Dislocation/Subluxation	29	4.2
Disc Pathology	19	2.8
Fracture	8	1.2
Meniscal/Labral Lesion	26	3.8
Neuroma	3	0.4
Post-Surgery	17	2.5
Sprain	161	23.3
Strain	134	19.4
Stress Fracture	16	2.3
Tendinopathy	68	9.9
Other	82	11.9
Not Reported	117	17.0

Table 6. Comparison of Confirmatory Factor Analysis Fit Indices across the Samples.

	Sample	n	GFI	CFI	TLI	IFI	RMSEA
DPA SF-10	1a	690 (351 males, 337 females, 2 not reported; mean age = 22.9 ± 9.3 years)	.975	.986	.980	.986	.047
	1b	746 (375 males, 369 females, 2 not reported; mean age = 23.1 ± 9.6 years)	.973	.980	.971	.980	.053
	1c	796 (400 males, 393 females, 3 not reported; mean age = 23.1 ± 9.6 years)	-	.981	.968	.982	.050
DPA SF-8	1a	690 (351 males, 337 females, 2 not reported; mean age = 22.9 ± 9.3 years)	.989	.996	.994	.996	.028
	1b	746 (375 males, 369 females, 2 not reported; mean age = 23.1 ± 9.6 years)	.992	.997	.996	.997	.021
	1c	796 (400 males, 393 females, 3 not reported; mean age = 23.1 ± 9.6 years)	-	.997	.994	.997	.023
DPA = Disablement in the Physically Active; SF = Short Form; GFI = Goodness of Fit Index (GFI); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation							

Table 7. Group Mean Scores and Range by Injury Classification on the DPA Scale, DPA SF-10, and DPA SF-8.

Scale	Group	Mean ± SD	Range
DPA Scale	Persistent Injury	26.65 ± 10.81	3-59
	Acute Injury	28.27 ± 11.53	1-62
	Sub-Acute Injury	28 ± 10.05	6-52
	Healthy	5.06 ± 7.06	0-39
DPA SF-10	Persistent Injury	15.09 ± 6.60	1-36
	Acute Injury	16.14 ± 6.90	1-38
	Sub-Acute Injury	15.61 ± 6.14	6-31
	Healthy	3.80 ± 4.61	0-20
DPA SF-8	Persistent Injury	12.03 ± 5.22	1-28
	Acute Injury	12.42 ± 5.28	1-32
	Sub-Acute Injury	12.10 ± 4.74	5-25
	Healthy	3.24 ± 3.81	0-13
DPA = Disablement in the Physically Active; SF = Short Form.			

Figure 1. The Disablement in Physically Active Scale Short Form-8 confirmatory factor analysis measurement model with loadings. Chi Sq = Chi Square ($\chi 2$), CMIN/DF = the $\chi 2$ / degrees of freedom ratio; GFI = Goodness of Fit Index (GFI); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation, df = degrees of freedom, p = alpha level.

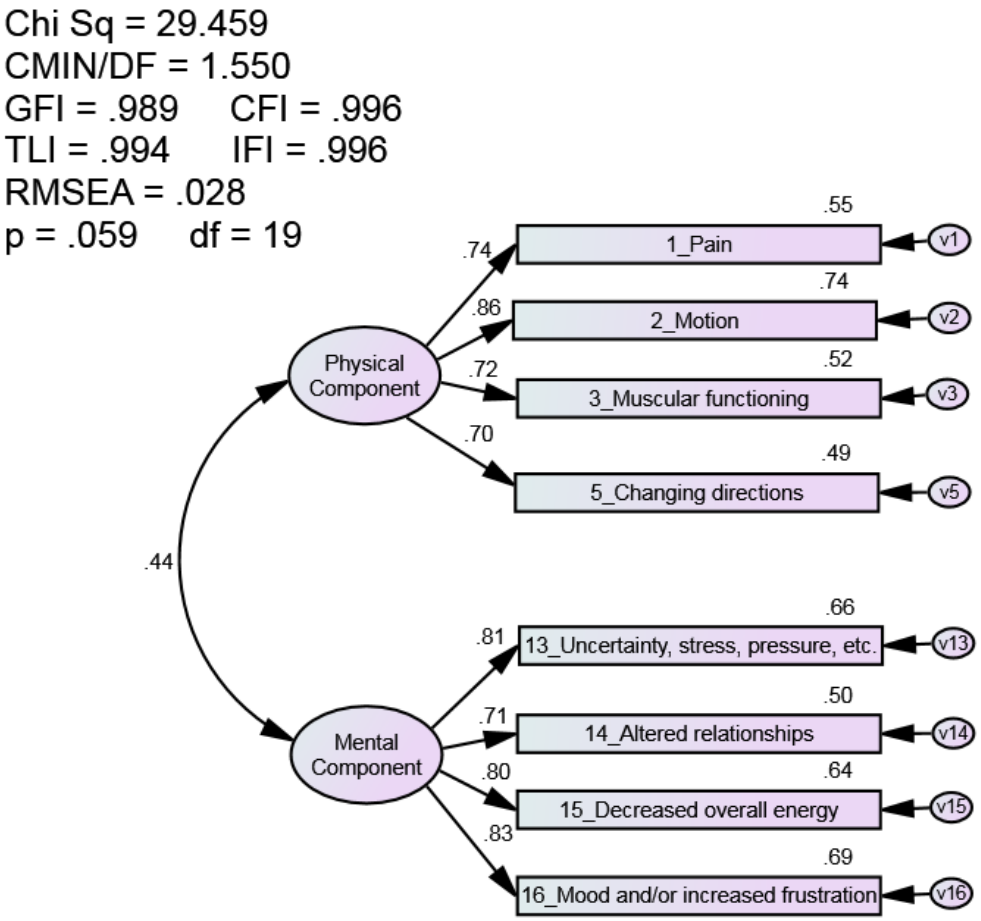


Figure 2. The Disablement in Physically Active Scale Short Form-10 hierarchical confirmatory factor analysis measurement model with loadings. Chi Sq = Chi Square ($\chi 2$), CMIN/DF = the $\chi 2$ / degrees of freedom ratio; GFI = Goodness of Fit Index (GFI); CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation, df = degrees of freedom, p = alpha level.

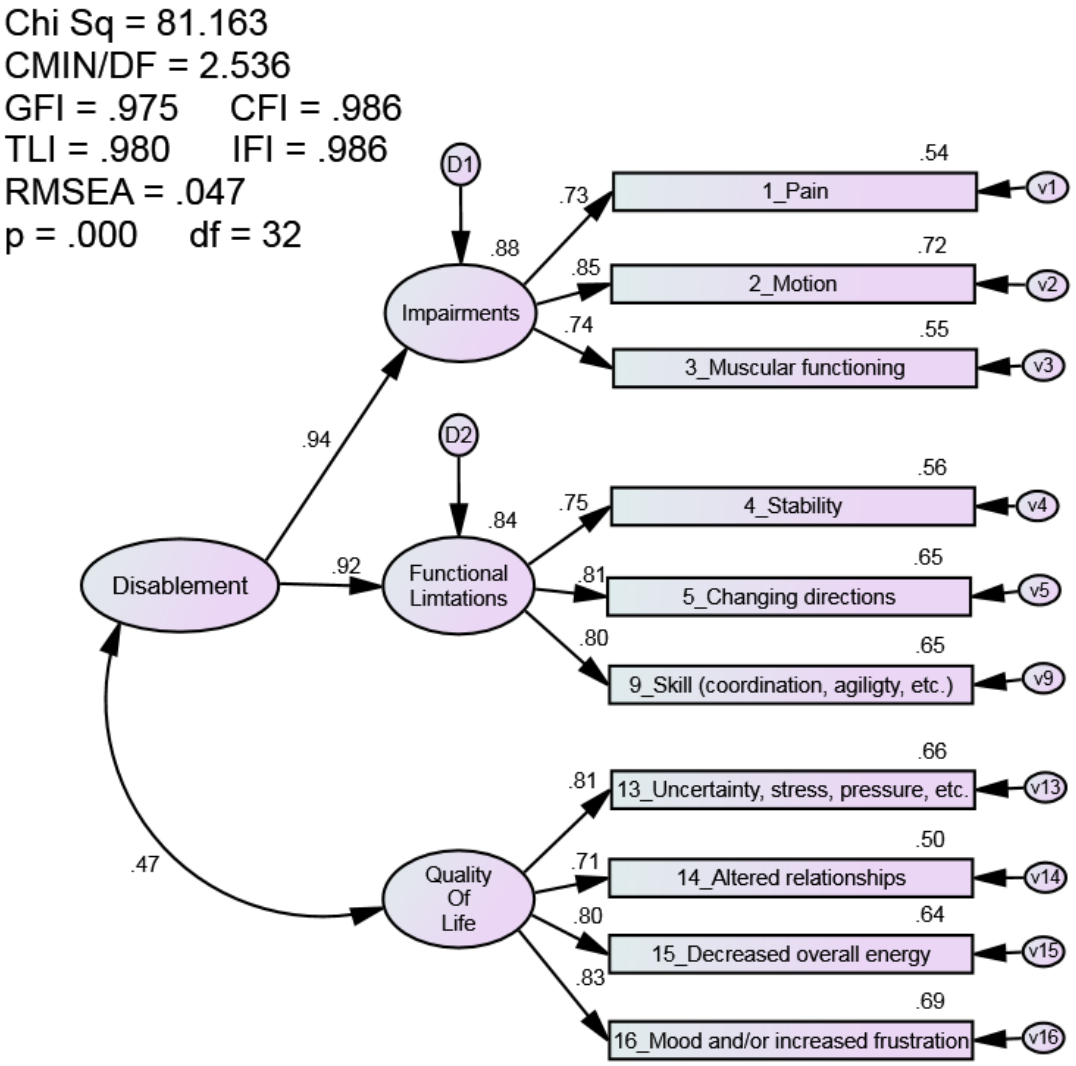


Figure 3. The Disablement in the Physically Active Short Form-8 (DPA SF-8).

Disablement in the Physically Active Short Form-8

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

KEY 1 – No Problem 2 – I have the problem(s), but it does not affect me 3 – The problem(s) slightly affects me 4 – The problem(s) moderately affects me 5 – The problem(s) severely affects me	No Problem	Does not Affect	Slight	Moderate	Severe
Physical Summary Component	1	2	3	4	5
Pain – "Do I have **pain**?"	O	O	O	O	O
Motion – "Do I have impaired **motion**?" Ex. Decreased range/ease of motion, flexibility, and/or increased stiffness	O	O	O	O	O
Muscular Functioning – "Do I have impaired **muscle function**?" Ex. decreased strength, power, endurance, and/or increased fatigue	O	O	O	O	O
Changing Directions – "Do I have difficulty with **changing directions** in activity?" Ex. twisting, turning, starting/stopping, cutting, pivoting	O	O	O	O	O
Physical Summary Score (Total Score – 4)	_____ / 16				
	No Problem	Does not Affect	Slight	Moderate	Severe
Mental Summary Component	1	2	3	4	5
Well Being – "Do I have difficulties with the following…?" 1) Increased uncertainty, stress pressure anxiety	O	O	O	O	O
Well Being – "Do I have difficulties with the following…?" 2) Altered relationships with team, friends, and/or colleagues	O	O	O	O	O
Well Being – "Do I have difficulties with the following…?" 3) Decreased overall energy	O	O	O	O	O
Well Being – "Do I have difficulties with the following…?" 4) Changes in my mood and/or increased frustration	O	O	O	O	O
Mental Summary Score (Total Score – 4)	_____ / 16				

Figure 4. The Disablement in the Physically Active Short Form-10 (DPA SF-10).

