Exploratory and Confirmatory Factor Analysis of the PROMIS Pain Quality Item Bank

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Abstract

Purpose—The assessment of pain sensation and quality is a key component in understanding the experience of individuals with chronic pain. This study evaluated the factor structure of the Patient-reported Outcome Measurement Information System (PROMIS) pain quality item bank.

Methods—As part of the PROMIS project, we developed a pool of 37 pain quality items, based on a review of existing pain questionnaires and development of new items. A Web-based survey was designed and completed by 845 members of the general population and 967 individuals with different types of chronic pain. Exploratory factor analysis (EFA) was conducted on a random split-half sample of the data to examine the factor structure of the 37 PROMIS pain quality items in the general population and in a chronic pain sample. A confirmatory factor analysis was conducted in the holdout sample.

Results—The EFA of the pain quality items resulted in comparable six-factor solutions for the general and chronic pain samples: (1) pulling/tugging pain; (2) tingling/numbness pain; (3) sharp/ stabbing pain; (4) dull/aching pain; (5) pounding/pulsing pain; and (6) affective pain. The confirmatory factor analysis in the holdout sample supported this factor structure.

Conclusions—Further research is needed to evaluate the psychometric characteristics of the derived scales based on their factor scores.

Keywords

Pain qualities; factor analysis; pain assessment; Patient-reported Outcome Measurement Information System; general population; chronic pain

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INTRODUCTION

Over the past two decades, there has been growing recognition that pain is a complex experience with sensory, affective, and other qualitative dimensions. Because pain has various sensory and affective qualities, different measures that target specific facets of pain may more fully describe the pain experience. [1,2] Assessments of different pain-related sensory and quality components may assist in identifying treatments that impact pain intensity and other facets of the pain experience.[1]

There is heightened recognition that pain is a multidimensional experience which has increased interest in measuring distinct aspects of the pain experience. Careful, self-report-based assessments of pain qualities are important for several reasons. First, such assessments may help clinicians better characterize and differentiate the unique qualities of pain associated with specific pain syndromes. Second, the quality of a patient's pain may provide clues to its underlying etiology. Finally, there is evidence that certain interventions relieve pain because they alter the affective quality of pain, while other interventions relieve pain because they alter the sensory intensity of pain.[3,4]

Several pain instruments have been developed to capture distinct dimensions of the pain experience, beginning with the adjective checklist of the McGill Pain Questionnaire (MPQ). [5,6] The MPQ is a widely used measure of sensory, evaluative, and affective qualities of pain. A short-form version, the SF-MPQ, includes an adjective checklist consisting of 15 pain descriptors rated on a four-point scale (none, mild, moderate, severe).[7] Modified versions of the SF-MPQ also have been developed, and empirical investigations have supported the psychometric properties of these new scales.[8,9] Other measures have been developed for the measurement of pain quality, including the Multidimensional Affects and Pain Survey (MAPS)[10] and the Pain Quality Assessment Scale (PQAS).[11]

Numerous factor analytic studies have explored the dimensionality of the pain quality items included in the MPQ.[8,12–19] Some studies have supported the MPQ's original domain structure; others have identified different factor structures.[8,12,13,18,19] For example, Crockett[13] found evidence supporting five factors, including affective-arousal, sensory pressure, perception of harm, somesthetic pressure, and cutaneous sensitivity (tugging-pulling, pinching-crushing, tender-splitting, etc.). Factor analytic studies of the MAPS have supported several affective and somatosensory factors, including cutaneous sensations, faint pain, muscle/joint pain, heat, intense pain, intermittent pressure, stinging, incisive pressure, traction/abrasion, and cold and numb pain.[10,20] The results of these studies largely support the item and content structure of the MAPS. For the PQAS, factor analyses have identified three factors, labeled as paroxysmal pain sensation (shooting, sharp, electric), superficial pain (itchy, cold, numb), and deep pain (aching, heavy dull).

The existing evidence suggests pain quality is multifactorial, but, to date, there is little agreement as to the composition of these factors. This may be due to the challenge in interpreting results from different studies that often used varying methods for deriving factors, applied different criteria for interpreting factor structure, used limited numbers of pain quality items, included diverse chronic and acute pain conditions, and had sample sizes ranging from 98 to 373 [8,12]. Few studies included general population samples [13]. A broader range of pain quality items and larger sample sizes may be needed to determine and interpret domains of pain quality.

