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# Comparing the Primary Concerns of Injured Collegiate-Athletes to the Content of Patient-Reported Outcome Measures.


## Abstract

**Context:** Patient-reported outcome measures(PROMs) have been endorsed for providing patient-centered care. However, PROMs must represent their target populations.

**Objective:** Identify the primary concerns of collegiate-athletes experiencing injury and compare those to the content of established PROMs.

**Design:** Cross-Sectional

**Setting:** Collegiate athletic training facilities

**Patients or Other Participants:** Collegiate athletes experiencing injury(n=149).

**Main Outcome Measures:** Open-ended response to the Measure Yourself Medical Outcome Profile(MYMOP-2) were used to identify primary concerns, which were linked to International Classification of Functioning, Disability and Health(ICF) taxonomy codes. Items of the Patient-Reported Outcomes Measurement Information System(PROMIS®), modified Disablement of the Physically Active Scale(mDPAS), Lower Extremity Functional Scale(LEFS), Knee injury and Osteoarthritis Outcome Score(KOOS), International Knee Documentation Committee Subjective Knee Form(IKDC), the Foot and Ankle Ability Measure (FAAM), Disablement of the Arm, Shoulder, and Hand(DASH), Functional Arm Scale for Throwers(FAST), and Kerlan-Jobe Orthopaedic Clinic questionnaire(KJOC) were linked to ICF codes. Chi-square single-sample goodness-of-fit tests examined if 70% of content was shared between PROM and participant-generated codes.

**Results:** Participant-generated concerns were primarily related to sport-participation(16%) and pain(23%). Chi-square tests showed that the LEFS and FAAM presented significant content differences with common participant-generated lower extremity responses at all levels. The PROMIS®, DASH, mDPAS, KOOS, IKDC, FAST, and KJOC did not have significant content differences for level 2 codes; however, significant differences were present for level 3 analyses except for the KOOS and IKDC.($p<0.001$). All measures except the IKDC contained significant superfluous content($p<0.05$).

**Conclusions:** The presence of significant content differences supports clinician perceived barriers regarding relevance of established PROMs. However, the IKDC was observed to be a relevant and efficient PROM for evaluating the primary concerns of collegiate-athletes experiencing lower extremity injury. Clinicians should consider utilizing patient-generated measures to support coverage of patient-specific concerns in care.


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**Key Words:** patient-centered care, patient reported outcome measures, disablement, health-related quality of life

**Key Points:**

-Pain and sport participation were the primary concerns of participants with limited variation based on injury location or classification.

-A large amount of extraneous and unrelated content was present among the commonly used established PROMs

- Only the IKDC maintained coverage of participant-generated concerns when analyzed at both ICF levels 2 and 3 and did not demonstrate a significant amount of superfluous content.

## Introduction:

Patient-reported outcome measures **(**PROMs) are defined as instruments patients complete that provide information about the effect of their health condition or injury on their health status or health-related quality of life(HRQOL) and that highlight the patient perspective.[1–3] Their utilization is intended to give the clinician a greater understanding of the patient's physical and psychosocial response to treatment.[1,3] This improved clarity is thought to result in a more educated and engaged patient, a more individualized treatment plan, an improved patient-clinician relationship, and therefore, an improved treatment outcome.[1–5] Despite these constructs supporting PROMs, traditional clinical measures(e.g. strength measures) and clinician experience remain as primary drivers of clinical decision making.[2–4]

Dependence upon disease and clinician-oriented measures may be linked to athletic trainers' perceptions that many PROMs are not relevant to their patient population.[2,5,6] This may be reality as many PROMs reportedly being used most commonly by athletic trainers(i.e. Lower Extremity Functional Scale(LEFS), Disability of the Arm Shoulder Hand Scale(DASH))[6–8] were designed with lower-demand populations and may not be ideal in a high-demand athletic population. Additionally, time to complete and analyze PROMs has also been documented as a barrier to PROM implementation.[2,5,9] To optimize the utility of PROMs in traditional athletic training settings, PROMs must be both relevant, by addressing the primary concerns of athletes experiencing injury, and efficient, by having limited content that is not related to those primary concerns.

The International Classification of Function, Disability, and Health(ICF) framework, developed by the World Health Organization(WHO), intends to provide a standard language to serve as a reference for describing and/or comparing health states.[10–12] Rather than focusing on a diagnosis or condition, the ICF aims to emphasize experience and changes in functional ability, encouraging recognition of the patient's perception and individualized response to their treatment and/or condition.[10,12–14] Common PROMs have previously been analyzed to identify which ICF domains (health condition, body structure and function, activity, participation, environmental and personal factors)[6]; however, neither PROM

content nor self-identified patient concerns have been analyzed and compared utilizing the full ICF coding taxonomy. Therefore, the ICF provides an ideal framework by which to classify patient primary concerns and the content covered within commonly used PROMs.[11,12,14,15]

The primary aims of this study were to utilize the ICF framework to identify the primary concerns of collegiate athletes experiencing an injury, to describe if these primary concerns vary based on phase of injury or injury region, and to determine if these primary concerns are sufficiently and efficiently represented in the following established PROMs; the Patient-Reported Outcomes Measurement Information System Global Health Scale version 1.2(PROMIS®), modified Disablement of the Physically Active Scale(mDPAS), LEFS, Knee injury and Osteoarthritis Outcome Score(KOOS), International Knee Documentation Committee Subjective Knee Form(IKDC), Foot and Ankle Ability Measure (FAAM - including both the activities of daily living and sports subscales), DASH, Functional Arm Scale for Throwers(FAST), and Kerlan-Jobe Orthopaedic Clinic questionnaire(KJOC). We hypothesized that 1)differences in primary concerns would exist among participants in an acute, subacute, or chronic phase of injury, 2)that the PROMIS®, and those region-specific PROMs reported as being most commonly used by athletic trainers for lower extremity injuries(LEFS) or upper extremity injuries(DASH)[6–8,16] would fail to contain relevant content and efficiently address the primary concerns of collegiate athletes experiencing injury, and 3)that those PROMs designed for use with highly active populations(mDPAS, KOOS, IKDC, FAST, and KJOC)[17–22] would contain relevant content and efficiently address the most commonly occurring participant-generated ICF codes.