Disablement in the Physically Active Scale Short Form-10

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

KEY 1 – No Problem 2 – I have the problem(s), but it does not affect me 3 – The problem(s) slightly affects me 4 – The problem(s) moderately affects me 5 – The problem(s) severely affects me	No Problem	Does not Affect	Slight	Moderate	Severe
Impairments Summary Component	1	2	3	4	5
Pain – "Do I have **pain**?"	O	O	O	O	O
Motion – "Do I have impaired **motion**?" Ex. Decreased range/ease of motion, flexibility, and/or increased stiffness	O	O	O	O	O
Muscular Functioning – "Do I have impaired **muscle function**?" Ex. decreased strength, power, endurance, and/or increased fatigue	O	O	O	O	O
Impairments Summary Score (Total Score – 3)	_____ / 12				
Functional Limitations Summary Component	1	2	3	4	5
Stability – "Do I have impaired stability?' Ex. The injured area feels loose, gives out, or gives way	O	O	O	O	O
Changing Directions – "Do I have difficulty with **changing directions** in activity?" Ex. twisting, turning, starting/stopping, cutting, pivoting	O	O	O	O	O
Skill Performance – "Do I have difficulties with **performing skills** that are required for physical activity?" Ex. twisting, turning, starting/stopping, cutting, pivoting	O	O	O	O	O
Impairments Summary Score (Total Score – 3)	_____ / 12				
Quality of Life Summary Component	1	2	3	4	5
Well Being – "Do I have difficulties with the following…?" 1) Increased uncertainty, stress pressure anxiety	O	O	O	O	O
Well Being – "Do I have difficulties with the following…?" 2) Altered relationships with team, friends, and/or colleagues	O	O	O	O	O
Well Being – "Do I have difficulties with the following…?" 3) Decreased overall energy	O	O	O	O	O
Well Being – "Do I have difficulties with the following…?" 4) Changes in my mood and/or increased frustration	O	O	O	O	O
Mental Summary Score (Total Score – 4)	_____ / 16				

Manuscript 3: Development and Validation of the Health Status Assessment Questionnaire: A New Patient-Reported Outcome Scale with Summary Components

Collecting, assessing, and providing evidence of practice effectiveness is a vital component of evidence-based practice (EBP) because it allows for appropriate health care decisions for a given patient in a specific clinical circumstance.[1-3] Reflective assessment on, and demonstration of effective practice through, patient outcomes assessment is a critical component of studying practitioners' practice decisions to improve patient care and solve clinical problems.[4,5] When done well, the process leads to improved clinical decision-making, improved communication among the relevant stakeholders, and provision of effective patient-centered care.[2,6-9] Additionally, utilizing this practice in patient care is vital for guiding clinical decision-making processes from practical, ethical, and financial lenses to allow for optimal care in each patient scenario.[1,10] The process guides and improves the efficacy of clinical practice,[11] while also providing valuable information about treatment effectiveness and patient recovery to the patient, health care providers, and insurance companies.[2,3]

Patient improvement and practice assessment is often assessed through a unidimensional lens assessing a specific patient complaint. Clinicians often utilize disease-oriented outcomes (e.g., range of motion) to measure rehabilitation progress.[12] The use of disease-oriented outcomes, however, often fails to determine patient improvement through measures that are important to the patient or broad enough to truly assess all of the changes relevant to a patient's condition.[2,3] Thus, these concerns were sufficient to create patient reported outcome (PRO) scales to examine specific constructs or symptoms (e.g., pain, functional limitation) meaningful to patients.[3] The PRO instruments may be generic

instruments designed to measure a variety of health concepts[9,13] or may be more specific instruments focused on a disease, body region, or specific domain.[3]

Scales, such as the Numeric Pain Rating Scale (NPRS)[14,15] and Patient Specific Functional Scale (PSFS),[3,16] are commonly utilized unidimensional assessment instruments focused on a specific domain to assess patient progress.[17] Assessing patient improvement through a multi-dimensional lens, however, is often preferred because it provides a richer understanding of the patient's condition and recovery.[18-21] Multi-dimensional instruments are often used to assess a variety of health-related constructs, such as patient symptomology, functional status, or quality of life, and they have become an important component of health care research and practice.[10,18-21]

In the health professions, the multi-dimensional PRO instruments are commonly questionnaires or scales designed to measure the 'disablement' process.[19,22-24] Disablement models often include the assessment of impairments, functional limitations, and disability.[25-27] Impairments are often related to symptomology or physiological abnormality associated with an active pathology.[28] Measuring symptomology has often been focused on assessing the patient's perception of an abnormal physical, emotional, or cognitive state following injury.[10] Functional limitations has been defined as one's inability to meet basic needs, complete usual roles, and maintain health and well-being at the level of the whole person.[28,29] The disability construct has been designed to assess the performance roles or activities normally completed within one's environment.[28]

Another construct, quality of life (QOL), is not part of many disablement models, but it is important to consider because the psychosocial dimension plays a significant role in injury response and the rehabilitation process.[28,30-33] Further, it has been suggested that

multiple factors, such as injury symptomology, functional status, and general health perceptions, affect QOL.[34] A concern regarding the use of QOL criteria, however, is that it has been used as a generic label for an assortment of physical functioning and psychosocial variables without truly representing QOL[35] or is used interchangeably with health status.[35-37]

Quality of life is often used to represent the changes in physical, psychological, and social function experienced by patients following injury or illness.[28,35,38] In healthcare, QOL is often repackaged as health-related quality of life (HRQOL), which typically includes quality of life components and non-quality of life components focused on health status (e.g., symptoms, functional status).[10,28,35,38-40] Reduction in symptoms, increases in functional performance, improvement in general health, and better quality of life are all important for every healthcare profession and leads to improved patient outcomes.[10] However, there are a number of concerns with viewing QOL through this lens. First, QOL is more than just health status because it involves overall wellness and is not dependent on injury status. A person could be well and perceive experiencing a low QOL or be suffering from illness or injury and still perceive experiencing a high quality of life.[10,41] Furthermore, patients view health status and quality of life as distinct, but related, constructs where either health status or QOL could be weighed more heavily than the other depending on the situational context.[10,35]

Thus, many currently utilized PRO instruments may be inappropriate for measuring QOL,[10,35,42] and the interpretation of treatment effectiveness for improving QOL or health status may be different based on the scale being used in the study.[35] When a more focused definition of QOL has been used to design QOL instruments, the assessment of scale effectiveness has primarily occurred in chronically ill populations or those who cannot be cured, without consideration for the role of physical activity or musculoskeletal injury may

have on QOL.[10,35,42,43] Thus development of instruments to assess changes in QOL in physically active people and post-musculoskeletal injury are needed.[28] The instrument, however, must assess QOL from a mental health status without inter-mixing it with the other constructs or causal indicators (e.g., functional status, symptomology, etc.) of physical health status.[10,28,35,40,44,45]

As health care professionals and researchers define constructs, such as QOL, the constructs have items that can be used to accurately measure the construct of interest. Theoretically, psychometric analysis fundamentals hypothesize that if all possible items are known, the construct could be measured without error.[10] While it may not be possible to identify all possible items, we should be able to identify enough meaningful and viable items to accurately measure proposed constructs of interest. In athletic training, the Disablement in Physically Active (DPA) Scale is the primary instrument designed to assess a disablement model in the physically active population, while also considering QOL as a unique construct focused on mental health.[28,46]

The DPA Scale was designed to assess HRQOL as a unique construct, while also assessing the disablement model through the sub-dimensions of impairment, functional limitations, and disability.[46] The structure of the items in the scale, however, led to the sub-dimensions of the DPA Scale (i.e., impairment, functional limitation, and disability) being highly correlated ($r \geq .90$),[46] while subsequent analysis of the DPA Scale provided only two summary components: (1) Physical Summary Component (i.e., Items 1-12 of impairment, functional limitation, and disability constructs), and (2) Mental Summary Component (Items 13-16 of quality of life construct).[47] Our previous findings (i.e., Studies 1 and 2) provided further evidence challenging the usefulness of the DPA Scale, including: (1) the model did not

meet all of the recommended fit indices, and (2) the DPA Scale, even with modification, only effectively assessed two primary dimensions without providing a scoring mechanism for the sub-constructs (e.g., pain, functional limitation) that are commonly assessed with unidimensional instruments.[3]

While instrument validity is a vital component for determining scale use, it is not the only issue associated with the use of PRO scales in clinical practice or research. The various uni-dimensional and multi-dimensional instruments used to assess injury and recovery leads to complications with efficient recording of outcomes, interpreting outcomes, and promoting compliance from patients and clinicians.[3] Additionally, healthcare professionals have a varied case load, which can make determining which instrument to use, and when to use it, difficult.[16] The differences in patient cases and clinical circumstance is exacerbated when one considers that athletic populations often score differently on the scales than the general patient population because the development and validation process for these instruments often does not include participants with high-levels of physical functioning.[48,49] Moreover, clinicians also report other barriers that negatively impact their use a PRO instruments, including, but not limited to: lack of knowledge about the instrument, questionnaires being difficult to use, or instruments taking too long to complete.[50,51] While evidence suggests it is feasible for clinicians to utilize two outcome instruments,[3,17] the situation becomes more challenging when there is a need to use multiple instruments or completion time is overly long. Trying to accurately assess QOL and health status is challenging in the current environment and is likely to result in compliance issues given the number of instruments that must be used.[3,16,52]

Thus, it is important to create an instrument that can be applied to a variety of conditions, be administered easily, quickly scored, and used across varied populations,

including the physically active.[3,16] An instrument meeting these requirements, while also accurately assessing the different constructs of the disablement model and QOL related to overall health status, would allow clinicians and researchers to better understand the recovery process and assess the effectiveness of treatment options. Additionally, a scale that assessed health status, while also having summary components (e.g., pain, functional limitations, quality of life), may allow clinicians and researchers to assess individual components of the recovery process, in addition to the higher order construct of health status.[47] Ultimately, the scale could reduce barriers for utilizing PRO instruments to determine patient recovery and treatment effectiveness. Therefore, the purpose of this study was to develop a new instrument by following a systematic, psychometrically sound development process that included: (1) creation of an item pool, and (2) evaluation of the psychometric properties of this new instrument, created to efficiently assess health status by measuring disablement constructs and QOL. The goal was to begin the process of creating an instrument capable of measuring important summary components of the injury recovery process, which can be administered effectively in physically active populations.