The objective of this study was to evaluate the factor structure of pain quality items developed as part of the National Institutes of Health (NIH) Patient-Reported Outcomes Measurement Information System (PROMIS) project. PROMIS is a NIH roadmap initiative to develop item banks and assessment instruments for pain and other patient-reported

outcome domains (e.g., physical functioning, emotional distress, fatigue).[21,22] Factor analyses of responses to the items were completed using the PROMIS general population sample[21] and a sample of patients with chronic pain (American Chronic Pain Association Survey).

MATERIALS AND METHODS

Study Design

A Web-based survey was developed and administered to field test the candidate items of the PROMIS item banks, including pain quality items. The survey was completed during 2006 and survey participants were recruited from an existing US national internet panel maintained by YouGov/Polimetrix (see www.polimetrix.com), a polling firm based in Palo Alto, California, and from PROMIS research sites. The field test involved administering candidate items from five domains (i.e., pain, fatigue, physical functioning, etc.) to more than 20,000 participants.[21] A complex sampling approach was required because of the large number of items that needed to be tested. A portion of participants was randomly assigned to receive two full banks, that is, all candidate items from two separate domain-specific banks. Therefore, only a portion of the sample took all of the candidate pain quality items (44 candidate items). Other respondents completed blocks of seven items from each of 13 PROMIS domains; therefore, these persons responded to seven candidate pain quality items, and their responses were not included in the factor analyses reported here. To supplement the PROMIS Wave I data, a Web-based sample of individuals with chronic pain was recruited from among the members of the American Chronic Pain Association (ACPA). This research was approved by the NorthShore University Health System institutional review board and all participants provided informed consent.

Study Participants

The PROMIS field test sample was selected to be generally comparable to national distributions of age, gender, race/ethnicity (White/Black/Hispanic/Other) and education (High School or less versus more than High School) based on the 2000 US Census data. [21,23] Individuals participating in the internet panel were selected for the general population sample. For the current study, we included only the 845 participants from the general population sample who responded to the full bank of candidate pain quality items.

Participants with chronic pain were recruited through the ACPA. An invitation to complete the PROMIS pain survey was posted on the ACPA Web site. To be eligible, participants had to be aged 21 or older and have one or more chronic pain conditions for at least three months prior to participating in the survey.

Those who met eligibility criteria were asked to complete an informed consent form. After giving informed consent, participants immediately began the survey. The survey was posted on the Web site of the ACPA from September 2007 to March 2008. The ACPA Survey included 967 participants who completed candidate pain quality items.

Measures

Pain Quality Item Bank—As part of the PROMIS project, a candidate pain quality item bank was developed based on existing instruments[5, 8,9,10, 11], clinician review, and qualitative research in patients with various kinds of pain. The items covered diverse qualities of the pain experience, including items assessing piercing, stabbing, throbbing, crushing, dull, cold, numb, pulling, dull, and aching pain. Each item was developed to cover a single sensory experience (e.g., stabbing, cool, etc.). Content of the final set of pain quality items was revised based on the results of cognitive debriefing interviews.[24] The candidate

pain quality item bank consisted of 44 items. Two different Likert response scales were used —frequency and severity. The frequency items asked "how often did you experience" specified types of pain and had a response scale of: 1 (never) to 5 (always). Based on the findings from cognitive debriefing interviews, we included one additional response option, "had no pain." A score of 1 (same as a response of "never") was assigned to this category. The severity items responses ranged from 1 (none) to 5 (very severe). Again, based on findings from cognitive debriefing interviews, we included two additional response options, "not sure if I had this type of pain" and "did not have this type pain," both of which were scored as 1 (same as a response of "none"). The recall period for all pain quality items was the past seven days. Based on results of initial psychometric analyses, seven items were dropped from the candidate pool. Chief reasons for dropping these items were item redundancy and poor response distributions. All follow-up analyses were limited to the remaining 37 items.

