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Patient-Reported Outcomes Measurement Information System Physical Function Item Bank, Version 1.0: Physical Function Assessment for Athletic Patient Populations

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Context: The Patient-Reported Outcomes Measurement Information System (PROMIS) item banks have been validated for general populations, but their application to high-functioning patient populations remains speculative.

Objective: To examine the measurement properties of the PROMIS physical function item bank, version 1.0, when applied to individuals representing high levels of physical ability.

Design: Cross-sectional study.

Setting: National Collegiate Athletic Association Division I and III collegiate athletic training rooms and intramural events.

Patients or Other Participants: A heterogeneous sample of 215 adults from Division I or Division III collegiate or recreational sports volunteered for this study. Participants were divided into 4 groups depending on sport activity and injury status: healthy collegiate (HC; 33 men, 37 women; age = 19.7 ± 1.1 years), injured and currently active in sport (IP; 21 men, 29 women; age = 19.9 ± 1.2 years), injured and currently not active in sport (INP; 12 men, 18 women; age = 19.7 ± 1.3 years), and healthy recreational (HR; 47 men, 18 women; age = 20.1 ± 1.4 years).

Main Outcome Measure(s): Participants completed 2 assessments: (1) an injury-history questionnaire and (2) the PROMIS physical function item bank, version 1.0, in computer-adaptive form. Mean PROMIS physical function scores were determined for each group.

Results: The PROMIS physical function score for the HC group (61.7 ± 6.0) was higher than for the IP (54.9 ± 7.5) and INP (44.1 ± 8.2) groups ($P < .001$). The IP group had a higher score than the INP group ($P < .001$). Mean PROMIS scores were not different between the HC and HR participants (mean difference = 1.9, $P = .10$).

Conclusions: The computer-adaptive PROMIS physical function item bank, version 1.0, accurately distinguished injury status in elite-level athletes on a physical function latent trait continuum. Although it was unable to distinguish HC athletes from HR athletes, exposing a possible ceiling effect, it offers potential for use as an outcome instrument for athletic trainers and other sports medicine clinicians.

Key Words: athletic injuries, clinical decision making, PROMIS

Key Points

- The Patient-Reported Outcomes Measurement Information System (PROMIS) physical function item bank, version 1.0, accurately differentiated physical function in collegiate athletes who were healthy, injured and participating, or injured and not participating.
- The PROMIS did not distinguish healthy collegiate athletes from healthy recreational athletes. The most difficult sport-related items address running speed and distance, which may not accurately distinguish elite athletes from the general population.
- Based on these findings, the PROMIS may be a useful tool for assessing physical ability in the early stages of rehabilitation. However, it seems to lack the ability to identify healthy individuals with unrestricted participation.

As athletic trainers (ATs) embrace the global health care approach of evidence-based decision making,[1–4] identifying outcome-assessment instruments that are appropriate for their clientele becomes paramount. Specifically, ATs must adopt patient-reported outcome (PRO) instruments that can efficiently and effectively measure the entire spectrum of a patient's abilities. Because ATs practice in a variety of settings, the physical functioning of clientele can vary significantly. Therefore, PRO instruments must enable ATs to capture all levels of functional ability from the acutely injured recreational walker (low functional ability) to the healthy, injury-free, elite-level athlete (high functional ability).

Unfortunately, the assessment tools currently available to ATs have limitations.[2,5,6] First, many of the assessment instruments used in athletic training environments are based on classical test theory, which limits the adaptability of the instrument and forces patients to answer lengthy questionnaires, regardless of their current physical function levels.[3,5,7] For example, a patient who is using crutches during the early stages of rehabilitation will answer questions related to walking up stairs and jogging. Second,

researchers have recommended that clinicians administer both generic and region-specific PRO instruments throughout the course of a patient's treatment protocol to accurately assess all dimensions of health-related quality of life.[6] So, instead of 1 lengthy questionnaire, clinicians are now asked to administer a number of instruments, further contributing to time constraints in the clinic. Ultimately, administering lengthy questionnaires that cannot adapt to a patient's level of functional ability or individual injury places an excessive burden on both the patient and the clinician.[5]