## Methods

This observational cross-sectional study used the Measure Yourself Medical Outcome Profile(MYMOP-2)[23] to identify items most relevant to injured collegiate student-athletes and to compare those symptoms and activities to those represented on established PROMs. This study was approved by the XXXXXXX Institutional Review Board.

*Participants*

Participants included a convenience sample of student-athletes experiencing an injury at 4 collegiate institutions in two states in the mid-Atlantic region of the United States, including NCAA division I (Football Bowl Subdivision), division II (two schools), and division III schools. Any student-athlete receiving care for any injury over the age of 18, fluent in English, who was identified by their treating athletic trainer as having modified or restricted their sport participation, in games or practices, due to injury and was willing to sign a HIPAA release for their athletic trainer to share information regarding their injury was eligible to participate. Participants were not enrolled more than once for a given body region.

*Procedures*

Participants were asked to complete the MYMOP-2, and a demographics form identifying their treating athletic trainer, age, year in school, sport, date of injury, and location/description of injury. Data collection occurred one time per participant, per region of injury. At the time of enrollment, the treating athletic trainers were asked their assessment of the injury phase of each participant (acute, subacute, chronic).

*ICF Linking*

Each participant's responses to the MYMOP-2 and each item on the included established PROMs were linked to an ICF code via the established ICF linking rules described by Cieza et al.[11] In brief, 3 raters reviewed all MYMOP-2 responses independently and assigned a code in the deepest relevant level of the ICF taxonomy. The raters included two licensed athletic trainers and an individual licensed as both an athletic trainer and a physical therapist. Prior to rating responses, reviewers underwent additional training in the ICF Model via the ICF e-learning tool; reviewed recommendations from literature outlining and examining the ICF model, the World Health Organization ICF Manuals, and previously conducted studies with similar methodologies; and completed pilot linking sessions and discussed and

compared results.[10–12,14,15] The ICF model is a flexible, multi-tiered, hierarchical framework split into two parts. Part one contains the domains of body functions(b), body structures(s), and activity and participation(d). Part two contains contextual factors called environmental factors(e) and personal factors(pf). Each contains up to 4 levels. The first level is referred to as the chapter, and each chapter contains up to three nested levels(second-level, third-level, fourth-level) increasing in specificity[10,11] This hierarchical structure was used to link each patient concern to an ICF code, guided by the ICF browser definitions, inclusions, and exclusions available at the second and third levels.[24] For example, if a response states "pitching a baseball", it would be coded as "d4454 Throwing. The definition for this code states: "Using fingers, hands and arms to lift something and propel it with some force through the air, such as when tossing a ball." The process to arrive at this code is as follows:

- d Activities and Participation - *Domain*
  - d4 Mobility - *Chapter*
    - d430-d449 Lifting and carrying objects – *Component*
      - d445 Hand and arm use – *Level 2*
        - d4454 Throwing - *Level 3*

Raters were permitted to assign multiple ICF codes to a single MYMOP-2 response to fully represent the participant's concern. For example, if a participant listed "pain when I run", separate codes were assigned to represent pain(b280) and running(d4552). Similarly, multiple codes could be assigned as needed for PROM items. Once individual rating was complete, raters met to review identified codes. When disagreement existed between raters, the code(s) was discussed among raters until a consensus was reached. Fleiss kappa statistics indicated moderate-very good (0.433-0.846) interrater agreement for coding of MYMOP-2 responses at both levels 2 and 3 prior to the consensus process that was used to

arrive at final codes for each participant response and each PROM item.[25] The linking process resulted in a final single set of agreed upon codes for each participant response and PROM item. Throughout the review process, previously agreed upon codes were reviewed to ensure consistency.

*Instrumentation*

The MYMOP-2 is a patient-generated outcome measure. It asks the patient to "Choose one or two symptoms (physical or mental) that bother you the most" and "…choose one activity (physical, social, or mental) that is important to you, and that your problem makes difficult or prevents you from doing".[23] The MYMOP-2 has been examined in various acute and chronic settings and has been reported to detect changes in several populations, including military[26–28]; therefore, its application to an athletic population is not unreasonable. Because it is an open-ended tool, it allows for a patient-centered evaluation of symptoms across multiple phases of injury/disease/condition, and across multiple pathologies.[26–28] Although not completed by participants, all possible items of the investigated PROMs were linked to ICF codes. These instruments were selected because the DASH and LEFS have been identified as the most commonly used upper and lower extremity specific PROMs used by practicing athletic trainers[6] and the PROMIS® has widely been proposed as a generic HRQOL instrument that can be utilized across populations.[16] The mDPAS, FAST, KJOC, IKDC, KOOS, and FAAM (including sports subscale) were included due to their utilization in athletic populations. The mDPAS is a general HRQOL PROM designed to evaluate both mental and physical components of disability in physically active populations.[18] The FAST is an upper extremity, region-specific PROM targeting overhead throwing athletes experiencing multiple domains of disablement.[20] The KJOC is region-specific PROM which evaluates function and performance for overhead athletes experiencing upper extremity injuries.[17] The IKDC is a region-specific measure of symptoms, function, and sports activity for those experiencing knee-related problems. The KOOS is a knee-specific PROM which assesses pain, symptoms, activities of daily living, sport and recreation function, and knee-related quality of life.[19] Finally, the FAAM is a region-specific