Methods

Participants

The University of Idaho institutional review board determined this project to be exempt. Participants provided informed consent prior to completing the instrument packet. In the case of minors, assent was provided by the minor, while the legal guardian provided informed consent. Participants were recruited from athletic training clinics (n = 21) and outpatient rehabilitation clinics (n = 2) across the United States. Participants were physically active (Table 1) and could be classified into one of four injury categories identified by their

athletic trainer: acute injury, sub-acute injury, chronic injury, or healthy. Due to chronic pain having unpredictable patterns across patients, participants with chronic pain were excluded from the study.[46,53] Injuries were classified based on a priori definitions for each injury category (Table 1). Activity levels of participants were also classified according to a priori definitions for each physical activity category (Table 2).

Instruments

Health Status Assessment Questionnaire (HSAQ Version 1; Appendix C). The initial 53 item pool for developing the Health Status Assessment Questionnaire (HSAQ) had five hypothesized dimensions including: (1) Pain Characteristics (n =10), (2) Impairments (n = 10), (3) Functional Limitations (n = 12), (4) Disability (n = 10), and (5) Quality of Life (n = 11). The items were written to assess important aspects of each of the five proposed dimensions of the injury process. Items were constructed based on a review of the literature and a review of previously validated PRO instruments (e.g., DPA Scale, Lysholm Knee Scoring Scale, The Roland-Morris Disability Questionnaire, Disabilities of the Arm, Shoulder and Hand, McGill Pain Questionnaire, etc.).[43,46,54-66]

The items were evaluated by five athletic trainers who had more than 5 years of clinical experience and survey research background. Based on reviewer evaluations, the items were altered to improve content and clarity. Each reviewing athletic trainer also indicated which dimension each item best fit. Items that did not have perfect agreement in a dimension were included in the proposed dimension suggested by the majority of the reviewers. Each member of the expert panel approved the final item pool. The items were randomized in the final packet completed by participants instead of being grouped by dimensions. Each item was evaluated using a 5 point Likert scale, ranging from 0 (not applicable/no agreement) to 4

(complete agreement; Appendix C). Overall readability levels of the items was under a 7th grade level on the Flesch-Kinkaid scale (i.e., scores ranging from Grade 0.5 to 10.9), and the HSAQ took less than 8 minutes to complete.

Quality of Life Scale (QOLS; Appendix C). The QOLS is a self-administered, self-report instrument utilizing 15 or 16 items to assess QOL.[43] Patients rate the items on a 7 point Likert scale, ranging from 1 ("terrible") to 7 ("delighted"). Completion of the scale takes approximately 5 minutes. The QOLS is scored by summing the score for each item, with the final score ranging from 16 to 112. Respondents with higher scores are presumed to have a higher QOL. A score of 90 is considered the average score in a healthy population, while populations with diseases produce mean scores ranging from 61 to 92 prior to intervention.[43] The 15 item QOLS has been found to have high internal consistency (α = .82 to .92) and test-retest reliability (r = .78 to .84) in chronic illness patients.[67] Similar results have been found with the 16 item version of the scale when used with chronic pain patients[10] and when translated to different languages.[68-70] Convergent and construct validity in chronic illness groups has also been established by comparing the QOLS to the Life Satisfaction Index-Z (r = .67 - .75).[71] Construct validity, using exploratory factor analysis (EFA) techniques, was also established for the 15 and 16 item scales and identified three factors: (1) Relationships and Material Well-Being, (2) Health and Functioning, (3) Personal, Social and Community Commitment.[43] The 16 item version was utilized for this study.

Numeric Pain Rating Scale (NPRS; Appendix C). The NPRS is a commonly utilized patient-reported pain intensity scale.[14,15] Patients are asked to rate their current, best, and worst pain from 0 (i.e., no pain) to 10 (i.e., worst pain imaginable). A cumulative pain score is

created by averaging the reported pain scores for best, worst, and current pain. The NPRS has been found to be a valid and reliable scale in various patient populations.[14,15]

Patient Specific Functional Scale (PSFS; Appendix C). The PSFS is a patient-reported instrument designed to assess the patient's perception of functional status.[3,16] The participant is asked to list 1 to 5 activities affected by their current condition. The participant then rates his/her ability to perform the activity on a 0 (i.e., unable to perform activity) to 10 (i.e., able to perform activity at the same level as before injury or problem) scale. For this study, the participants were asked to choose one important activity they were unable to do or were having difficulty performing as a result of their condition. The PSFS has been found to be a quick, valid, reliable, and meaningful scale for assessing patient-reported function.[3,16]

Global Ration of Change (GRoC; Appendix C). The GRoC is a patient-reported transitional scale (i.e., retrospective), requiring participants to recall and quantify changes in health status.[72,73] The scale uses a 15 point Likert Scale from -7 (i.e., a very great deal worse) to 7 (i.e., a very great deal better), with the mid-point score of 0 equating to "no change." The GRoC is easy to administer and has been found to be a valid scale for various patient populations.[72,73]

Participant Demographic Questionnaire (PDQ; Appendix C). The athletic trainer working with the participant collected eight types of demographic information, including: injury category (i.e., persistent, acute, sub-acute, or healthy), patient athletic status (e.g., competitive athlete, recreational athlete, occupational athlete), age, sex, sport, general injury location (i.e., lower extremity, spine, and upper extremity), specific injury location (e.g., head/neck, shoulder/arm, ankle/foot, etc.), and type of injury (e.g., arthritis, neuroma, strain, sprain, post-surgery, etc.). The participant reported the length of their current symptoms, their

physical activity level, ethnicity, and highest level of education. The collected information was de-identified and input into Qualtrics by the athletic trainer. The athletic trainer also reported the type of clinical site (e.g., outpatient rehabilitation clinic).

Data Analysis Plan

Data cleaning. Data was downloaded from Qualtrics. Data analysis procedures were conducted using Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) Version 24.0 and Analysis of Moment Structure (AMOS, SPSS, Inc.) Version 24.0. Missing data was treated conservatively. Any participant response missing more than 10% of the items for a given scale, excluding demographic information, was removed from the data set. Any missing demographic data was left as missing values. Data cleaning was conducted using univariate distributions to assess normal distribution and Mahalanobis distance to identify multivariate outliers.

Factorial validity. An EFA was conducted using principal components analysis (PCA) extraction and direct oblimin rotation to allow for hypothesized correlations among the factors within the scale. Factors with eigenvalues greater than or equal to 1.0 were retained in the final solution. Following estimation, the measurement model was re-specified, eliminating items that: (a) had no substantial loadings on any factor (loadings ≤ 0.40), (b) had simultaneous, substantial loadings on multiple factors (i.e., loadings ≥ 0.30 on more than one factor), and/or (c) did not fit conceptually with the other items identified as loading on the factor.[74] To ensure that the final solution was not a function of a specific extraction method, the factor structure of the final measurement model was re-estimated using the maximum likelihood (ML) extraction method. Cronbach's alpha was calculated to assess the internal consistency of the items in each factor. An *a priori* value range of $\geq .70$, but $\leq .89$, was used

to establish acceptable internal consistency and produce a solution without more items than necessary to reliably measure the construct.[74]

Covariance modeling, using AMOS and the maximum likelihood estimation procedures, was conducted on the proposed version of the HSAQ scale. The measurement model specified within the covariance modeling analysis was consistent with the measurement model extracted from the EFA. To assess model fit, the likelihood ratio statistic (CMIN or chi-square statistic; $\chi 2$), the $\chi 2$ / degrees of freedom ratio (CMIN/DF), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Bollen's Incremental Fit Index (IFI) were used. Because the $\chi 2$ test is sensitive to sample size and creates the potential for misrepresenting model fit,[75] this test carried less weight in assessing model fit. The fit indices equaling a good fit were assessed at the following a priori values: CFI $\geq$ .95 preferred with $\geq$ .90 acceptable, TLI $\geq$ .95 preferred with $\geq$ .90 acceptable,[75,76] RMSEA $\leq$ .06 preferred with $\leq$ .08 acceptable,[76,77] and IFI $\geq$ .95 preferred with $\geq$ .90 acceptable.[75]

Correlational analysis. Bivariate correlations were used to assess the correlations between composite scores on the sub-dimensions of the HSAQ and the uni-dimensional scales (i.e., NPRS, PSFS, QOLS). A covariance modeling approach was used to assess the correlations between the latent variables for the sub-dimensions of the HSAQ and the uni-dimensional scales (i.e., NPRS, PSFS, QOLS). A two-tailed Pearson correlation was run comparing the score of the "pain" sub-scale on the HSAQ with the cumulative NPRS ratings to assess the relationship between composite scores, while a covariance modeling approach was taken to assess correlation of the latent variables (i.e., "pain") for each pain scale. To compare QOL, a two-tailed Pearson correlation was run comparing the composite score of the

QOL sub-dimension of the HSAQ with the total score on the QOLS, while a covariance modeling approach was used to assess the correlations of the latent variables (i.e., "QOL") for each scale. To compare measurement of the functional limitations sub-dimension, a two-tailed Pearson correlation was run comparing the composite score of this sub-dimension of the HSAQ with the PSFS rating, while a covariance modeling approach was taken to assess correlation of the latent variable on the HSAQ and the PSFS observed score. To assess relationship patterns between scores on the HSAQ sub-dimensions and scores on the NPRS, PSFS, and QOLS, a canonical correlation was conducted on manifest scores for each participant on each scale or sub-dimension of the HSAQ.

Results

Preliminary Analysis

Within the entire sample (n = 839), 55 participants (7%) were missing responses to ≥ 10% of the HSAQ or QOLS and were removed from the data set. Analysis of the remaining 784 responses indicated a total of 88 (11%) participants reported scores that were possible univariate (z scores ≥ 3.4) or multivariate outliers (Mahalanobis distance violation). However, when examining distributional properties for the entire sample (i.e., skewness and kurtosis values), only 3 items had non-normal distributions (i.e., skewness ≥ 3.4, but ≤ 6.0). Given these findings, and that transforming data only leads to marginal improvements,[78] no further transformations or adjustments (i.e., outlier removal) were made to the data.

The sample was comprised of 398 males and 383 females (sex was not reported for 3 participants) who had a mean age of 22.8 ± 8.93 years (age range = 14 to 74 years). The majority of the participants were classified as competitive athletes (506; 64.5%), recreational athletes (n = 102, 13%), or occupational athletes (n = 71; 9%). A total of 105 (13.5%) were

classified as physically active through activities of daily life. The sample was relatively evenly distributed across participants who were classified with persistent injury (n = 249, 32%), acute injury (n = 162, 20%), sub-acute injury (n = 164, 21%), and healthy (n = 204; 27%) status. A variety of injury locations (Table 3) and types were reported (Table 4). The majority of participants reported participating in a variety of primary sports or sporting activities (Table 5), and responses were primarily collected in the traditional athletic training clinical setting at collegiate (Division I = 2, 0.3%; Division II = 212, 27.0%; Division III = 52, 6.6%; NAIA = 65, 8.3%; Junior College = 57, 7.3%) and high school (n = 206; 26.3%) facilities. Almost a quarter of the sample (n = 190; 24.3%), however, was collected in an out-patient clinic setting.