Finally, although many of the commonly used PRO instruments have at least some supporting evidence for validity, their ability to assess individuals representing the top tier of functional ability (eg, elite athletes) has not been established. Item difficulty, item discrimination, and ceiling effects are the basis of all measurement limitations associated with traditional PRO instruments.[3,5,7] For example, the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) is a popular questionnaire designed to measure a patient's general health status based on both physical and mental constructs.[8] However, 37% to 72% of the general population will reach the ceiling of the functional dimensions in this test,[9] making it difficult for clinicians to apply the results to a sport-specific population. In other words, a perfect score on the SF-36 does not necessarily mean an athlete is healthy and ready to return to competition; rather, it merely indicates that the athlete's level of physical function is comparable with that of the general population. Only by completing additional evaluations will a clinician be able to determine a more accurate functional assessment.

However, a potential solution to the measurement concerns regarding athletic training clientele and traditional PRO instruments is available. Computer-adaptive testing, grounded in the principles of modern measurement theory, offers the ideal platform through which ATs can use PROs. Unlike classical test theory, computer-adaptive tests use psychometric properties of item response theory to rank order unidimensional items based on difficulty.[10,11] Essentially, the difficulty of the items and the ability of the patients can be placed on a common metric to allow for a better understanding of the capabilities and precision of an instrument. When these tests are administered using computer-adaptive platforms, unnecessary or redundant items are eliminated and fewer questions are then needed to capture a patient's current health status, improving test accuracy and alleviating patient and clinician burden.[12] Furthermore, because these computer-adaptive tests can draw upon large item banks, they offer the potential to minimize ceiling effects.[13]

A specific example of a PRO instrument that has the potential for use by ATs is the Patient-Reported Outcomes Measurement Information System (PROMIS),[14] a project of the National Institutes of Health that began in 2004. This project was designed to create universal computer-adaptive item banks that could assess a number of health care domains, including pain, fatigue, emotional distress, physical function, and social function.[15] To formulate these item banks, PROMIS investigators drew individual questions from a number of well-established paper-and-pencil PRO instruments and applied the properties of item response theory.[15] Researchers[16] can now use PROMIS software to create computer-adaptive tests that mathematically administer questions from larger item banks depending on the patient's current health status.

Those ATs seeking to monitor the effectiveness of a treatment protocol may find the PROMIS physical function item bank of particular interest. This item bank contains 124 items (ie, questions) designed to measure an individual's ability to perform physical tasks ranging from low-level skills (eg, activities of daily living) to more difficult skills requiring mobility, strength, and endurance.[16] Preliminary validity evidence for the PROMIS physical function item banks has been established in general populations compared with the SF-36 (Pearson $r = 0.88$),[16,17] as have precision and reliability for lower extremity injury, central body function, and activities of daily living.[17–19] More recent research[20] has demonstrated strong convergence correlation of the PROMIS physical function item bank with the International Knee Documentation Committee Subjective Knee Form ($r = 0.75$) and fair correlation with the Simple Shoulder Test ($r = 0.67$) and the American Shoulder and Elbow Surgeons shoulder ($r = 0.63$) assessment instruments. Although these item banks offer the potential for use in athletic training practice and research, the measurement properties of the PROMIS physical function item bank must first be established for individuals who represent high levels of physical ability. Therefore, the purpose of our study was 2-fold. First, we examined whether the PROMIS physical function item bank, version 1.0, in computer-adaptive form could accurately distinguish collegiate-level athletes based on health status. We hypothesized that the mean PROMIS scores for healthy (HC), injured and participating (IP), and injured and not participating (INP) collegiate athletes would differ, making the test a useful tool for monitoring functional improvements over the course of rehabilitation. Second, we compared the mean PROMIS scores of HC athletes with those of healthy intramural athletes to assess the ability of this instrument to measure individuals with high levels of physical ability. For this secondary purpose, we assumed that collegiate athletes inherently possess a higher degree of physical function than individuals who participate solely in intramural activities, as collegiate athletes are exposed to daily training regimens and structured sport-conditioning programs. Under this assumption, we hypothesized that the mean PROMIS scores for collegiate athletes would be different from those of the intramural group, providing evidence that the current PROMIS item bank does not suffer from ceiling effects.