PROM assessing concerns related to ADL's and sport specific concerns for those experiencing injuries of the lower leg, ankle, and foot.[22]

**Statistical Analysis**

To reduce the data to those codes representing the items most important to the majority of participants, frequency counts were performed to identify those codes cumulatively representing 80% of patient-generated ICF codes overall, by phase of injury, and for upper and lower extremities. Those codes in the cumulative 80% were considered the primary concerns/codes and were used for our analyses. Primary concerns were examined by phase of injury and region for substantial content differences. To examine varying levels of specificity, codes were examined at both at level 2 and 3 of the ICF taxonomy. To examine the *relevance* of the established PROMs, we determined that a minimum of 70% of the primary participant-generated codes must be encompassed in a PROM if it was to be considered representative of patient concerns(i.e., were 70% of the cumulative 80% of generated codes addressed by the established PROM). The a priori 70% threshold was based on established logic that determines if a special test is considered clinically useful[29] Additionally, an approximately 70% threshold has also been applied in recent Delphi analyses examining both return-to-sport decisions(70%)[30] and PROM content validity among both researchers and practicing clinicians(67%).[31] Collectively, this past use of a 70% threshold, supports its application as an established and acceptable standard for clinical decision making and PROM related research. To evaluate the *efficiency* of commonly used PROMs and determine the amount of extraneous content present, we examined if 70% of the established PROM codes were among the primary participant-generated codes. Chi-square one-sample goodness of fit tests were performed to test the a priori selected 70% thresholds. If less than 70% ($p<0.05$) of the relevant most common participant-generated codes were represented in the established PROMs, they were considered to be non-representative of the participant-generated primary concerns. If less than 70% of the established PROM-generated codes were encompassed by the most common participant-generated codes, the PROM was considered to have a significant amount of extraneous content.

## Results

Participants included 149 collegiate athletes(74 females, 75 males) (age: 19.6 ± 1.3), and represented 150 injuries. Lower extremity injuries represented 77% of our sample and upper extremity injuries represented 15%. Back, head, and neck injuries represented 6%, with 2% of region of injury reports missing. Most participants were classified by their treating athletic trainers as being in the acute phase of injury at time of collection(50%), followed by chronic(35%), subacute(7%), and missing(7%). Table 1 contains participant sport distributions. Forty participants chose to only list as single symptom on the MYMOP-2 in response to the question prompting to list 1 or 2 symptoms. The final set of agreed upon ICF codes for participant responses yielded 594 total codes, containing 90 unique codes. The majority were represented in the Body Function(56%) and Activities and Participation(41%) domains. The Body Structure domain represented 1%, and 2% were not codable(ns). Code frequency distributions for the commonly occurring codes overall are displayed in Tables 2 and 3. There was substantial overlap in code frequency distributions by extremity and phase of injury and this information is available in the supplemental materials. Frequency counts of participant-generated ICF codes overall, by extremity, and by phase of injury are represented in Table 4. A summary of shared codes between the primary concerns of participants and established PROMs can be seen in Table 5.

### *Global PROMs*

Comparisons between all participant-generated common codes and the PROMIS® were mixed, with PROMIS® content being observed to be relevant at level 2($p=0.061$), but falling significantly below the 70% threshold for relevance at level 3($p<0.001$). In contrast, the PROMIS® was observed to efficiently evaluate primary concerns at level 3($p=0.081$), but not at level 2 ($p=0.011$). When all participant-generated codes were compared to codes generated from the mDPAS, level 2 codes appeared relevant to the primary concerns of participants($p=0.506$). However, this relevance was lost for level 3

codes(p=0.004). Additionally, based on codes generated from the mDPAS, it was not efficient in evaluating the primary concerns of injured student athletes at either level($p<0.001$; $p<0.001$).

*Lower Extremity PROMs*

Among participants with lower extremity injuries, analyses of level 2 and level 3 codes revealed that the LEFS was not relevant to the primary concerns of participants($p<0.001$). Likewise, the LEFS was not efficient in evaluating participant concerns at either level 2 or level 3($p<0.001$). Comparison of participant-generated concerns for lower extremity injuries to the IKDC indicated relevance for both level 2 and 3 codes($p=0.801$; $p=0.143$). Additionally, the IKDC was efficient in evaluating primary concerns at both level 2($p=0.159$) and 3 ($p=0.078$). Comparison of codes for those experiencing lower extremity injuries to the KOOS demonstrated relevancy at both level 2($p=0.705$) and 3($p=0.143$) analyses. However, the KOOS was not efficient at either level($p=0.003$; $p<0.001$). Comparison of participant-generated codes to the FAAM revealed a lack of relevance at both level 2($p=0.001$) and level 3($p=0.001$) analyses. Similarly, the FAAM was not observed to be efficient at either level($p=0.001$; $p<0.001$).