Scale Structure of the Health Status Assessment Questionnaire

Exploratory factor analysis results. The EFA results using PCA extraction methods revealed a 16 item, 4 factor structure accounting for 73.5% of the variance in participant responses to HSAQ items (Table 6). The first factor represented the dimension "functional limitations (FL)." The factor included Items FL-2, FL-4, FL-6, and FL-11 and accounted for 49% of the variance. The second factor represented a "disability (DIS)" dimension. This factor was comprised of four items, DIS-7, DIS-6, FL-7, and FL-8, and accounted for 9% of the variance. The third factor, "quality of life (QOL)," was comprised of 4 items (i.e., QOL-4, QOL-8, QOL-9, and QOL-10) and accounted for 8% of the variance. The final factor represented "pain characteristics (PN)" and also contained 4 items (i.e., Items PN-1, PN-3, PN-4, and PN-5) which accounted for 7.5% of the variance. As the final solution was not substantially different using ML extraction procedures, the final solution from the PCA analysis was accepted. Cronbach's alpha coefficients were strong for each of the constructs

(i.e., FL, α = .898; DIS, α = .840; QOL, α = .880; PN, α = .854), and the alpha reliability of the factors could not be improved by removing any item from the constructs. The items, their originally proposed constructs, and the final solution using PCA and ML extraction methods are presented in Table 7.

Covariance modeling results. The correlations between the sub-dimensions of the HSAQ were all ≤ .70 (Range = .61 - .69) and significant (p ≤ .001; Figure 1). Initial fit for the covariance model of the HSAQ solution indicated sound fit (χ^2 [100] = 485.565, CMIN/DF = 4.856, p ≤ .001) as the fit indices met or exceeded recommended levels (CFI = .950, TLI = .933, IFI = .951, RMSEA = .070; Figure 2). All factor loadings were significant (p ≤ .001).

Correlation analysis between scales. The correlation between the latent variable 'Pain Characteristics' on the HSAQ and the latent variable for pain using the NPRS was high (r = .81). This was similar to the relationship between the cumulative NPRS composite scores and the composite score of the 'Pain Characteristics' items in the HSAQ (r = .80). The correlation between the latent variable 'Functional Limitations' on the HSAQ and PSFS scores was moderate (r = -.63). The relationship between the PSFS score and the composite score of HSAQ FL items was similar (r = -.67). The correlation between the 'QOL' latent variable of the HSAQ and the latent variable for the QOLS was moderate (r = .34). The correlation between total score on the QOLS and composite score on the QOL sub-scale of the HSAQ was also moderate (r = .32).

Canonical correlation indicated two relationship patterns between scores on the HSAQ sub-dimensions and scores on the NPRS, PSFS, and QOLS existed. The first canonical correlation was R = .79 (F [12] = 85.967, Eigenvalue = 1.652, p ≤ .001, R^2 = .62) and with the first removed, the second correlation was R = .40 (F [6] = 29.259, Eigenvalue = .195, p ≤

.001, R^2 = .16). The correlations and canonical loadings are provided in Table 8. Group mean scores on the HSAQ and sub-dimensions are provided in Table 9.

Discussion

The purpose of this study was to develop a new generic PRO instrument that was psychometrically sound and could be used to measure important summary components of the injury recovery process in physically active populations. The original item pool included 53 items reduced to a 16 item solution examining the second-order construct of health status. The second-order construct was measured indirectly through the indicator items of the four first-order factors (i.e., [1] "functional limitations," [2], "disability," [3] "quality of life", and [4] "pain characteristics") included in the model. The generated constructs fit a multi-dimensional lens by which a clinician could get a broad understanding of the patient's health status, including dimensions of the disablement model[18-21,25] and QOL.[28,31-33,37] The sub-dimensions allow for QOL to be measured separately from the physical components of a person's injury to see how the unique construct may be impacting their overall health status without influencing items that measure other dimensions, such as functional limitations.[35,41] Furthermore, the sub-dimensions identified in the HSAQ also created a distinction between functional limitations and disability as separate constructs. This distinction not always found with other disablement models[46,79] and allows the constructs to be evaluated as unique dimensions.

Psychometric Analysis of Scale Structure

Initial HSAQ analysis using EFA produced a four-factor structure that accounted for 73.5% of the variance in participants' responses. Each of the dimensions was comprised of 4 items with substantial loadings (≥ .66) on that factor and no substantial cross loadings (≤ .17)

on any other factor in the solution using both extraction methods. All of the eigenvalues were above 1.0 in PCA analysis, while the "pain characteristics" sub-dimensions had an eigenvalue slightly below the 1.0 cut-point (.85) with maximum likelihood extraction (Table 6). The majority of the items used in the final solution factored together within their originally hypothesized dimensions. The "disability" construct, however, included two items that were originally proposed to measure functional limitations. During initial assessment, reviewers did not reach a consensus on whether these items (FL-7 and FL-8) were assessing disability (n = 2) or functional limitations (n = 3). The results indicate patients perceive these items similarly to the other disablement items. We felt the items were a conceptual fit for the proposed definition for the disability dimension, so these items were retained with the originally proposed disability items (DIS-6 and DIS-7) within our proposed "disability" sub-scale (Table 6 and 7). The four-dimensions also had acceptable internal consistency as demonstrated by each sub-scale having a Cronbach's alpha coefficient ≥ .840 (Table 6).

Correlational analysis of the latent structure model revealed significant correlations between the sub-dimensions of the HSAQ (Figure 1). Because the constructs are theorized to be interrelated dimensions of health status, a moderate correlation was expected between the constructs. The correlation values (range, r = .61-.69) are acceptable for supporting a relationship between the constructs without having excessive overlap between the constructs, supporting the notion that items are assessing unique dimensions. For comparison, the DPA Scale uses a similar factor structure to measurement disablement (e.g., functional limitations construct, disability construct, etc.). The correlation values between the disablement constructs (e.g., functional limitations, disability) within the DPA Scale have been reported to be substantially higher ($r \geq .90$)[46] than the relationship we found between our proposed

disablement model based constructs (r range = .61 - .69). In contrast, the relationship (r = .65) between the disablement and QOL dimensions of the DPA Scale[46] was more in-line with our findings of the relationships (r range = .62-.64) between QOL and other sub-dimensions of the HSAQ.

Covariance modeling of the HSAQ produced a second-order model that met or exceeded the fit indices recommendations. This analysis technique is a more contemporary and restricted measurement technique allowing for more rigorous testing of the psychometric properties of our instrument.[80-82] Within our sample, the CFI and IFI values exceeded the most restrictive requirements ($\geq .95$), while the remaining fit indices values were acceptable and approaching the more stringent cut points.[75-77]

Correlational Analysis

The NPRS is one of the most commonly utilized uni-dimensional scales to assess pain intensity.[14,15] Correlation results demonstrated high correlations ($r \geq .80$) between the "pain characteristic" sub-dimensions on the HSAQ and the NRPS using both manifest and latent variable scores for the analyses. This sub-dimension on the HSAQ accounted for at least 64% of the variance in NPRS scores using either correlational analysis approach. Because the "pain characteristics" items of the HSAQ accounted for more than just pain intensity, it is not surprising that the correlation values between the two are not higher. Further comparison of this sub-dimension of the HSAQ with other scales used to assess pain would be valuable for determining the validity of the sub-dimension.

Similarly, the "functional limitations" sub-dimension of the HSAQ was moderately correlated with the PSFS using a bivariate approach on manifest scores (r = -.67) or a latent variable approach (r = -.63). While the PSFS is a commonly used tool for assessing

functional status, there is variation in the manner in which it is applied in patient care (i.e., assessing 1 to 5 activities).[3,16] In this study, participants were only required to rate their functional status on one activity using the PSFS. While the scores on the functional limitations section of the HSAQ accounted for an acceptable percentage of the variance in PSFS scores (range = 40-45%), this sub-dimension assesses a broad range of limitations (e.g., changing direction, acceleration, agility, etc.) within the construct and these limitations may not have been fully represented by the one activity the participant chose on the PSFS. Further study should be conducted using the PSFS with more activities (i.e., 3) or other functional scales to fully assess the validity of this HSAQ sub-scale.

The correlation values between the QOL sub-construct on the HSAQ was only moderately correlated with scores on the QOLS using a latent variable approach (r = .34) or manifest score approach (r = .32). A potential explanation for these findings is that QOL is a broad construct and various items to may capture different patient perceptions of the construct depending on one's life circumstances (e.g., age, health status, etc.). Thus, the items within "QOL" construct of the HSAQ may be measuring a different aspect of QOL than the items used to measure the construct within the QOLS.[35] For example, the QOLS has primarily been assessed in patients who are chronically ill, as opposed to those who are physically active and suffering from musculoskeletal injury.[10,35,42,43] Thus, invariance testing is needed to ensure that certain groups of people (e.g., acutely injured versus chronically ill) are not biased to answer the items differently. Another explanation could be psychometric measurement issues with the QOLS in general. While EFA has been conducted on the QOLS,[43] more strict and contemporary approaches (e.g., confirmatory factor analysis) have not been conducted to

assess the measurement properties of the scale. Thus, more studies are needed to assess the validity of the QOLS and this sub-dimension of the HSAQ across various populations.

Canonical correlation analysis using manifest scores from the four sub-dimensions of the HSAQ and the manifest scores on the NPRS, PSFS, and QOLS revealed a strong, significant correlation ($R = .79$, $R^2 = 62.4\%$) for the first correlation and a significant moderate correlation for the second correlation ($R = .40$, $R^2 = 16\%$). Examination of the loadings indicates a pattern involving scores on the HSAQ sub-dimensions being similar to those on the other scales (e.g., a person rates their pain, QOL, functional limitations as highly impaired on the HSAQ also does so on the NPRS, PSFS, and QOLS) for the first relationship. Examination of the loadings for the second relationship seems to indicate a pattern of higher scores for physical factors (e.g., pain, functional limitations), with less impact on QOL.

Limitations

While our study include a large and diverse sample from a geographic perspective, we also relied on a cross-sectional sample that was primarily comprised of participants who identified as athletes. Additionally, we excluded participants who were experiencing chronic pain. Thus, additional study in patients with chronic pain and other sub-samples of the population (e.g., geriatric) is needed. Further testing can also be done to compare the HSAQ to other scales to determine how patient responses on other valid scales are represented by their scores on the HSAQ. Finally, while the HSAQ had acceptable to good psychometric properties, further testing (e.g., invariance testing, longitudinal assessment) is needed to fully establish the validity of the HSAQ and the ability to use the scale to assess patient improvement following intervention.

Conclusion

The HSAQ was found to be a reliable and valid instrument for the assessment of health status in those who are physically active. The internal consistency was above appropriate levels for reliability, while fit indices recommendations were met or exceeded for establishing the factorial validity of the scale structure. The findings provide preliminary evidence that the scale has sub-dimensions that may be able to be used in place of other scales (e.g., NPRS, PSFS) which may reduce the barriers/burdens for patients and clinicians who want to use PRO instruments. Further analysis is needed to determine scale responsiveness and invariance for use in research and clinical practice.

References:

1) Sackett DL, Rosenburg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. *Br Med J*. 1996;313(7024):71-72.