METHODS

Participants

National Collegiate Athletic Association Division I and Division III collegiate ($n = 153$) and recreational ($n = 65$) athletes volunteered for this study. To eliminate age as a confounding variable, we recruited only individuals between 18 and 30 years of age. Participants completed a health history questionnaire, which included information pertaining to their sport, current accounts of musculoskeletal injuries, and demographics including height, weight, age, and sex. A participant who was currently injured and receiving treatments from a professional health care

Table. Categorization of Distance-Running Versus Sprinting, Agility, and Power Sports

Distance-Running Sports	Sprinting, Agility, and Power Sports
Cross-country	Baseball
Track (athletes competing in events longer than 400 m)	Basketball
Soccer (excluding goalkeepers)	Football
	Soccer goalkeepers
	Softball
	Swimming
	Tennis
	Track (field events)
	Track (sprinting $\leq$400 m)
	Volleyball
	Wrestling

provider was asked to provide a brief description of the injury and current activity status. Each participant was asked to disclose any other injury or condition that might affect physical activity. Three collegiate athletes were excluded from the study because they reported medical conditions that altered physical function but could not be classified as a musculoskeletal injury. Therefore, data from 150 collegiate athletes were available for analysis.

Participants were divided into 4 groups based on their current health status and level of sport activity. The 4 groups were HCs, IPs, INPs, and healthy recreational athletes (HRs). The HC group (33 men, 37 women; mean age = 19.7 $\pm$ 1.1 years) consisted of 21 Division I and 49 Division III athletes with no reports of musculoskeletal injury who had full medical clearance to participate without limitations. The IP group (21 men, 29 women; mean age = 19.9 $\pm$ 1.2 years) consisted of 29 Division I and 21 Division III athletes with medical clearance to participate in athletic competition who were receiving treatment for a musculoskeletal injury from a certified AT, physical therapist, chiropractor, or physician. The INP group (12 men, 18 women; mean age = 19.7 $\pm$ 1.3 years) consisted of 17 Division I and 13 Division III athletes currently experiencing a musculoskeletal injury who were not cleared to participate in athletic competitions. The HR participants (47 men, 18 women; mean age = 20.1 $\pm$ 1.4 years) were currently healthy (ie, no report of musculoskeletal injury) and participating in an intramural sport rather than an organized collegiate athletic program.

Before the study, all participants read and signed, on a laptop computer, an electronic informed consent document that was approved by the university institutional review board for the protection of human subjects. The board also approved the study.

Procedures

For the purpose of this investigation, we created the computer-adaptive test using the PROMIS physical function item bank, version 1.0, and based item response theory calibrations for each item on quantitative evaluations by PROMIS experts.[16] From July 2006 to March 2007, PROMIS experts reported that these same item response theory calibrations demonstrated reliable, precise, and valid outcomes when the test was used to assess physical function in the general population.[16]

Once the participant began the PROMIS assessment, a question of medium difficulty (eg, "Does your health now limit you in doing vigorous activities, such as running, lifting heavy objects, participating in strenuous sports?") was posed. The participant answered the question by choosing from 1 of 5 response options: (1) *not at all*, (2) *very little*, (3) *somewhat*, (4) *quite a lot*, or (5) *cannot do*. Once the participant answered the first question, a second question was displayed. Each item within the PROMIS physical function item bank is rank ordered by how physically demanding the proposed functional task is, so subsequent questions vary depending on the participant's current physical ability and response choices. For example, if a participant reported an inability to perform the first functional task, the next question would describe an easier task. If, for this next question, the participant indicated an ability to complete the task without difficulty, the subsequent question would describe a slightly more difficult task, and so on. The computer-adaptive assessment continued in this way until the standard error fell below an acceptable level and the patient's responses were consistent with a certain level of physical function on a latent trait continuum.[11] This often resulted in the participant answering between 4 and 12 questions before the assessment ended. Once the computer-adaptive test was complete, a raw physical function score between 0 and 100 was calculated along with a standard deviation that placed each participant along the same latent trait continuum. Therefore, the results could be compared across all groups, with higher PROMIS physical function scores representing a higher degree of self-reported physical function.