*Upper Extremity PROMs*

Among those with upper extremity injuries, level 2 ICF code analysis revealed 7 of the 8 primary codes(88%) were represented in the DASH, indicating PROM relevance($p=0.28$). However, this relevance was not maintained at level 3($p<0.001$). Furthermore, in examining ICF codes generated from the DASH, it did not efficiently evaluate the primary concerns of participants at either level 2 or level 3($p<0.001$). The FAST was observed to be relevant in capturing participant concerns at level 2($p=0.758$), but not level 3($p=0.006$). Additionally, the FAST was observed to not be efficient at either level 2($p=0.027$) or level 3($p<0.001$). Comparison of participant codes for upper extremity injuries to KJOC-generated codes at level 2 supported KJOC relevance and efficiency($p=0.758$; $p=0.076$). However,

analysis of the more specific level 3 ICF codes did not support continuation of this relevance or efficiency($p=0.006$, $p<0.001$).

## Discussion

The objective of this study was to identify the primary concerns held by injured collegiate athletes and compare those concerns, as measured by the MYMOP-2, to the content of established PROMs. Sensations of pain and sport participation were the most commonly reported participant concerns, representing 39% of all participant concerns. Codes related to running/moving around, emotional functions (stress, confidence, frustration, anxiety, etc.), mobility(range of motion), swelling, and strength/muscle power were also consistently among the primary participant concerns overall. It is important to note that regardless of level of analysis (level 2 or 3 of the ICF taxonomy) or region of injury, "not codable" was consistently present as well. These primary areas of concerns were consistent with previous works linking participant concerns to ICF codes.[15] Pain, sport, and movement functions were among the most common concerns reported across all phases of injury. There were notably fewer participants in the subacute and chronic phases; however, their primary concerns were consistent with those in the acute phase, regardless of region of injury. These results may suggest that use of the same PROM may be appropriate throughout the rehabilitation process. However, it is critical that selected PROMs reflect the patient's concerns and be sensitive enough to detect change at varying stages of rehabilitation.

### *Global PROMs*

Both the PROMIS® and mDPAS are global PROMs intended to evaluate health related quality of life; however, the mDPAS was specifically developed for use with physically active populations. For both global measures the percent agreement between PROMs content and primary concerns at ICF level 2 were not statistically different from 70%. However, the mDPAS addressed more level 2 participant

concerns (62%) than the PROMIS® (46%). This greater representation within the mDPAS is likely because it was specifically developed for active populations. Significant content differences were present at level 3 for both measures. Uniquely for the PROMIS®, we observed significant superfluous content at level 2, but not level 3. These results indicate that both measures have potential utility in assessing more general level 2 concerns (e.g., muscle power functions, recreation and leisure, hand and arm use)[24] but not more specific and descriptive level 3 concerns (e.g., sports, throwing, catching, running, jumping)[24]. However, the PROMIS® was observed to be the more efficient instrument, with 40-50% of its content aligning with the primary concerns of patients. These results are counter to our hypothesis that PROMS designed for highly active individuals would be more relevant and efficient than PROMS designed for use with the general population. A previous analysis of the mDPAS reported a strong focus on physiological domains of health and the activity domain of the ICF, with less representation in psychological or participation areas.[6] Conversely, our participants concerns aligned more with their lived experiences, as exemplified through consistent reports of emotional functions and sport participation concerns. These differences in primary focus may explain the lack of alignment at the specific level 3 analysis.

*Lower Extremity PROMs*

The LEFS and FAAM content failed to represent the primary concerns of participants as measured by the MYMOP-2. Perhaps most notable is that pain, the most commonly occurring participant concern, was not represented in the LEFS or FAAM content. Our results also indicated that the LEFS and FAAM contain a large amount of extraneous content. It should be noted that we evaluated the full FAAM and the sport specific subscale, and the results could differ if only the sport specific subscale of the FAAM were examined. However, these results are consistent with previously reported concerns regarding the FAAM's ability to address concerns of an injured athletic population.[32] Lam et al. previously classified both these instruments as being heavily focused on physical health and almost exclusively on the activity domain of the ICF.[6] Given the large number of our patient generated responses that were pain,

sport performance and emotional function related, it is not surprising that the LEFS and FAAM appear to have limited relevance to the primary concerns of injured collegiate athletes.

The IKDC and KOOS demonstrated the strongest agreement between content and the primary concerns of collegiate athletes experiencing lower extremity injury as assessed by the MYMOP-2. Both PROMs adequately represented the concerns of participants at both ICF level 2 and 3. These results support the hypothesis that these instruments, designed to address a wide range of activity levels, accurately represent both broad and specific concerns of participants. Furthermore, the percentage of ICF codes generated from the IKDC at level 2(53%, 8/15)) and 3(52%, 11/21) were not significantly different than the 70% criterion value, supporting that the IKDC is the most efficient of the investigated PROMs at evaluating the concerns of participants experiencing lower extremity injuries. Conversely, the KOOS presented significant extraneous content at both level 2 and 3, suggesting that the IKDC is preferable for use with highly active lower-extremity patients. The relevance and efficiency of the IKDC may be a product of its development. The IKDC was specifically designed to represent knee impairment related symptoms and limitations in function and sports activity.[21] Furthermore, the IKDC was iteratively tested with large samples of patients representing the target population and revised through a formal item reduction process.[21] The use of patient engagement in PROM development is proposed to improve relevance to the patient.[33] The KOOS similarly engaged patients in development, but developers purposefully included a subgroup specific to osteoarthritis.[19] It is possible that items relevant to patients with osteoarthritis may not align with the primary concerns of college-age participants in the current study, resulting in the lack of efficiency observed for the KOOS. This observation highlights a challenge of PROM selection and development. An instrument that is broadly generalizable may lack specificity and/or efficiency for a target population. While generalizability can be beneficial, a lack of perceived relevance by both clinicians and patients can be a barrier to PROMs adoption.[2,6,9] Overall, the IKDC was observed to be the most relevant and efficient PROM included in this analysis for addressing the primary concerns of student-athletes experiencing injury.