2) Evans TA, Lam KC. Clinical outcomes assessment in sport rehabilitation. *J Sport Rehabil*. 2011;20:8-16.

3) Nicholas P, Hefford C, Tumilty S. The use of the patient-specific functional scale to measure rehabilitative progress in a physiotherapy setting. *J Man Manip Ther*. 2012;20(3):147-152.

4) Morrison B, Lilford R. How can action research apply to health services? *Qual Health Res*. 2001;11(4):436-449.

5) Koshy E, Koshy V, Waterman H. *Action Research in Healthcare*. Thousand Oaks, CA: SAGE Publishing Ltd; 2011.

6) Childs JD, Cleland JA. Development and application of clinical prediction rules to improve decision making in physical therapist practice. *Phys Ther*. 2006;86(1):122-131.

7) Michener LA. Patient- and clinician-rated outcome measures for clinical decision making in rehabilitation. *J Sport Rehabil*. 2011;20(1):37-45.

8) Jette DU, Halbert J, Inverson C, Miceli E, Shah P. Use of standardized outcome measures in physical therapist practice: perceptions and applications. *Phys Ther*. 2009;89(2):125-135.

9) Valovich McLeod TC, Snyder AR, Parsons JT, Bay CR, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice, part II: clinical outcomes assessment. *J Athl Train*. 2008;43(4):437–445.

10) Anderson KL, Burckhardt CS. Conceptualization and measurement of quality of life as an outcome variable for health care intervention and research. *J Adv Nurs*. 1999;29(2):298-306.

11) Valier AR, Jennings AL, Parsons J, Vela LI. Benefits of and barriers to using patient-rated outcome measures in athletic training. *J Athl Train*. 2014;49(5):674-683.

12) Abrams D, Davidson M, Harrick J, Harcourt P, Zylinski M, Clancy J. Monitoring the change: current trends in outcome measure usage in physiotherapy. *Man Ther*. 2006;11(1):46-53.

13) Ware JE Jr, Sherbourne CD. The MOS 36-item short form health survey (SF-36). I. Conceptual frameworks and item selection. *Med Care*. 1992;30(6):473-483.

14) Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. *J Clin Nurse*. 2005;14(7):798-804.

15) Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. *Pain*. 2011;152(10):2399-2404.

16) Westaway MD, Stratford PW, Binkley JM. The patient-specific functional scale: validation of its use in persons with neck dysfunction. *J Orthop Sports Phys Ther*. 1998;27(5):331-338.

17) Hefford C, Lodge S, Elliot K, Abbot H. Measuring patient-specific outcomes in musculoskeletal clinical practice: a pilot study. *NZ J Physiother*. 2008;36(2):41-48.

18) Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med*. 1994;38(1):1–14.

19) Jette AM. Outcomes research: shifting the dominant research paradigm in physical therapy. *Phys Ther*. 1995;75(11):965–970.

20) Dobrzykowski E. The methodology of outcomes measurement. *J Rehabil Outcomes Meas*. 1997;1(1):8–17.

21) Watts J, Clement D. Conceptual framework for rehabilitation outcomes research. *J Rehabil Outcomes Meas*. 2000;4(2):55–61.

22) Haley SM, Coster WJ, Binda-Sundberg K. Measuring physical disablement: the contextual challenge. *Phys Ther*. 1994;74(5):443–451.

23) Hawkins-Watts J, Clement DG. Conceptual framework for rehabilitation outcomes research. *J Rehabil Outcomes Meas*. 2000;4(2):55–61.

24) Kane RL. Approaching the outcomes question. *J Rehabil Outcomes Meas*. 1999;3(1):50–58.

25) Nagi S. Disability concepts revisited: implications for prevention. In: Pope A, Tarlov A, eds. *Disability in America: Toward a National Agenda for Prevention*. Washington, DC: National Academy Press; 1991:309–327.

26) World Health Organization. *International Classification of Functioning, Disability and Health (ICF)*. Geneva, Switzerland: World Health Organization; 2001:7–20.

27) Snyder AR, Parsons JT, Valovich-McLeod TC, Bay R, Michener LA, Sauers EL. Using disablement models and clinical outcomes assessment to enable evidence-based athletic training practice, part I: disablement models. *J Athl Train. 2008*;43(4):428–436.

28) Vela LI, Denegar CR. Transient disablement in the physically active with musculoskeletal injuries, part 1: a descriptive model. *J Athl Train*. 2010; 45(6):615-629.

29) Leidy NK. Functional status and the forward progress of meery-go rounds: toward a coherent analytical framework. *Nurs Res*. 1994;43(4):196-202.

30) McDonald SA, Hardy CJ. Affective response patterns of the injured athlete: an exploratory analysis. *Sport Psychol*. 1990;4(3):261–274.

31) Petrie T, Falkstein D, Brewer B. Predictors of Psychological Response to Injury in Female Collegiate Athletes. Chicago, IL: Annual Meeting of the American Psychological Association; August 15–19, 1997.

32) Wiese-Bjornstal DM, Smith AM, Shaffer SM, Morrey MA. An integrated model of response to sport injury: psychological and sociological dimensions. *J Appl Sport Psychol*. 1998;10(1):46–69.

33) Albinson CB, Petrie TA. Cognitive appraisals, stress, and coping: preinjury and postinjury factors influencing psychological adjustment to sport injury. *J Sport Rehabil*. 2003;12(4):306–322.

34) Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life. *JAMA*. 1995;273(1):59-65.

35) Smith KW, Avis NE, Assmann SF. Distinguishing between quality of life and health status in quality of life research: a meta-analysis. *Qual Life Res*. 1999;8(5):447-459.

36) Spitzer W. Advances in health assessment conference discussion panel. *J Chron Dis*. 1987;40(Suppl 1):187S- 189S.

37) McDowell I, Newell C. *Measuring Health: A Guide to Rating Scales and Questionnaires*. 2nd ed. New York, NY: Oxford University Press; 1996.

38) Parsons J T, Snyder A R. Health-related quality of life as a primary clinical outcome in sport rehabilitation. *J Sport Rehabil*. 2011;20(1):17–36.

39) Ware J Jr, Kosinski M, Keller SD. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care*. 1996;34(3):220-233.

40) Revicki DA, Osoba D, Fairclough D, Barofsky I, Berzon R, Leidy NK, Rothman M. Recommendations on health-related quality of life research to support labeling and promotional claims in the United States. *Qual Life Res*. 2000;9(8):887-900.

41) Pender NJ. *Health Promotion in Nursing Practice*. 3rd ed. Norwalk, CT: Appleton & Lange, 1996.

42) Burckhardt CS, Anderson KL. The quality of life scale (QOLS): reliability, validity, and utilization. *Health Qual Life Outcomes*. 2003;I:60.

43) Burckhardt CS, Anderson KL, Archenholtz B and Hägg O: The Flanagan Quality of Life Scale: Evidence of Construct Validity. *Health Qual Life Outcomes*. 2003;I:59.

44) Ware JE Jr. The status of health assessment1994. *Annu Rev Public Health*. 1995;16:327-354.

45) Ware JE, Kosinski M, Bayliss MS, McHorney CA, Rogers WH, Raczek A. Comparison of methods for the scoring and statistical analysis of SF-36 health profile and summary measures: summary of results from the Medical Outcomes Study. *Med Care*. 1995;33(4 Suppl):AS264-279.

46) Vela LI, Denegar CR. The disablement in the physically active scale, part II: the psychometric properties of an outcome scale for musculoskeletal injuries. *J Athl Train*. 2010;45(6):630-641.

47) Houston MN, Hoch JM, Van Lunen BL, Hoch MC. The development of summary components for the disablement in the physically active scale in collegiate athletes. *Qual Life Res*. 2015;24(11):2657-2662.

48) Fritz JM, Clifford SN. Low back pain in adolescents: a comparison of clinical outcomes in sports participants and nonparticipants. *J Athl Train*. 2010;45(1):61-66.

49) Hsu JE, Nacke E, Park MJ, Sennett BJ, Huffman GR. The Disabilities of the Arm, Shoulder, and Hand questionnaire in intercollegiate athletes: validity limited by ceiling effect. *J Shoulder Elbow Sur*. 2010;19(3):349-354.

50) Kay TM, Myers AM, Huijbregts MP. How far have we come since 1991? A comparative survey of physiotherapists use of outcome measures. *Physiother Can*. 2001;53(4):268-275.

51) Huijbregts MP, Myers AM, Kay TM, Gavin TS. Systematic outcome measurement in clinical practice: challenges experienced by physiotherapist. *Physiother Can*. 2002;54(1):25-31.

52) Jolles BM, Buchbinder R, Beaton DE. A study compared nine patient-specific indices for musculoskeletal disorders. *J Clin Epidemiol*. 2005;58(8):791-801.

53) Strong J, Unruh AM, Wright A, Baxter GD. *Pain: A Textbook for Therapists*. Edinburgh, Scotland: Churchill Livingstone; 2002;425-433.

54) Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. *Arthroscopy*. 1993;9(2):159-163.

55) Marx RG, Jones EC, Allen AA, Altchek DW, O'Brien SJ, Rodeo SA, Williams RJ, Warren RF, Wickiewicz TL. Reliability, validity, and responsiveness of four knee outcome scales for athletic patients. *J Bone Joint Surg Am*. 2001;83-A(10):1459-1469.

56) Davidson M, Keating JL. A comparison of five low back disability questionnaires: reliability and responsiveness. *Phys Ther*. 2002;82(1):8-24.

57) Roland M, Fairbank J. The Roland-Morris Disability Questionnaire and the Oswestry Disability Questionnaire. *Spine*. 2000;25(24):3115-3124.

58) Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application.

North American Orthopaedic Rehabilitation Research Network. *Phys Ther*. 1999;79(4):371-383.

59) Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the disabilities of the arm, shoulder and hand outcome measure in different regions of the body. *J Hand Ther*. 2001;14(2):128-146.

60) Stratford PW, Binkley JM, Stratford DM. Development and initial validation of the Upper Extremity Functional Index. *Physiother Can*. 2001;53:259-267.

61) Martin R, Irrang J, Conti S, vanSwearingen J. Evidence of validity for the foot and ankle Ability Measure. *Foot Ankle Intern*. 2005;26(11):968-983.

62) Thorborg K, Roos EM, Bartels EM, Pertersen J, Holmich P. Validity, reliability and responsiveness of patient-reported outcome questionnaires when assessing hip and groin disability: a systematic review. *Br J Sports Med*. 2010;44(16):1186-1196.

63) Melzack R. The McGill Pain Questionnaire: Major properties and scoring methods. *Pain*. 1975;1(3):277-299.

64) Woby SR, Roach NK, Urmston M, Watson PJ. Psychometric properties of the TSK-11: A shortened version of the Tampa Scale for Kinesiophobia. *Pain*. 2005;117(1-2):137-144.

65) Chung KC Pillsbury MS et al. Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. *J Hand Surgery*. 1998;23A:575-587.

66) Vincent JI, MacDermid JC, King GJ, Grewal R. Validity and sensitivity to change of patient-reported pain and disability measures for elbow pathologies. *J Orthop Sports Phys Ther*. 2013;43(4):263-274.