Statistical Analysis

We analyzed the mean PROMIS physical function scores for the HC, IP, INP, and HR groups using SPSS (version 12; SPSS Inc, Chicago, IL). First, a 1-way analysis of variance was calculated to compare scores among the 3 collegiate groups: HC, IP, and INP. An independent-samples *t* test was used to investigate differences between the healthy groups: HC and HR.

To further assess item specificity after data collection, we divided the HC participants into 2 subgroups (distance-running athletes [DRAs] and sprinting, agility, and power athletes [SAPAs]; Table). Using an independent-samples *t* test, we compared the mean PROMIS physical function scores between the 2 subgroups of the HC participants: DRA and SAPA.

RESULTS

We found differences among the HC, IP, and INP groups ($F_{2,149} = 67.42$, $P < .001$; Figure A). A Tukey honestly significant difference post hoc analysis showed that the HC group (mean = 61.7 $\pm$ 6.0) had a higher PROMIS score than either the IP (mean = 54.9 $\pm$ 7.5) or the INP (mean = 44.1 $\pm$ 8.2) group, and the IP group had a higher score than the INP group. We observed no difference in physical function scores between the HC and HR groups (mean difference = 1.90, $t_{133} = 1.68$, $P = .10$; Figure B). Finally, we noted no difference between the mean physical function scores of the DRA and SAPA subgroups (mean difference = 1.65, $t_{68} = 1.18$, $P = .25$; Figure C).