*Upper Extremity PROMs*

Contrary to our hypothesis, for the upper extremity, relevance to patient concerns were similar among the more general DASH and the higher activity focused FAST and KJOC. In support of our hypothesis, a trend of greater efficiency with those PROMs designed for highly active individuals, particularly the KJOC, was observed. All of the investigated upper extremity PROMs were relevant to patient concerns at level 2, but none were relevant at level 3. Therefore, we conclude that the DASH, FAST, and KJOC may be sensitive to the general concerns of participants but are not specific to the precise concerns of participants as assessed by the MYMOP-2. When evaluating PROM efficiency, only the KJOC at level 2 achieved efficiency with the DASH and FAST containing a significant amount of superfluous codes at both level 2 and 3 analyses. Previous analysis of the DASH determined that physiological, social, physical and psychological domains of health and the ICF domains of body structure and function, activity, and participation are all encompassed within the DASH.[6] This broad spectrum of health assessment likely contributed to the DASH addressing the highest percentage of participant concerns (80%), but also having a significant amount of extraneous material (73-85%). Both the FAST[20] and KJOC[17] were specifically developed with input from baseball and softball players, while our sample included those with upper extremity injuries from a variety of sports in addition to baseball and softball. The heterogeneity of our upper extremity sample may have contributed to the limited agreement between FAST and KJOC content and the primary concerns of our participants. In particular, this may explain why the broad concerns of level 2 were adequately addressed, but not the more specific level 3 concerns.

*PROM Content Limitations and Recommendations*

The content differences we observed between the evaluated PROMs and patient concerns as assessed by the MYMOP-2 is consistent with the perceived barriers and concerns identified by surveyed

clinicians.[2,5] It is also consistent with the previously reported tendency of PROMs to focus on clinician-oriented items, such as strength and range of motion, but lack in coverage of items of importance to patients, such as psychological, and social factors.[34] Not only do the majority of measures examined in this study only superficially represent the patient-generated concerns, they also contain a large amount of extraneous content. The presence of this extraneous content places additional demands on the patient and adds unnecessary time for clinicians to score PROMs. Furthermore, perceived barriers and concerns regarding PROM implementation may be being reinforced by the PROMs being utilized in practice.[5] Lam et al, reported the FAAM, LEFS, and DASH as the most common extremity measures being utilized by athletic trainers using PROMs for clinical practice.[9] None of these instruments were both relevant and efficient for evaluating the primary concerns of student-athletes experiencing injury. To combat this, we believe that development and utilization of PROMs targeting athletic populations, informed by both clinician and patient concerns, is essential to facilitate the clinical utility of PROMs in athletic training.[1] PROMs must be purposefully developed and selected with their end use in mind, and clinicians and researchers should not assume that a form is useful or appropriate simply because it has frequently been used in the past.

Additionally, we believe the presented results support the use of a patient-generated outcome measure, such as the MYMOP-2 or the patient-specific functional scale.[35] Such open ended measures may be beneficial as patient concerns are highly individualistic(Table 4) and frequently included items beyond standard ICF codes as evidenced by the consistent presence of "not codable" items in our results. Patient-generated items may be particularly useful if paired with the commonly used[9], single-item, Numeric Pain Rating Scale[36] given that nearly 30% of the identified codes were related to "sensation of pain". Similarly, it may be relevant to consider utilizing psychosocial measures if a PROM only addresses physical impairments or limitations. Finally, the limited ability of the investigated PROMs to address concerns at the more specific level 3 of the ICF highlights the importance of using PROMs not only as an

end point, but as another piece of the clinical evaluation that can prompt follow-up questions and lead to deeper and more engaging conversations with patients regarding their health.[1]

*ICF Limitations*

For both participant responses and PROMs items, many of the final codes were those listed as "other specified or unspecified" or not codable. Coding language limitations were evident when individuals reported emotional experiences, or symptoms such as swelling. Concerns related to a level of function surpassing ADLs were also constrained by the existing ICF taxonomy. For example, while there are codes for concerns such as "sport", "swimming", and "lifting", the definitions provided by the ICF do not necessarily encompass the participants' concerns. For example, the ICF code for lifting is defined as "raising up an object in order to move it from a lower to a higher level, such as when lifting a glass from the table." While this definition can be applied to both lifting weights (frequently listed by our participants) or "lifting or carrying a shopping bag" (as stated on the DASH)[14], these tasks are not clinically equivalent. These limitations in ICF taxonomy potentially contributed to some of the overlap in content between PROM generated codes and the participant-generated codes.

These concerns regarding the inclusivity of the ICF taxonomy are not unique. Mitra and Shakespeare propose that a revised ICF model would need to consider an individual is able to participate in components of life deemed personally meaningful.[37] Our data confirm this need, especially related to functional and psychosocial concerns. Specifically, while there is a small set of codes related to handling stress, the inclusion criteria do not lend themselves towards experiences frequently described by participants, such as anxiety, confidence, or frustration. Therefore, raters linked these concerns to the 'emotional functions' component, defined as: *"Specific mental functions related to the feeling and affective components of the processes of the mind. Inclusions: functions of appropriateness of emotion, regulation and range of emotion; affect, sadness, happiness, love, fear, anger, hate, tension, anxiety, joy, sorrow; lability of emotion; flattening of affect."* However, this definition is more related to pathologic disorders, rather than emotional responses to injury/external stimuli. The frequency of emotional

experiences among participant concerns highlights the need for improved recognition and evaluation of patient emotional states throughout care.