67) Burkhardt CS, Woods SL, Schultz AA, Ziebarth DM. Quality of life of adults with chronic illness: a psychometric study. *Res Nurs Health*. 1989;12(6):347-354.

68) Burckhardt CS, Archenholtz B, Bjelle A. Measuring quality of life of women with rheumatoid arthritis or systemic lupus erythematosus: A Swedish version of the Quality of Life Scale (QOLS). *Scand J Rheumatol*. 1992;21(4):190-195.

69) Neumann L, Buskila D. Measuring the quality of life of women with fibromyalgia: a Hebrew version of the quality of life scale (QOLS). *J Musculoskel Pain*. 1997;5:5-17.

70) Wahl A, Burckhardt CS, Wiklund I, Hanestad BR. The Norwegian version of the Quality of Life Scale (QOLS-N). A validity and reliability study in patients suffering from psoriasis. *Scand J Caring Sci*. 1998;12(4):215-222.

71) Wood V, Wylie ML, Sheafor B. An analysis of a short self-report measure of life satisfaction: Correlation with rater judgements. *J Gerontol*. 1969;24(4):465-469.

72) Jaeschke R, Singer J, Guyatt GH. Measurement of health status: ascertaining the minimal clinically important difference. *Control Clin Trials*. 1989;10(4):407-415.

73) Kamper SJ, Maher CG, Mackay G. Global rating of change scales: a review of strengths and weaknesses and considerations for design. *J Man Manip Ther*. 2009;17(3):163-170.

74) Leech NL, Barret KC, Morgan GA. *IBM SPSS for Intermediate Statistics: Use and Interpretation*. 5th ed. New York, NY: Routledge;2015.

75) Byrne BM. *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming*. 3rd ed. New York, NY: Routledge, 2016.

76) Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structural analysis: conventional criteria versus new alternatives. *Structural Equation Modeling*. 1999;6:1-55.

77) MacCullum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structural modeling. *Psychological Methods*. 1996;1:130-149.

78) Tabchnick BG, Fidell LS. *Using Multivariate Statistics*. 4th ed. Needham Heights, MA: Allyn & Bacon;2001.

79) Whiteneck G. Conceptual models of disability: past, present, and future. In: Field M, Jette A, Martin L, eds. *Workshop on Disability in America: A New Look - Summary and Background Papers*. https://www.nap.edu/catalog/11579/workshop-on-disability-in-america-a-new-look-summary-and. Accessed June 8, 2017.

80) Tenenbaum G, Eklund RC, Kamata A. *Measurement in sport and exercise psychology* Vol. 2. Champaign, IL: Human Kinetics;2012.

81) Brown TA. *Confirmatory Factor Analysis for Applied Research*. 2nd ed. New York, NY: The Guilford Press, 2015.

82) Kline RB. *Principles and Practice of Structural Equation Modeling*. 4th ed. New York, NY: The Guilford Press, 2016.

Table 1. Activity and Injury Definitions Used for Inclusion and Exclusion Criteria and Participant Stratification.

	Criterion	Definition[15]
Inclusion	Physically Active, and	"An individual who engages in athletic, recreational, or occupational activities that require physical skills and who uses strength, power, endurance, speed, flexibility, range of motion, or agility at least 3 days per week."[15]
	Healthy, or	An individual who is free from musculoskeletal injury and fully able to participate in sport or activity.
	Acute Injury, or	An individual who suffers a musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (0-72 hours post-injury).
	Sub-Acute Injury, or	An individual who suffers a musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (3 days to 1 month post-injury).
	Persistent Injury	An individual who suffers from "a musculoskeletal injury that has been symptomatic for at least 1 month."[15]
Exclusion	Chronic Pain	An individual who suffers from "pain that consistently does not get any better with routine treatment or non-narcotic medication."[15]

Table 2. Definitions Used for Participant Athletic Status Stratification.

Status	Definition
Competitive Athlete	"A participant who engages in a sport activity that requires at least 1 pre-participation examination, regular attendance at scheduled practices and/or conditioning sessions, and a coach who leads practices and/or competitions."[15]
Recreational Athlete	"Participants who meet the criteria for physical activity and participate in sport, but do not meet the criteria for competitive status."[15]
Occupational Athlete	A participants who meets the criteria for physical activity for occupation or recreation, but does not meet the criteria for being classified a competitive or recreational athlete.
Physically Active in Activities of Daily Living	Any participant who does not meet the criteria for the "athlete" categories, but is physically active through their daily activities.

Table 3. Clinician Reported Injury Locations for Participants.

Injury Location	Frequency	Percentage
Head/Neck	16	2.0
Shoulder/Arm	90	11.5
Elbow/Forearm	26	3.3
Wrist/Hand	21	2.7
Trunk/Thoracic Spine	20	2.6
Low Back/Pelvis	75	9.6
Hip/Thigh	74	9.4
Knee/Leg	160	20.4
Ankle/Foot	105	13.4
Not Reported	197	25.1

Table 4. Clinician Reported Injury Classification for Participants.

Injury Type	Frequency	Percentage
Dislocation/Subluxation	9	1.1
Disc Pathology	11	1.4
Fracture	11	1.4
Stress Fracture	5	0.6
Meniscal/Labral Lesion	19	2.4
Post-Surgery	24	3.1
Sprain	149	19.0
Strain	188	24.0
Tendinopathy	73	9.3
Other	107	13.6
Not Reported	188	24.0

Table 5. Primary Sport Activity as Reported by Participant.

Sport	Frequency	Percentage
Baseball	47	6.0
Basketball	64	8.0
Cheerleading	9	1.0
Cross-Country	5	0.6
Football	52	7.0
Gymnastics	1	0.1
Racquet Sports	9	1.0
Lacrosse	57	7.0
Recreational Running	17	2.0
Soccer	92	12.0
Softball	74	9.0
Swimming/Diving	15	2.0
Track and Field	79	10.0
Volleyball	22	3.0
Weight Lifting (Cross-Fit®, etc.)	38	5.0
Other (e.g., cycling, golf, rodeo, wrestling, etc.)	146	19.0
Does not participate in sport activities	102	13.0
Not Reported	12	1.5

Table 6. Exploratory Factor Analysis Pattern Matrix Loadings for the Health Status Assessment Questionnaire.

	Principal Components				**Maximum Likelihood**			
Item	Functional Limitations	Disability	Quality of Life	Pain	Functional Limitations	Disability	Quality of Life	Pain
FL-6:	.871				.857			
FL-4	.865				.862			
FL-11	.828				.768			
FL-2	.761				.661			
DIS-7		.895				.798		
FL-7		.828				.766		
FL-8		.695				.703		
DIS-6		.663				.666		
QOL-10			-.888				.862	
QOL-8			-.817				.735	
QOL-4			-.776				.703	
QOL-9			-.743				.666	
PN-1				.876				.831
PN-5				.837				.787
PN-4				.752				.690
PN-3				.746				.659
Eigenvalue	7.80	1.50	1.30	1.20	7.50	1.00	1.15	0.85
% of Variance	49.0	9.0	8.0	7.5	46.0	6.0	7.0	5.5
Cronbach's alpha	.898	.840	.880	.854				

Table 7. Original and Revised Construct Labels for the Health Status Assessment Questionnaire.

Phrasing of the Items in the Assessment of Health Status Questionnaire.	**Final Solution Dimension**	**Original Proposed Dimension**
My physical performance is impaired (FL-2).	FL	FL
Moving quickly is challenging (FL-4).	FL	FL
I find it difficult to change directions during physical activity (FL-6).	FL	FL
My agility is decreased (FL-11).	FL	FL
Tying my shoes is difficult to do (DIS-6).	DIS	DIS
Completing personal hygiene tasks (e.g., brushing your teeth) is challenging (DIS-7).	DIS	DIS
I am not able to reach for certain items (FL-7).	DIS	FL
I have difficulty carrying items (FL-8).	DIS	FL
I find it difficult to maintain a positive outlook (QOL-4).	QOL	QOL
I feel more uncertainty in my life because of my injury (QOL-8).	QOL	QOL
My mood fluctuates more because of my physical problems (QOL-9).	QOL	QOL
I have decreased self-confidence since my injury occurred (QOL-10).	QOL	QOL
My current pain is the worst I can imagine (PN-1).	PN	PN
At its worst, my pain is agonizing (PN-3).	PN	PN
I experience severe pain throughout the day (PN-4).	PN	PN
Even at its best, my pain is excruciating (PN-5).	PN	PN
FL = Functional Limitations, DIS – Disability, QOL = Quality of Life, PN = Pain Characteristics		

Table 8. Correlation and Standardized Coefficient's Between HSAQ Sub-Dimensions and the NPRS, Patient Specific Functional Scale, and the Quality of Life Scale.

Scale	Sub-Dimension	First Canonical Correlation Loading	Second Canonical Correlation Loading
HSAQ	Pain Characteristics	-.95	.38
	Quality of Life	-.62	-.09
	Disability	-.67	-.26
	Functional Limitations	-.84	-.51
NPRS		-.96	.26
PSFS		.73	.68
QOLS		-.24	-.08
HSAQ = Assessment of Health Status Questionnaire; NPRS = Numerical Pain Rating Scale; PSFS = Patient Specific Functional Scale; QOLS = Quality of Life Scale/			

Table 9. Group Mean Scores on the Health Status Assessment Questionnaire and Scale Sub-Dimensions.

Scale	Group	Mean ± SD	Range
Assessment of Health Status Questionnaire	Persistent Injury	14.17 ± 11.67	2-59
	Acute Injury	16.05 ± 11.36	2-53
	Sub-Acute Injury	14.27 ± 11.35	2-54
	Healthy	0.95 ± 3.12	0-7
Functional Limitations Sub-Dimension	Persistent Injury	5.80 ± 4.42	0-16
	Acute Injury	7.10 ± 4.49	0-16
	Sub-Acute Injury	6.50 ± 4.47	0-16
	Healthy	0.40 ± 1.22	0-4
Disability Sub-Dimension	Persistent Injury	2.01 ± 3.07	0-16
	Acute Injury	3.10 ± 3.76	0-16
	Sub-Acute Injury	2.55 ± 3.83	0-16
	Healthy	0.14 ± 0.83	0-2
Quality of Life Sub-Dimension	Persistent Injury	2.43 ± 3.48	0-16
	Acute Injury	1.96 ± 2.87	0-13
	Sub-Acute Injury	1.63 ± 2.79	0-12
	Healthy	0.17 ± 0.71	0-4
Pain Characteristics Sub-Dimension	Persistent Injury	4.04 ± 3.79	1-16
	Acute Injury	4.11 ± 3.78	1-16
	Sub-Acute Injury	3.56 ± 3.15	1-14
	Healthy	0.22 ± 0.80	0-3

Figure 1. First-order model of the Health Status Assessment Questionnaire providing correlational values between the sub-dimensions. Chi Sq = Chi Square (χ2), CMIN/DF = the χ2 / degrees of freedom ratio; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation, df = degrees of freedom, p = alpha level.