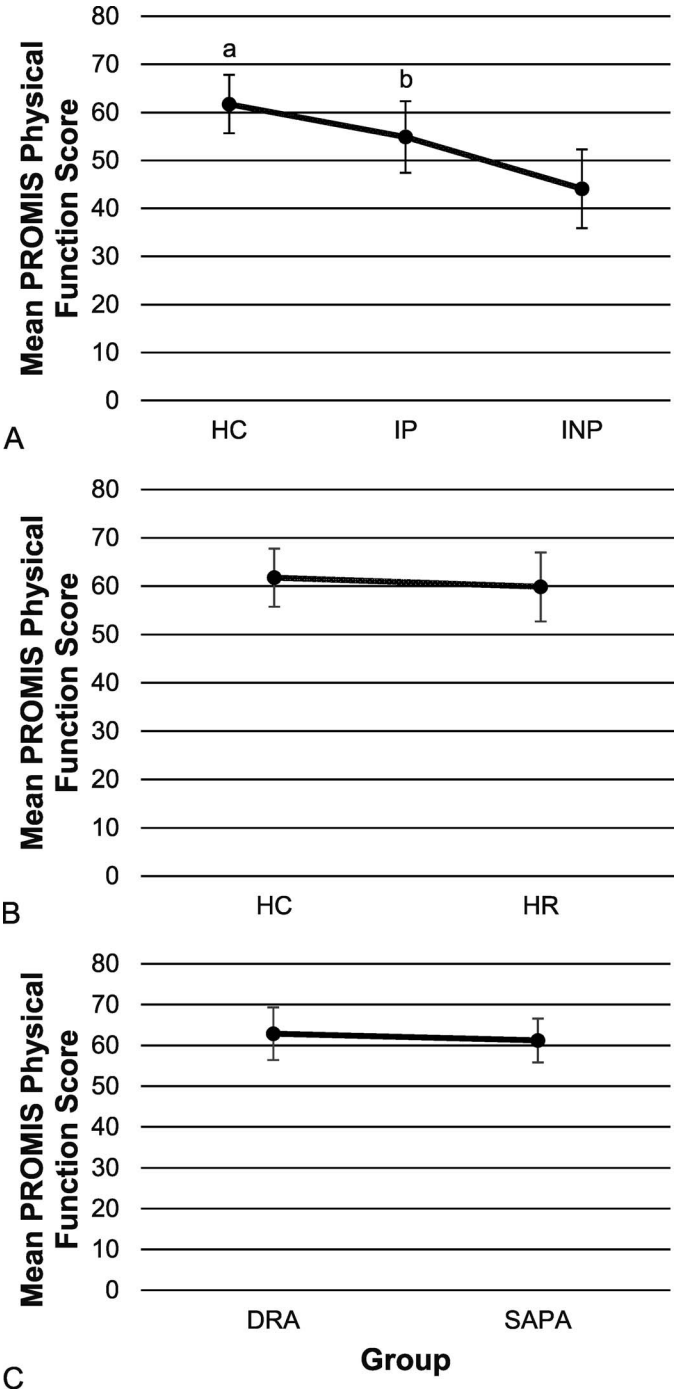

Figure. Graphic depiction of mean Patient-Reported Outcomes Measurement Information System (PROMIS) physical function scores ± 1 SD. A, The healthy (HC), injured and participating (IP), and injured and not participating (INP) collegiate athletes. B, The HC and healthy recreational (HR) athletes. C, The HC athletes further divided into distance-running (DRA) and sprinting, agility, and power (SAPA) athletes. [a] Difference between the mean PROMIS scores of the HC group versus the 2 injured groups (IP, INP) at the .05 level. [b] Difference between the mean PROMIS scores of the IP group versus the HC and INP groups at the .05 level.

DISCUSSION

Incorporating item response analysis into routine PRO assessment allows practitioners to estimate a latent trait (in this case, physical function) independently from the specific characteristics of the population.[21] Before this can be accomplished, item banks must represent a wide range of ability levels.[5] According to our results, the PROMIS physical function computer-adaptive test appears to contain question items that can accurately monitor elite-level athletes at various stages of musculoskeletal injury recovery.

We found differences among the mean PROMIS physical function scores of each collegiate athlete group; the lowest mean score belonged to the INP group and the highest mean score belonged to the HC group. After we compared these 3 groups, perhaps the most interesting finding was the difference in mean PROMIS scores (6.83) between the IP and HC athletes. According to our inclusion criteria, IP athletes had musculoskeletal injuries that required medical intervention but lacked the signs and symptoms that would otherwise require them to be withheld from competition. These individuals are frequently treated by ATs because of the diminished functional performance that typically accompanies such injuries. Therefore, an important step in improving PRO assessment for active patient populations is identifying an outcome instrument that can accurately differentiate healthy athletes from athletes participating despite minor functional limitations due to injury.

Upon closer inspection, the question "Does your health now limit you in doing strenuous activities such as backpacking, skiing, playing tennis, bicycling or jogging?" appears to be specific and difficult enough to distinguish HC from IP collegiate athletes. The computer-adaptive test administered this question to 124 of the 150 collegiate athletes, including every HC and IP participant (n = 120) and only 4 INP participants. The HC athletes who were currently participating in sporting events without any discomfort answered this question using the response option *not at all*, whereas the majority of IP athletes responded with *very little*. Ultimately, the slight variance in response options for this question led to 2 different assessments. Because of the principles of item response theory, any reported difficulties with these functional tasks could be attributed to a certain level of functional limitation.[13] The possible range of physical function scores for these participants began to narrow, and the number of questions needed to accurately place the participant along the latent trait continuum decreased dramatically.[10] The computer continued to administer more questions to the HC participants because the range of possible physical function was so broad. As a result, before receiving a score, the HC participants answered an average of 10 questions, whereas the IP participants answered an average of only 4 questions.

A secondary goal of our study was to determine if the PROMIS physical function item bank was limited by a potential ceiling effect in assessments of athletic training clientele. In other words, did the physical function scores appear to plateau when this outcomes instrument was used to measure physical function in individuals with high levels of physical ability? To test this, we compared the mean PROMIS physical function scores of the HC and HR groups. According to our analysis, the scores of these groups were not different. This result seems surprising given that collegiate scouts and coaches tend to recruit the most athletic individuals from the general population. In addition, collegiate athletes participate in regular team training sessions designed to increase physical ability and improve athletic performance so as to remain competitive

in organized collegiate sports. Although intramural athletes may work out regularly, they are not often exposed to the same structured conditioning programs or competitive athletic environments that collegiate athletes experience.