Other Measures—Information on demographic characteristics was collected from study participants (i.e., age, gender, race/ethnicity, education). All participants completed the average pain intensity 11-point numeric rating scale anchored at no pain (0) and worst pain imaginable (10).

Statistical Analysis

Statistics summarizing the demographic characteristics and average pain intensity for the combined sample were calculated. We report mean item scores and standard deviations for each pain quality item.

The combined samples (PROMIS general population and ACPA) were randomly split into two datasets of approximately equal size a "training sample" (N=725) and a "holdout sample" (N=709). Exploratory factor analysis (EFA) using weighted least square mean and variance (WLSMV) estimation was conducted on the training sample. Item responses were treated as categorical variables, and polychoric correlations were analyzed. Identification of the potential number of factors was informed by the eigenvalue >1.0 rule, the scree test, and principles of simple structure.[25] We generated multiple factor solutions with number of factors plus or minus two around the initially derived value based on the eigen-value rule. Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) are reported for each factor solution.. Oblique rotations using the GEOMIN method were generated to assist in factor interpretation, because we hypothesized that the pain quality factors were correlated. The final factor solution and interpretation was based on model fit, principles of simple structure, and model interpretability. Model fit was evaluated using the CFI, TLI, RMSEA, and SRMR.

A confirmatory factor analyses (CFA), using WLSMV estimation, for the holdout sample was completed to confirm the model identified from the EFA. This CFA used the 37 pain quality items that were included in both participant samples. Again, item responses were treated as categorical variables. Model fit was evaluated with CFI, TLI, and RMSEA. MPLUS was used to perform the EFA and CFA.[26]

RESULTS

Of the 845 general population participants who completed the pain quality items, 94 subjects had one or more missing responses for the 37 pain quality items. Thus, only 751 subjects were included in the analytic sample for this study. The average age of the respondents was 51.2 (SD=18.4), and 54% were female.

The sample was mostly Caucasian (79.0%), with 8.1% African-American and 10.8% Hispanic. Eighty-three percent were high school graduates or had further education. The mean pain intensity score for this sample was 2.4 (SD=2.3), indicating that few survey participants reported significant pain.

For the ACPA survey participants, 683 had no missing responses out of 967 subjects. Their average age was 48.0 years (SD=11.0). Eighty-one percent of the respondents were female, and 93% were Caucasian, 1.3% were African-American, and 4.8% were of Hispanic origin. Eighty-three percent of the participants had an education equal to or greater than high school. Mean pain intensity score for the ACPA sample was 6.6 (SD=1.6), indicating this sample had more severe pain than the PROMIS sample.

The means and standard deviations for the 37 pain quality items are summarized in Table 1. The most frequently endorsed pain quality items were those referencing dull, aching, sore, sharp, and annoying pain. Floor effects (not endorsing the item) were observed for cool (88%), tugging (82%), itchy (78%), freezing (77%), squeezing (75%), pulling (75%), and splitting (74%). None of the pain quality items demonstrated any ceiling effects (i.e., large numbers of respondents with scores at the most severe response scale).

Exploratory Factor Analysis in Training Sample

Results of the EFA of the 37 pain quality items for the training sample (N=725) of the pooled Wave 1 and ACPA samples supported as many as 4 factors based on the eigenvalue rule (>1.0) and the scree test. The eigenvalues were 23.048, 1.617, 1.389, and 1.097. Four to six factors were extracted and rotated with GEOMIN rotation. The CFI, TLI, RMSEA, and SRMR for the 4-factor solution was 0.959, 0.994, 0.070, and 0.033, respectively. For the 5-factor solution, CFI was 0.971, TLI was 0.996, RMSEA was 0.059, and SRMR was 0.027. Based on a review of these factor solutions, the six-factor solution was most interpretable based on factor loadings, the principles of simple structure, and the model fit statistics. The six-factor solution accounted for 78% of the variance in the pain quality items with CFI=0.981, TLI=0.997, RMSEA=0.049, and SRMR=0.023. The factor analysis, with oblique rotation, indicated six factors for the pain quality items: (1) pulling/tugging pain; (2) tingling/numbness pain; (3) sharp/stabbing pain; (4) dull/aching pain; (5) pounding/pulsing pain; and (6) affective pain (Table 2). The items with the largest factor loadings on the first factor included pulling (0.77) and tugging pain (0.69) items (Factor 1: pulling/tugging pain). Items loading highly on the second factor included tingling (0.71), numb (0.70), cool (0.62), freezing (0.52), and pricking (0.52) pain items (Factor 2: tingling/numbness pain). The third factor items included those referencing sharp (0.66), stabbing (0.62), piercing (0.57), and shooting (0.52) pain (Factor 3: sharp/stabbing pain). The items with the largest factor loadings on the next factor included dull (0.64), aching (0.60), sore (0.56), nagging (0.55), and annoying (0.52) pain (Factor 4: dull/aching pain). The fifth factor was defined by pounding (0.79), pulsing (0.66), throbbing (0.62), and splitting (0.55) (Factor 5: pounding/pulsing pain). A final factor included items reference unbearable (0.64), vicious (0.62), torturing (0.61), intolerable (0.60), and cruel pain (0.59) (Factor 6: affective factor).