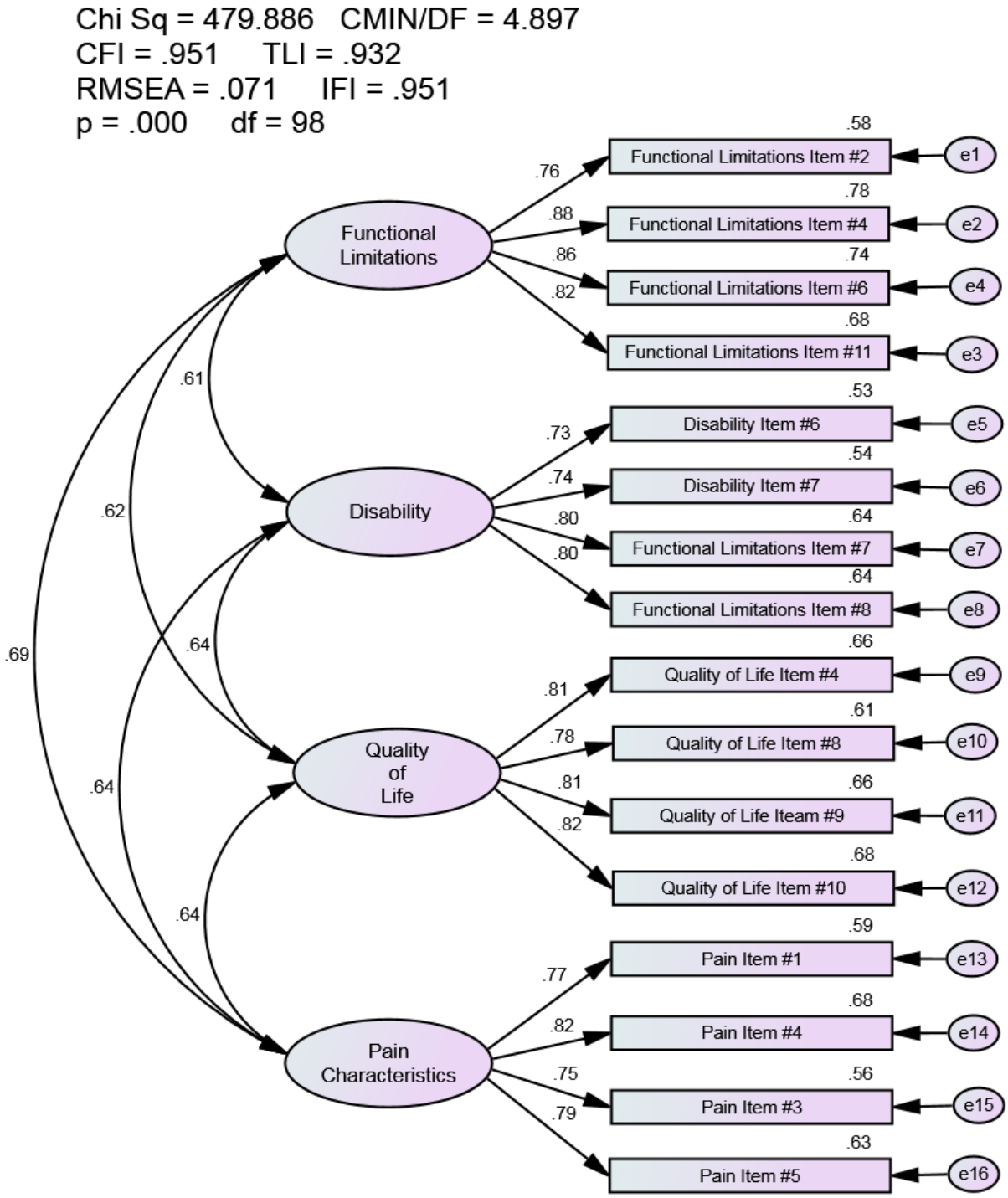


Figure 2. The Health Status Assessment Questionnaire second-order covariance measurement model with standardized loadings. Chi Sq = Chi Square ($\chi 2$), CMIN/DF = the $\chi 2$ / degrees of freedom ratio; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; IFI = Bollen's Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation, df = degrees of freedom, p = alpha level.

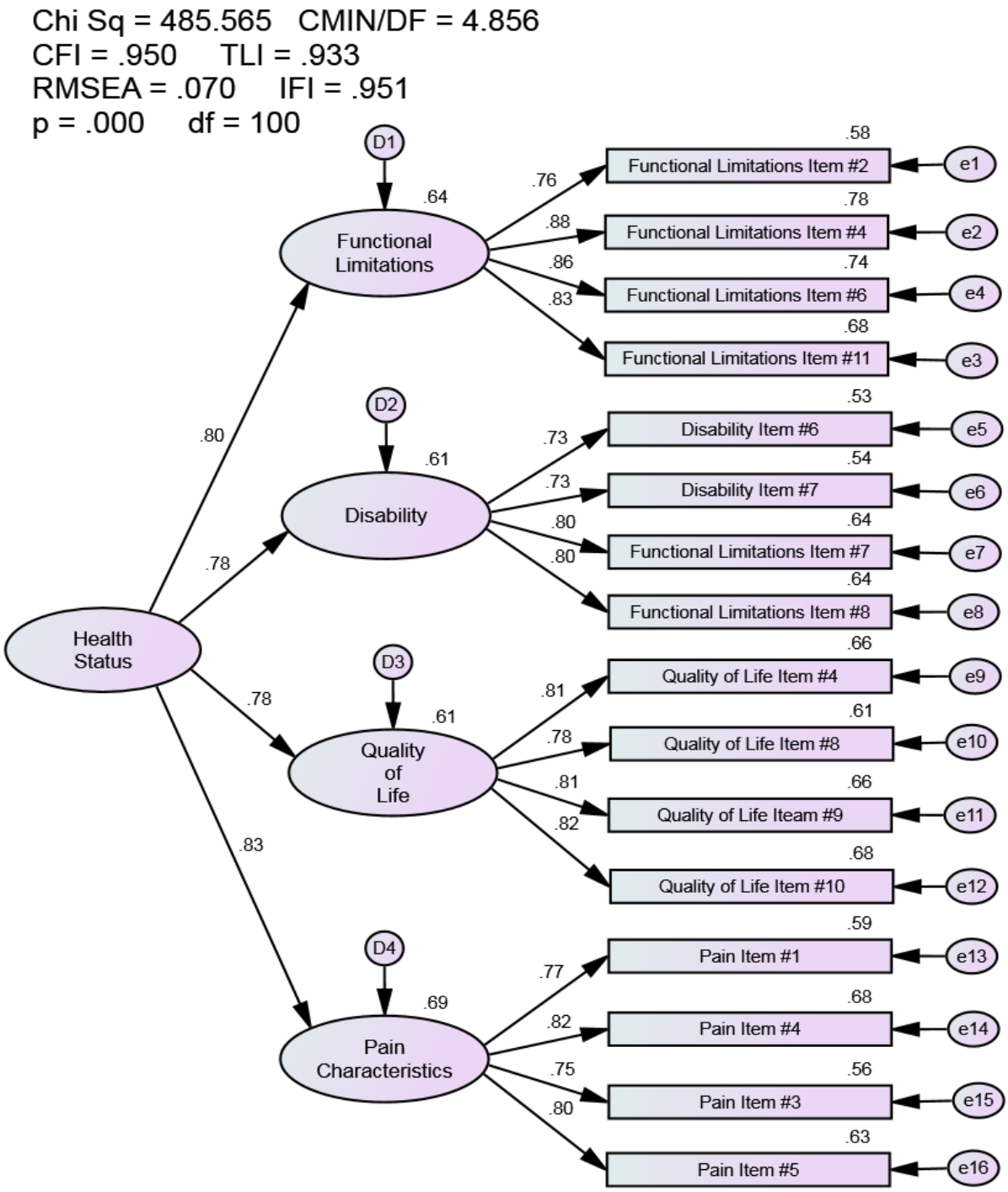


Figure 3. The Health Status Assessment Questionnaire.

Health Status Assessment Questionnaire (HSAQ)

Instructions: This questionnaire asks about your symptoms and ability to perform activities/tasks you want to complete each day. Please answer each statement, based on your condition in the past 24 hours, by shading in the circle that best identifies your level of agreement with each statement. If you are unsure about a statement, please make your best estimate of the response you think is the most accurate for you and your condition.

Likert Scale: 0: Not applicable/No Agreement 1: Mild Agreement 2: Moderate Agreement 3: Strong Agreement 4: Complete Agreement	None	Mild	Moderate	Strong	Complete
Pain Characteristics	**0**	**1**	**2**	**3**	**4**
My current pain is the worst pain I can imagine.	O	O	O	O	O
At its worst, my pain is agonizing.	O	O	O	O	O
I experience severe pain throughout the day.	O	O	O	O	O
Even at its best, my pain is excruciating.	O	O	O	O	O
Pain Characteristics Summary Score	_____ / 16				
Functional Limitations	**0**	**1**	**2**	**3**	**4**
My physical performance is impaired.	O	O	O	O	O
Moving quickly is challenging.	O	O	O	O	O
I find it difficult to change direction during physical activity.	O	O	O	O	O
My agility is decreased.	O	O	O	O	O
Functional Limitations Summary Score	_____ / 16				
Disability	**0**	**1**	**2**	**3**	**4**
Tying my shoes is difficult to do.	O	O	O	O	O
Completing personal hygiene tasks (e.g., brushing your teeth) is challenging.	O	O	O	O	O
I am not able to reach for certain items.	O	O	O	O	O
I have difficulty carrying items.	O	O	O	O	O
Disability Summary Score	_____ / 16				
Quality of Life	**0**	**1**	**2**	**3**	**4**
I find it difficult to maintain a positive outlook.	O	O	O	O	O
I feel more uncertainty in my life because of my injury.	O	O	O	O	O
My mood fluctuates more because of my physical problems.	O	O	O	O	O
I have decreased self-confidence since my injury occurred.	O	O	O	O	O
Quality of Life Summary Score	_____ / 16				
Total Score (Sum of the Scores):	_____ / 64				

Appendix A: Inclusion/Exclusion Participant Criteria and Terminology Classifications

Inclusion Criteria:

- Physically Active: An individual who engages in athletic, recreational, or occupational activities that require physical skills and who uses strength, power, endurance, speed, flexibility, range of motion, or agility at least 3 days per week.

Exclusion Criteria*:*

- Chronic Pain: Pain that consistently does not get any better with routine treatment or non-narcotic medication.

Other Definitions:

- **Injury Definitions**:
    - ***Healthy***: Free from musculoskeletal injury and fully able to participate in sport or activity.
    - ***Acute Injury***: A musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (0-72 hours post-injury).
    - ***Sub-Acute Injury***: A musculoskeletal injury that precludes full participation in sport or activity for at least 2 consecutive days (3 days to 1 month post-injury).
    - ***Persistent Injury***: A musculoskeletal injury that has been symptomatic for at least 1 month.
- **Activity Definitions**:
    - ***Competitive Athlete*****:** A participant who engages in a sport activity that requires at least 1 pre-participation examination, regular attendance at scheduled practices and/or conditioning sessions, and a coach who leads practices and/or competitions.
    - ***Recreational Athlete*****:** Participants who meet the criteria for physical activity and participate in sport, but do not meet the criteria for competitive status.
    - ***Occupational Athlete*****:** Participants who meet the criteria for physical activity for occupation or recreation, but do not meet the criteria for competitive or recreational athlete.
    - ***Activities of Daily Living*****:** Participants who do not meet the criteria for any "athlete" category, but who are physically active through their daily activities.