Several explanations are possible for the similarity in HC and HR scores. First, our assumption that collegiate athletes possessed higher levels of physical ability could have been wrong. Intramural and collegiate-level athletes may, in fact, not be different in functional ability. A second explanation is that the PROMIS physical function item bank has a ceiling effect when participants possess an inherently high level of functional ability. Yet a third explanation could be poor item specificity rather than the presence of a ceiling effect. For instance, the most difficult items included in the 124-item bank are questions such as "Are you able to run 2 miles at a fast pace?", "Are you able to run 5 miles?", and "Are you able to run 10 miles?" These questions do not necessarily pertain to the physical skills frequently performed by collegiate athletes. The physical attributes that set collegiate athletes apart from recreationally active adults are not always related to running long distances. Instead, some collegiate athletes may be more likely to pursue conditioning programs designed to improve power and perform exercises such as the squat, bench press, and dead lift than distance running. Therefore, many of the collegiate athletes in our healthy participant pool may have had the same difficulty running long distances as adults in the general public.

Before collecting data, we were aware that the most difficult question items included in the PROMIS item bank focused on long-distance running activities. However, for our initial analysis, we grouped HC athletes regardless of their sport. To further assess item specificity, we performed a separate analysis in which the HC athletes were divided into 2 subgroups depending on the physical demands of their sport. According to this analysis, the mean PROMIS physical function scores for DRAs and SAPAs were similar despite their having different training regimens. Even though SAPAs were rarely exposed to long-distance running, we cannot necessarily conclude that these athletes were responsible for lowering the average physical function score for the entire HC group and making them look similar to the HR group. In fact, scores for the healthy cross-country runners who trained specifically for long-distance running events were among the lowest scores in the HC group. Because cross-country runners often run for extended periods of time, they may have a better understanding of how difficult running 5 to 10 miles actually is. In other words, even though these items may be difficult, only certain types of athletes understand the full magnitude of these tasks.

The original goal in developing the PROMIS item banks was to create a set of questions that could measure PROs across common medical conditions[22] and not to distinguish healthy athletes based on sport type. However, to produce truly accurate scores across athletes in all sports, our results suggest that high levels of physical function should not be attributed solely to an increase in running distance. Instead, the PROMIS physical function item bank, version 1.0, should include items that are specific to all sport skills so that athletes accurately comprehend the difficulty of each task.

CONCLUSIONS

The PROMIS physical function item bank, version 1.0, appears to be a useful instrument for assessing physical function in athletes recovering from musculoskeletal injuries. The 124-item bank accurately differentiated physical function of the HC, IP, and INP athletes. Sports medicine clinicians looking to assess the effectiveness of a treatment in the early stages of a rehabilitation protocol will find the PROMIS physical function item bank beneficial. In particular, ATs will appreciate the added benefits of diminished time constraints that accompany computer-adaptive instruments. However, we found that relying on descriptions of long-distance running tasks to measure elite levels of physical function was insufficient. As collegiate athletes rehabilitate and begin practicing functional tasks specific to their sport, the PROMIS item bank does not appear to contain questions that are sufficiently specific to provide an accurate assessment across all sports. Researchers should make every effort to collaborate with PROMIS investigators in the future so that the most accurate item banks can be developed for sport-specific clienteles.