Confirmatory Factor Analysis

The CFA assessed the fit of the six factor structure using the holdout sample (N=709). For this six-factor model, the CFI was 0.934, the TLI was 0.994, and the RSMEA was 0.083, suggesting adequate model fit. Table 3 summarizes the factor loadings for the CFA. Fitting the CFA model required no constraints on residual correlations. We inspected standardized residual correlations, and observed that no residual correlation was greater than 2.0.

DISCUSSION

The assessment of pain is based primarily on patient reports of their perceptual experiences. Assessments of pain quality are potentially useful for diagnosis of pain conditions, decisions among intervention options, and evaluation of treatment outcomes. In this study, we examined the factor structure underlying a representative set of pain quality items administered to a general population sample and a sample with chronic pain. As with previous factor analyses of pain quality items, we were able to identify multiple interpretable factors. These factors included pulling/tugging pain, tingling/numbness pain, sharp/stabbing pain, dull/aching pain, pounding/pulsing pain, and affective pain. These pain quality factors may prove useful for describing and monitoring the pain experience of patients with different kinds of pain.

The six derived factors were all moderately correlated (0.36 to 0.49). The moderate correlations highlight the unique contributions of the separate dimensions in understanding the pain experience.

The factor analyses of the combined ACPA and PROMIS samples, suggested a dull/aching factor that also included items referencing sore, annoying, and nagging pain. The results suggest that this dull/aching factor was comparable across the chronic pain and general population samples (see appendix). Clark et al.[10] also found support for a muscle/joint pain factor, including aching, sore, tight, and stiff pain. The tingling/numbness pain factor covers the sensation of tingling, numbness and coolness, as well as freezing and pricking pain in the combined general population and ACPA sample. The pain quality items were factor analyzed, and comparable factors were seen in the general population, chronic pain and pooled samples (see appendix), which were most clearly defined by tingling and numbness pain.

The derived sharp/stabbing pain factor included most of the items on sharp, stabbing, piercing, and shooting pain in the combined PROMIS general population and the chronic pain sample. Clearly, this finding provides strong support for a piercing/stabbing factor across participant samples. Victor et al.[27] found a similar factor based on shooting, sharp, and other items.

The derived tingling/numbness, dull/aching, and sharp/stabbing factors from this study were comparable to the continuous, neuropathic, and intermittent pain factors observed by Dworkin et al.[9] in a sample of individuals with chronic pain. Other studies have found evidence supporting the acute pain factor.[8,12,13,15,19] The remaining two factors seen in this study, pounding/pulsing type pain and affective pain overlap little with the factors seen in Dworkin et al.[9], although Clark et al.[10] found intermittent pressure (i.e., throbbing, pounding) and affective pain factors. Victor et al.[27] also found evidence for a deep pain factor that included cramping and throbbing items. Pounding/pulsing pain was most associated with questions regarding pounding, pulsing, and throbbing pain. Similar factors were observed in both the chronic pain and general population samples (see appendix).