Appendix B: The Disablement in Physically Active Scale Packet

Disablement in the Physically Active Scale (DPA Scale)

DPA Scale items are evaluated on a 5-point Likert scale (1 = no problem; 5 = the problem(s) severely affects me).

Item 1: Pain – Do I have pain?

Item 2: Motion – Do I have impaired motion?

Item 3: Muscular functioning – Do I have impaired muscle function?

Item 4: Stability – Do I have impaired stability?

Item 5: Changing Directions – Do I have difficulty with changing directions in activity?

Item 6: Daily Actions – Do I have difficulty with daily actions that I would normally do?

Item 7: Maintaining Positions – Do I have difficulty maintaining the same position for a long period of time?

Item 8: Skill Performance – Do I have difficulties with performing skills that are required for physical activity (ex: running, jumping, kicking, throwing, & catching)?

Item 9: Skill Performance – Do I have difficulties with performing skills that are required for physical activity (ex: coordination, agility, precision, & balance)?

Item 10: Overall Fitness – Do I have difficulty maintaining my fitness level?

Item 11: Participation in Activities – Do I have difficulty with participating in activities (ex: participating in leisure activities, hobbies, and games)?

Item 12: Participation in Activities – Do I have difficulty with participating in activities (ex: participating in my sport[s] of preference)?

Items 13-16: Well Being – Do I have difficulties with the following….

13: Increased uncertainty, stress, pressure, and/or anxiety

14: Altered relationships with team, friends, and/or colleagues

15: Decreased overall energy

16: Changes in my mood and/or increased frustration

For Clinician during DPA Scale Collection:

1. Patient De-identified ID Number: _____

2: Injury Category: Persistent, Sub-Acute, Acute, Healthy

3. Athlete Status: Competitive Athlete, Recreational Athlete, Occupational Athlete

4. Patient Age: _____

5. Patient Sex: _____

4. Current Sport (if applicable): _____

5. General Injury Location: Lower Extremity, Spine, Upper Extremity, Head/Face

6. Specific Injury Location (e.g., head/neck, shoulder/arm, etc.): _____

6. Type of Injury (e.g., sprain, strain, etc.): _____

7. Clinician Site (e.g., NCAA Division I, Outpatient Clinic): _____

Appendix C: Health Status Assessment Questionnaire Packet

Instructions: This questionnaire asks about your symptoms and ability to perform activities/tasks you want to complete each day. Please answer **each statement**, based on your condition in the past 24 hours, with the one response that best identifies your level of agreement with each statement. If you are unsure about a statement because you haven't experienced it in the past 24 hours, please make your best estimate of the response you think is the most accurate for you and your condition.

Likert Scale: 0: Not applicable/No Agreement; 1: Mild Agreement; 2: Moderate Agreement; 3: Strong Agreement 4: Complete Agreement

Pain = an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage

Impairment = loss or abnormality of a physiological or anatomical nature attributable to an active condition.

Functional Limitation = limitation in performance at the level of the whole organism or person.

Disability = limitation in performance of socially defined roles and activities within a sociocultural and physical environment.

Quality of Life = Factors that affect the quality or goodness of life, including psychological and physical conditions.

Pain Characteristics Items (10):

1. My current pain is the worst pain I can imagine.
2. I am in constant pain.
3. At its worst, my pain is agonizing.
4. I experience severe pain throughout the day.
5. Even at its best, my pain is excruciating.
6. Activity makes my pain worse.
7. I experience pain even while at rest.
8. There is nothing I can do to reduce my pain.
9. Even small tasks make me uncomfortable due to the pain I experience.
10. My pain is debilitating.

Impairments Items (10):

1. I find it difficult to perform certain movements.

2. My injured area does not feel stable.
3. My flexibility has decreased due to my physical problems.
4. My injured area "gives out."
5. I have decreased range of motion due to my injury.
6. My strength has declined because of my physical problems.
7. I am less mobile because of my physical problems.
8. My physical endurance has decreased since my injury.
9. I have impaired motion.
10. I fatigue more quickly during activity.

Functional Limitations Items (12):

1. I am unable to maintain certain positions throughout the day.
2. My physical performance is impaired.
3. I am not able to complete daily physical tasks normally.
4. Moving quickly is challenging.
5. I have to alter my normal technique to complete my activities.
6. I find it difficult to change directions during physical activity.
7. I am not able to reach for certain items.
8. I have difficulty carrying items.
9. My injury makes it difficult to stay physically fit.
10. I feel less coordinated as a result of my injury.
11. My agility is decreased.
12. I have decreased balance.

Disability Items (10):

1. I can't participate in my preferred physical activities.
2. It takes me more time to complete daily activities.
3. Regular physical activity isn't possible right now.
4. I don't have the stamina to complete normal activities.
5. I avoid activities I think will make my physical problem worse.

6. Tying my shoes is difficult to do.
7. Completing personal hygiene tasks (e.g., brushing your teeth) is challenging.
8. I have to limit my effort when completing daily activities because of my injury.
9. My injury makes it difficult to sleep through the night.
10. My injury impacts what activities I choose to do each day.

Quality of Life (Well-Being) Items (11):

1. I have decreased energy throughout the day.
2. My physical problem has led to altered relationships with people.
3. I am frustrated because of my physical problem.
4. I find it difficult to maintain a positive outlook.
5. I feel increased daily stress/anxiety.
6. In general, I don't enjoy all of the things I used to.
7. I find myself worrying a lot more than I did preinjury.
8. I feel more uncertainty in my life because of my injury.
9. My mood fluctuates more because of my physical problems.
10. I have decrease self-confidence since my injury occurred.
11. I am afraid I will reinjure myself with activity.

Quality of Life Scale

Please read each item and circle the number that best describes how satisfied you are at this time. Please answer each item even if you do not currently participate in an activity or have a relationship. You can be satisfied or dissatisfied with not doing the activity or having the relationship (e.g., you may be satisfied with not having children).

	Delighted	Pleased	Mostly Satisfied	Mixed	Mostly Dissatisfied	Unhappy	Terrible
Material comforts of home, food, conveniences, financial security…..	7	6	5	4	3	2	1
Health - being physically fit and vigorous….	7	6	5	4	3	2	1
Relationships with parents, siblings & other relatives- communicating, visiting, helping….	7	6	5	4	3	2	1
Having and rearing children….	7	6	5	4	3	2	1
Close relationships with spouse or significant other……	7	6	5	4	3	2	1
Close friends….	7	6	5	4	3	2	1
Helping and encouraging others, volunteering, giving advice…..	7	6	5	4	3	2	1
Participating in organizations and public affairs…..	7	6	5	4	3	2	1
Learning- attending school, improving understanding, getting additional knowledge……	7	6	5	4	3	2	1
Understanding yourself - knowing your assets and limitations - knowing what life is about……	7	6	5	4	3	2	1
Work - job or in home…..	7	6	5	4	3	2	1
Expressing yourself creatively…..	7	6	5	4	3	2	1
Socializing - meeting other people, doing things, parties, etc……	7	6	5	4	3	2	1
Reading, listening to music, or observing entertainment…..	7	6	5	4	3	2	1
Participating in active recreation…..	7	6	5	4	3	2	1
Independence, doing for yourself…..	7	6	5	4	3	2	1

Numeric Pain Rating Scale, Patient Specific Functional Scale, and Global Rating of Change

Numeric Pain Rating Scale

Please indicate the intensity of your current, best, and worst pain levels over the past 24 hours on a scale of 0 (no pain) to 10 (worst pain Imaginable).

Current Pain Rating: _____ Best Pain Rating: _____ Worst Pain Rating: _____

Patient Specific Functional Scale

Please indicate your ability to perform an important activity that you are unable to do or are having difficulty with as a result of your injury/problem. Please rate your ability on a scale of 0 (unable to perform activity) to 10 (able to perform activity at the same level as before injury or problem).

Functional Activity Rating: _____ Activity Selected: _____

Global Rating of Change Scale

With respect to your injury/problem, how would you describe yourself now compared to immediately after your first noticed the injury/problem (check only one):

- ☐ A very great deal worse (-7)
- ☐ A great deal worse (-6)
- ☐ Quite a bit worse (-5)
- ☐ Moderately worse (-4)
- ☐ Somewhat worse (-3)
- ☐ A little bit worse (-2)
- ☐ A tiny bit worse (-1)
- ☐ Unchanged (0)
- ☐ A tiny bit better (1)
- ☐ A little bit better (2)
- ☐ Somewhat better (3)
- ☐ Moderately better (4)
- ☐ Quite a bit better (5)
- ☐ A great deal better (6)

- A very great deal better (7)

Demographic Items

For Participant:

1) How long have you been experiencing your health condition/pain/injury?

- ☐ Less than 24 hours
- ☐ 24-72 hours
- ☐ 3 days to 1 week
- ☐ 1 to 4 weeks
- ☐ 1 to 6 months
- ☐ 6 months to 1 year
- ☐ More than 1 year

2) How would you describe your current physical activity level (Baseline activity refers to the light-intensity activities of daily life, such as standing, walking slowly, and lifting lightweight objects. Moderate activity includes activities such as brisk walking, yoga, and lifting weights.)?

- ☐ Inactive: No activity beyond baseline activity.
- ☐ Low: Activity beyond baseline, but fewer than 150 minutes of moderate intensity exercise per week.
- ☐ Medium: 150 to 300 minutes of moderate intensity activity per week.
- ☐ High: More than 300 minutes of moderate intensity activity per week.

3) What is your self-identified sex?

- ☐ Male
- ☐ Female
- ☐ Other

4) What is your age (in years)? _____

5) What is your ethnicity?

- ☐ Caucasian/White
- ☐ African American
- ☐ Hispanic
- ☐ Asian/Pacific Islander

- Other _____

6) What is the highest education level you have completed?

- High School or GED
- Some College
- Associate's Degree
- Bachelor's Degree
- Master's Degree
- Doctorate Degree (PhD, EdD, etc.)
- Other: _____

For Clinician:

1. Patient De-identified ID Number: _____

2: Injury Category: Persistent, Sub-Acute, Acute, Healthy

3. Athlete Status: Competitive Athlete, Recreational Athlete, Occupational Athlete, Activities of Daily Living

4. Current Sport (if applicable): _____

5. General Injury Location: Lower Extremity, Spine, Upper Extremity, Head/Face

6. Specific Injury Location (e.g., head/neck, shoulder/arm, etc.): _____

6. Type of Injury (e.g., sprain, strain, etc.): _____

7. Clinician Site (e.g., NCAA Division I, Outpatient Clinic): _____