*Study Limitations*

Data was collected from four collegiate campuses from 2019-2020 and was shortened due to the COVID-19 pandemic. Although it is assumed that the responses provided by participants are generalizable to other collegiate-athletes, further investigation is needed to verify this, particularly among individuals with upper extremity injuries due to our limited sample. For both participant-generated responses and PROM questions, we chose to link every component of a response/question. This generated multiple codes for most responses and questions. It is possible that if we were to link only the questions themselves, less extraneous content may be identified; however, common concerns might also be eliminated. Additionally, we chose to classify injuries by body region and did not separate them by individual joints. We also chose to operationally define the primary concerns as those cumulatively representing 80% of all patient-generated codes and used 70% content agreement as the threshold by which to evaluate PROMs for relevance and efficiency.

**Conclusions**

This study aimed to identify the primary concerns of collegiate athletes experiencing injuries and determine if those PROMs commonly used or recommended for use in athletic training adequately and efficiently encompass those primary concerns. These results validate concerns expressed by clinicians regarding PROM content, while also identifying the primary concerns of an athletic population as primarily pain and sport participation ability when assessed by the MYMOP-2. Most PROMs investigated, presented with notable differences in content compared to the primary concerns of participants, particularly at the more descriptive ICF level 3. Similarly, most PROMs analyzed revealed significant amounts of extraneous content. Our results indicate that of the investigated PROMs, the IKDC was the most relevant and efficient for collegiate athletes experiencing lower extremity injuries.

Additionally, the development or use of measures designed for highly active populations based upon the identified primary concerns participants may be beneficial as the primary codes were highly consistent (pain, sport, mobility/muscle function of involved limb, emotional functions/experiences) regardless of injury phase or location. Finally, there is need for improved, patient-centered evaluation of emotional experiences which were largely inadequately encapsulated by both the evaluated PROMs and the ICF taxonomy. Implementation of patient-generated evidence is imperative to facilitating successful well-rounded practice, as well as the AT research agenda surrounding PROMs. To continue to further these endeavors, future efforts must focus on developing and implementing PROMs targeting athletic populations with a focus on relevance and efficiency.

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Figures and Tables in order throughout document

**Table 1: Sport Distribution**

| Sport | Percent (n) | Cumulative Percent |
|---|---|---|
| Soccer | 30.67% (46) | 30.67% |
| Football | 16% (24) | 46.67% |
| Lacrosse | 11.33% (17) | 58.00% |
| Track and Field | 8.67% (13) | 66.67% |
| Volleyball | 6.67% (10) | 73.34% |
| Basketball | 6% (9) | 79.34% |
| Softball | 5.33% (8) | 84.67% |
| Baseball | 3.33% (5) | 88.00% |
| Cheerleading | 3.33% (5) | 91.33% |
| Cross Country | 2% (3) | 93.33% |
| Cycling | 1.33% (2) | 94.66% |
| Field Hockey | 1.33% (2) | 95.99% |
| Swimming | 1.33% (2) | 97.33% |
| Tennis | 1.33% (2) | 98.66% |
| Wrestling | 1.33% (2) | 100% |
| Total | 100% (150) | 100% |

**Table 2: Most Common Participant-Generated ICF Codes Overall (Level 2)**

| Code | Description | Percent (n) | Cumulative Percent |
|---|---|---|---|
| b280 | Sensation of pain | 22.73% (135) | 22.73% |
| d920 | Recreation and leisure | 15.63% (93) | 38.38% |
| d455 | Moving around | 10.23% (61) | 48.65% |
| b780 | Sensations related to muscles and movement functions | 7.57% (45) | 56.23% |
| b152 | Emotional functions | 5.38% (32) | 61.62% |
| d450 | Walking | 4.04% (24) | 65.66% |
| b289 | Sensation of pain, other specified and unspecified | 3.36% (20) | 69.02% |
| b798 | Movement functions, other specified and unspecified | 2.52% (15) | 71.55% |
| b710 | Mobility of joint functions | 2.02% (12) | 73.57% |
| b439 | Functions of the hematological and immunological systems, other specified and unspecified | 1.85% (11) | 75.42% |
| d445 | Hand and arm use | 1.68% (10) | 77.10% |
| ns | Not codable | 1.68% (10) | 78.79% |
| b199 | Mental functions, unspecified | 1.51% (9) | 80.30% |

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**Table 3: Most Common Participant-Generated ICF Codes Overall (Level 3)**

| Code | Description | Percent (n) | Cumulative Percent |
|---|---|---|---|
| b2801 | Pain in body part | 15.66% (93) | 15.66% |
| d9201 | Sport | 13.81% (82) | 29.46% |
| b280 | Sensation of pain | 6.91% (41) | 36.36% |
| b7808 | Sensations related to muscles and movement functions, unspecified | 6.23% (37) | 42.59% |
| d4552 | Running | 5.90% (35) | 48.48% |
| b1528 | Emotional functions, other specified | 3.87% (23) | 52.36% |
| d4509 | Walking, unspecified | 3.53% (21) | 55.89% |
| b289 | Sensation of pain, other specified and unspecified | 3.36% (20) | 59.26% |
| b798 | Neuromusculoskeletal and movement-related functions, other specified | 2.52% (15) | 61.78% |
| b439 | Functions of the hematological and immunological systems, other specified and unspecified | 1.85% (11) | 63.64% |
| d4558 | Moving around, other specified | 1.68% (10) | 65.32% |
| Ns | Not codable | 1.68% (10) | 67.00% |
| b1522 | Range of emotion | 1.51% (9) | 68.52% |
| b199 | Mental functions, unspecified | 1.51% (9) | 70.03% |
| d4553 | Jumping | 1.51% (9) | 71.55% |
| b7800 | Sensation of muscle stiffness | 1.34% (8) | 72.90% |
| d4300 | Lifting | 1.34% (8) | 74.24% |
| b298 | Sensory functions and pain, other specified | 1.17% (7) | 75.42% |
| b7100 | Mobility of a single joint | 1.17% (7) | 76.60% |
| b799 | Neuromusculoskeletal and movement-related functions, unspecified | 1.01% (6) | 77.61% |
| b1349 | Sleep functions, unspecified | 0.84% (5) | 78.45% |
| b7109 | Mobility of joint functions, unspecified | 0.84% (5) | 79.30% |
| d4551 | Climbing | 0.84% (5) | 80.13% |