In the combined PROMIS general population and ACPA samples, the affective pain factor was most represented by items referencing unbearable, vicious, torturing, cruel and intolerable crushing pain. When factor analytic results were completed using the 37 pain quality items, comparable factors were derived for the ACPA and general population samples (see appendix). These were defined mostly by torturing, vicious, and unbearable pain. Clark et al.[10] and others[8,12,13,18,19] have found evidence supporting an affective factor based on patients from clinic settings.

In general, these factor analyses confirm and extend previous factor analyses of pain quality items.[8,12,13,18,19] However, there are a number of significant contrasts among the results of the current factor analyses and those previously published (e.g., Crockett et al.[13]). The observed differences in factor structure and content may be attributable to differences in item content and samples. Few studies have evaluated pain quality items in general population samples.

The PROMIS pain quality, pain interference and pain behavior item banks represent an advance in pain assessment. The pain behavior[28] and pain interference[29] banks allow researchers to develop targeted short forms or to use computerized adaptive tests for studies. The pain behavior and interference scores can also be interpreted based on normative data from the general US population, providing a unique method for interpreting changes in pain scores. The flexibility and normative interpretation of the PROMIS pain scores has advantages compared to the usual approach to pain assessment. The pain quality items and factor scores can be used to develop subscale scores to evaluate different sensory outcomes of the pain experience.

There are several potential limitations associated with these factor analyses and the sample. First, these data were derived from an extensive set of pain quality items administered to a general population sample. Few individuals reported moderate to severe pain, however, when we performed the factor analyses on the combined chronic pain and general population samples, interpretable pain quality factors emerged. Second, for some of the items, there were significant floor effects (i.e., freezing, crushing, tearing, torturing, cruel, vicious, sickening, unbearable, burning, nearly unbearable, and tight pain), and the resulting restricted range in responses may have affected the factor analyses findings. However, the factor structure proposed here is supported by the comparability of the factor analysis results across samples. Third, the demographic characteristics for the study sample were largely Caucasian, female, and well-educated, and may limit the generalizability of these findings. Fourth, we had missing data foin 11% of the general population sample and in 30% of the chronic pain sample. These missing data may have affected the results of the factor analyses. Finally, the pain quality questions asked about either intensity or frequency of the pain quality concept, and this may vary the reporting of the pain experience. Additional research is needed to confirm these results in a more diverse sample.

The pain quality factors derived in this study describe clinically important sub-domains of pain sensory experience and may be most useful for describing and monitoring the pain experience of patients with different kinds of chronic pain. Previous research indicates that measures of the affective component of pain are differentiated from pain intensity measures and may be responsive to treatment.[1,3,4] The sensory and affective subscales of the MPQ have shown responsiveness in clinical trials comparing treatments for chronic pain.[30,31] The IMMPACT group has recommended that measures of sensory and affective pain be included in clinical trials of pain treatments.[1]

Future research is needed to determine whether these factors are relevant for chronic pain conditions and persistent disease-related pain populations. These study findings clarify and expand previous research on pain quality factors and can be used to help identify appropriate measures for understanding pain outcomes and experience in both the general and chronic pain population. Future research is needed to evaluate the psychometric properties of scales based on the items within the derived factors.

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APPENDIX

Table A1

EFA Pain Quality - Rotated Factor Pattern from Exploratory Factor Analysis Pain Quality 37-item Based on PROMIS Wave1 Data only Base on 6-factor solution using Maximum Likelihood estimator

ID	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
PAINQU12	How intense was your aching pain?	0.77	–0.02	–0.06	0.05	0.12	0.00
PAINQU49	How intense was your annoying pain?	0.72	0.02	0.05	0.10	0.03	0.00
PAINQU1	How intense was your dull pain?	0.71	–0.04	–0.03	–0.04	0.04	0.04
PAINQU53	How often did you experience nagging pain?	0.63	0.19	0.13	–0.07	–0.00	–0.03