REFERENCES

1. Snyder AR, Valovich McLeod T, Sauers EL. Defining, valuing, and teaching clinical outcomes assessment in professional and post-professional athletic training education programs. *Athl Train Educ J*. 2007;2(2):31–41.
2. Steves R, Hootman JM. Evidence-based medicine: what is it and how does it apply to athletic training? *J Athl Train*. 2004;39(1):83–87.
3. Snyder AR, Parsons JT, Valovich McLeod TC, Curtis 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.
4. Evans TA, Lam KC. Clinical outcomes assessment in sport rehabilitation. *J Sport Rehabil*. 2011;20(1):8–16.
5. Jette AM, Haley SM. Contemporary measurement techniques for rehabilitation outcomes assessment. *J Rehabil Med*. 2005;37(6):339–345.
6. Hoch JM, Druvenga B, Ferguson BA, Houston MN, Hoch MC. Patient-reported outcomes in male and female collegiate soccer players during an athletic season. *J Athl Train*. 2015;50(9):930–936.
7. Valovich McLeod TC, Snyder AR, Parsons JT, Curtis Bay R, 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.
8. McHorney CA, Ware JE, Raczek AE. The MOS 36-Item Short-Form Health Survey (SF-36), II: psychometric and clinical tests of validity in measuring physical and mental health constructs. *Med Care*. 1993; 31(3):247–263.
9. Brazier J, Jones N, Kind P. Testing the validity of the Euroqol and comparing it with the SF-36 health survey questionnaire. *Qual Life Res*. 1993;2(3):169–180.
10. Chang CH, Reeve BB. Item response theory and its applications to patient-reported outcomes measurement. *Eval Health Prof*. 2005; 28(3):264–282.
11. Khanna D, Krishnan E, DeWitt EM, Khanna PP, Spiegel B, Hays RD. The future of measuring patient reported outcomes in rheumatology: Patient-Reported Outcomes Measurement Information System (PROMIS). *Arthritis Care Res (Hoboken)*. 2011; 63(suppl 11):S486–S490.
12. Hart DL, Mioduski JE, Stratford PW. Simulated computerized adaptive tests for measuring functional status were efficient with

good discriminant validity in patients with hip, knee, or foot/ankle impairments. *J Clin Epidemiol*. 2005;58(6):629–638.
13. Chakravarty EF, Bjorner JB, Fries JF. Improving patient reported outcomes using item response theory and computerized adaptive testing. *J Rheumatol*. 2007;34(6):1426–1431.
14. Reeve BB, Hays RD, Bjorner JB, et al. Psychometric evaluation and calibration of health-related quality of life item banks: plans for the Patient-Reported Outcomes Measurement Information System (PROMIS). *Med Care*. 2007;45(5 suppl 1):S22–S31.
15. DeWalt DA, Rothrock N, Yount S, Stone AA. Evaluation of item candidates: the PROMIS qualitative item review. *Med Care*. 2007; 45(5 suppl 1):S12–S21.
16. Cella D, Riley W, Stone A, et al. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. *J Clin Epidemiol*. 2010;63(11):1179–1194.
17. Hung M, Franklin JD, Hon SD, Cheng C, Conrad J, Saltzman CL. Time for a paradigm shift with computerized adaptive testing of general physical function outcomes measurements. *Foot Ankle Int*. 2014;35(1):1–7.
18. Hung M, Clegg DO, Greene T, Saltzman CL. Evaluation of the PROMIS physical function item bank in orthopaedic patients. *J Orthop Res*. 2011;29(6):947–953.
19. Hung M, Baumhauer JF, Latt LD, et al. Validation of PROMIS Physical Function computerized adaptive tests for orthopaedic foot and ankle outcome research. *Clin Orthop Relat Res*. 2013;471(11): 3466–3474.
20. Robins RJ, Zhang Y, Anderson MB, Presson AP, Burks RT, Greis PE. Convergent validity of the Patient Reported Outcomes Measurement Information System's (PROMIS) Physical Function Computerized Adaptive Test (PF-CAT) for the knee and shoulder injury sports medicine patient population. *Orthop J Sports Med*. 2015;3(suppl 2):2325967115S00147.
21. Hays RD, Morales LS, Reise SP. Item response theory and health outcomes measurement in the 21st century. *Med Care*. 2000;38(suppl 9):II28–II42.
22. Cella D, Yount S, Rothrock N, et al. The Patient-Reported Outcomes Measurement Information System (PROMIS): progress of an NIH Roadmap cooperative group during its first two years. *Med Care*. 2007;45(5 suppl 1):S3–S11.

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