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**Table 4: Number of ICF Codes Represented and not Represented Among Most Common Participant-Generated Responses**

| Level of Analysis | All | Upper | Lower | Acute | Subacute | Chronic |
|---|---|---|---|---|---|---|
| Level 2 Unique Codes | 58 | 20 | 51 | 48 | 14 | 36 |
| Level 3 Unique Codes | 90 | 26 | 73 | 75 | 20 | 54 |
| Top 80% Level 2 | 13 | 8 | 12 | 6 | 1 | 3 |
| Top 80% Level 3 | 23 | 12 | 20 | 10 | 1 | 4 |
| Codes not in top 80% Level 2 | 45 | 12 | 39 | 42 | 13 | 33 |
| Codes not in top 80% Level 3 | 67 | 14 | 53 | 65 | 19 | 50 |

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**Table 5: Summary of ICF Codes Shared by Most Common Participant Concerns and Established PROMS**

| Patient-Reported Outcome Measure (PROM) | Percentage of Most Common Concerns Addressed (codes addressed/total common concerns) | | P-value for test for 70% of Common Concerns | Percentage of PROM Content Representing Most Common Concerns (common codes/total codes represented) | | P Value for test for 70% of Content |
|---|---|---|---|---|---|---|
| *Patient-Reported Outcome Measures Information System Global Health Scale (PROMIS®)* | | | | | | |
| ICF Level 2 | 46%* | (6/13) | 0.061 | 40% | (6/15) | 0.011 |
| ICF Level 3 | 35% | (8/23) | <0.001 | 50% | (8/16) | 0.081* |
| *modified Disablement of the Physically Active Scale (mDPAS)* | | | | | | |
| ICF Level 2 | 62%* | (8/13) | 0.506 | 33% | (8/23) | <0.001 |
| ICF Level 3 | 43% | (10/23) | 0.004 | 23% | (10/43) | <0.001 |
| *Lower Extremity Functional Scale (LEFS)* | | | | | | |
| ICF Level 2 | 25% | (3/12) | <0.001 | 23% | (3/13) | <0.001 |
| ICF Level 3 | 25% | (5/20) | <0.001 | 21% | (5/24) | <0.001 |
| *International Knee Documentation Committee Subjective Knee Form (IKDC)* | | | | | | |
| ICF Level 2 | 66%* | (8/12) | 0.801 | 53%* | (8/15) | 0.159 |
| ICF Level 3 | 55%* | (11/20) | 0.143 | 52%* | (11/21) | 0.078 |
| *Knee injury and Osteoarthritis Outcome Score (KOOS)* | | | | | | |
| ICF Level 2 | 75%* | (9/12) | 0.705 | 41% | (9/22) | 0.003 |
| ICF Level 3 | 55%* | (11/20) | 0.143 | 28% | (11/39) | <0.001 |
| *Foot and Ankle Ability Measure (FAAM)* | | | | | | |
| ICF Level 2 | 25% | (3/12) | 0.001 | 21% | (3/14) | <0.001 |
| ICF Level 3 | 35% | (7/20) | 0.001 | 29% | (7/24) | <0.001 |
| *Disablement of the Arm, Shoulder, and Hand (DASH)* | | | | | | |
| ICF Level 2 | 88%* | (7/8) | 0.28 | 27% | (7/26) | <0.001 |
| ICF Level 3 | 42% | (5/12) | <0.001 | 15% | (5/33) | <0.001 |
| *Functional Arm Scale for Throwers (FAST)* | | | | | | |
| ICF Level 2 | 75%* | (6/8) | 0.758 | 43% | (6/14) | 0.027 |
| ICF Level 3 | 42% | (5/12) | 0.006 | 29% | (5/17) | <0.001 |
| *Kerlan-Jobe Orthopaedic Clinic questionnaire (KJOC)* | | | | | | |
| ICF Level 2 | 63%* | (5/8) | 0.758 | 45%* | (5/11) | 0.076 |
| ICF Level 3 | 33% | (4/12) | 0.006 | 27% | (4/15) | <0.001 |

**Shared content not significantly different from 70% (p>0.05)*

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552 **Comparing the primary concerns of injured athletes to patient-reported outcome measures**

553 **SUPPLEMENTAL MATERIALS**

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**Supplemental Table 1: Most Common Participant-Generated ICF Codes for Upper Extremity Injuries Level 2**

| Code | Description | Percent (n) | Cumulative percent |
|---|---|---|---|
| b280 | Sensation of pain | 29.87% (23) | 29.87% |
| d920 | Recreation and leisure | 18.18% (14) | 48.05% |
| d445 | Hand and arm use | 10.38% (8) | 58.44% |
| b780 | Sensations related to muscles and movement functions | 5.19% (4) | 63.64% |
| d430 | Lifting and carrying objects | 5.19% (4) | 68.83% |
| b289 | Sensation of pain, other specified and unspecified | 3.89% (3) | 72.73% |
| b710 | Mobility of joint functions | 3.89% (3) | 76.62% |
| ns | Not Codable | 3.89% (3) | 80.52% |

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**Supplemental Table 2: Most Common Participant-Generated ICF Codes for Upper Extremity Injuries Level 3**

| Code | Description | Percent (n) | Cumulative percent |
|---|---|---|---|
| b2801 | Pain in body part | 22.08% (17) | 22.08% |
| d9201 | Sport | 18.18% (14) | 40.26% |
| b280 | Sensation of pain | 6.49% (5) | 46.75% |
| b7808 | Sensations related to muscles and movement functions, other specified | 5.19% (4) | 51.95% |
| d4300 | Lifting | 5.19% (4) | 57.14% |
| d4454 | Throwing | 5.19% (4) | 62.34% |
| b289 | Sensation of pain, other specified and unspecified | 3.90% (3) | 66.23% |
| d4458 | Hand and arm use, other specified | 3.90% (3) | 70.13% |
| ns | Not codable | 3.90% (3) | 74.03% |
| b1349 | Sleep functions, unspecified | 2.60% (2) | 76.62% |
| b7109 | Mobility of joint functions, unspecified | 2.60% (2) | 79.22% |
| b7300 | Power of isolated muscles and muscle groups | 2.60% (2) | 81.82% |

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**Supplemental Table 3: Most Common Participant-Generated ICF Codes for Lower Extremity Injuries Level 2**

| Code | Description | Percent (n) | Cumulative percent |
|---|---|---|---|
| b280 | Sensation of pain | 21.61% (102) | 21.61% |
| d920 | Recreation and leisure | 14.61% (69) | 36.23% |
| d455 | Moving around | 11.86% (56) | 48.09% |
| b780 | Sensations related to muscles and movement functions | 8.47% (40) | 56.57% |
| b152 | Emotional functions | 6.14% (29) | 62.71% |
| d450 | Walking | 4.87% (23) | 67.58% |
| b289 | Sensation of pain, other specified and unspecified | 3.60% (17) | 71.19% |
| b798 | Neuromusculoskeletal and movement-related functions, other specified | 2.75% (13) | 73.94% |
| b439 | Functions of the hematological and immunological systems, other specified and unspecified | 2.11% (10) | 76.06% |
| b199 | Mental functions, unspecified | 1.90% (9) | 77.97% |
| b710 | Mobility of joint functions | 1.90% (9) | 79.87% |
| ns | Not codable | 1.48% (7) | 81.36% |

**Supplemental Table 4: Most Common Participant-Generated ICF Codes for Lower Extremity Injuries Level 3**

| Code | Description | Percent (n) | Cumulative percent |
|---|---|---|---|
| b2801 | Pain in body part | 14.00% (66) | 14.00% |
| d9201 | Sport | 12.70% (60) | 26.70% |
| b280 | Sensation of pain | 7.4% (35) | 34.10% |
| d4552 | Running | 7.00% (33) | 41.10% |
| b7808 | Sensations related to muscles and movement functions, other specified | 6.80% (36) | 47.90% |
| b1528 | Emotional functions, other specified | 4.20% (20) | 52.10% |
| d4509 | Walking, unspecified | 4.20% (20) | 56.40% |
| b289 | Sensation of pain, other specified and unspecified | 3.60% (17) | 60.00% |
| b798 | Neuromusculoskeletal and movement-related functions, other specified | 2.80% (13) | 62.70% |
| b439 | Functions of the hematological and immunological systems, other specified and unspecified | 2.12% (10) | 64.80% |
| b1522 | Range of emotion | 1.91% (9) | 66.70% |
| b199 | Mental functions, unspecified | 1.91% (9) | 68.60% |
| d4553 | Jumping | 1.91% (9) | 70.60% |
| b7800 | Sensation of muscle stiffness | 1.69% (8) | 72.20% |
| d4558 | Moving around, other specified | 1.69% (8) | 73.90% |
| ns | Not codable | 1.48% (7) | 75.40% |
| b298 | Sensory functions and pain, other specified | 1.27% (6) | 76.70% |
| b7100 | Mobility of a single joint | 1.27% (6) | 78.00% |
| b799 | Neuromusculoskeletal and movement-related functions, unspecified | 1.06% (5) | 79.00% |
| d4551 | Climbing | 1.06% (5) | 80.10% |

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**Supplemental Table 5: Phase of Injury Most Common Codes Level 2**

| Code | Description | Acute | Subacute | Chronic |
|---|---|---|---|---|
| b152 | Emotional functions | x | | |
| b280 | Sensation of pain | x | x | x |
| b780 | Sensations related to muscles and movement functions | x | | |
| d450 | Walking | x | | |
| d455 | Moving around | x | | x |
| d920 | Recreation and leisure | x | | x |

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**Supplemental Table 6: Phase of Injury Most Common Codes Level 3**

| Code | Description | Acute | Subacute | Chronic |
|---|---|---|---|---|
| b1528 | Emotional functions, other specified | x | | |
| b280 | Sensation of pain | x | | x |
| b2801 | Pain in body part | x | x | x |
| b289 | Sensation of pain, other specified | x | | |
| b439 | Functions of the hematological and immunological systems, other specified and unspecified | x | | |
| b7808 | Sensations related to muscles and movement functions, other specified | x | | |
| b798 | Neuromusculoskeletal and movement-related functions, other specified | x | | |
| d4509 | Walking, other specified | x | | |
| d4552 | Running | x | | x |
| d9201 | Sport | x | | x |

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