ID	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
PAINQU33	How intense was your sore pain?	0.62	−0.02	0.13	−0.01	−0.07	0.15
PAINQU19	How intense was your tender pain?	0.37	0.15	0.09	−0.03	0.05	0.17
PAINQU50	How intense was your radiating pain?	0.31	0.16	0.05	0.19	0.09	0.12
PAINQU3	How intense was your cramping pain?	0.26	−0.03	0.07	0.10	0.13	0.13
PAINQU45	How often did you experience torturing pain?	−0.01	0.79	−0.02	0.12	0.10	−0.06
PAINQU54	How often did you experience vicious pain?	0.02	0.77	−0.06	0.02	0.11	0.04
PAINQU38	How often did you experience cruel pain?	0.09	0.75	−0.03	0.05	0.00	0.02
PAINQU47	How often did you experience unbearable pain?	0.08	0.74	−0.04	0.15	0.01	−0.01
PAINQU42	How often did you experience tearing (ripping) pain?	0.07	0.62	0.20	−0.18	−0.02	0.14
PAINQU26	How often did you experience sickening pain?	0.10	0.56	0.13	0.18	−0.06	−0.07
PAINQU28	How often did your pain feel intolerable?	0.43	0.52	−0.01	0.05	0.02	−0.16
PAINQU9	How often did you experience freezing pain?	−0.19	0.52	0.29	−0.02	−0.02	0.12
PAINQU32	How intense was your tingling pain?	0.22	−0.05	0.65	0.21	−0.06	−0.06
PAINQU27	How intense was your numb pain?	0.18	0.05	0.58	0.08	−0.09	0.01
PAINQU31	How intense was your pricking pain?	−0.12	0.04	0.53	−0.03	0.24	0.29
PAINQU41	How intense was your stinging pain?	−0.03	0.16	0.47	−0.10	0.24	0.15
PAINQU13	How intense was your itchy pain?	−0.01	−0.04	0.45	0.14	−0.01	−0.07
PAINQU22	How often did you experience burning pain?	0.19	0.28	0.45	−0.08	0.06	−0.06
PAINQU35	How intense was your hot pain?	0.03	0.13	0.33	0.13	0.13	0.01
PAINQU30	How intense was your pulsing pain?	0.03	−0.04	0.07	0.71	0.13	−0.02
PAINQU46	How intense was your pounding pain?	−0.03	0.11	0.07	0.65	0.07	−0.00
PAINQU39	How intense was your throbbing pain?	0.25	0.01	0.18	0.53	0.00	−0.04
PAINQU52	How intense was your splitting pain?	−0.02	0.17	0.05	0.44	0.12	0.12
PAINQU37	How intense was your squeezing pain?	−0.00	0.21	0.12	0.40	−0.10	0.25
PAINQU48	How intense was your pressing pain?	0.13	0.19	0.02	0.32	−0.07	0.25
PAINQU10	How intense was your stabbing pain?	0.05	0.06	0.00	0.08	0.80	−0.06
PAINQU24	How intense was your piercing pain?	−0.01	−0.01	0.01	0.13	0.69	0.04

ID	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
PAINQU36	How intense was your sharp pain?	0.29	0.09	0.04	−0.03	0.59	−0.03
PAINQU51	How intense was your shooting pain?	0.17	0.13	0.05	0.01	0.53	0.04
PAINQU11	How intense was your pulling pain?	0.23	−0.05	−0.11	−0.02	−0.00	0.78
PAINQU18	How intense was your tugging pain?	0.04	−0.03	0.11	0.05	−0.01	0.68
PAINQU2	How intense was your cool pain?	−0.13	0.17	0.09	0.12	0.01	0.34
PAINQU23	How intense was your heavy pain?	0.25	0.23	−0.17	0.22	0.03	0.30

Table A2

EFA Pain Quality - Rotated Factor Pattern from Exploratory Factor Analysis Pain Quality 37-item using ACPA data: ACPA Survey Only Base on 6-factor solution using Maximum Likelihood estimator

ID	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
PAINQU32	How intense was your tingling pain?	0.74	0.03	−0.07	−0.01	0.17	−0.11
PAINQU31	How intense was your pricking pain?	0.65	−0.05	0.01	0.07	0.09	0.02
PAINQU27	How intense was your numb pain?	0.58	0.08	0.00	0.04	0.02	−0.08
PAINQU9	How often did you experience freezing pain?	0.51	−0.05	0.15	0.01	−0.19	0.25
PAINQU22	How often did you experience burning pain?	0.50	−0.04	0.17	−0.19	0.12	−0.00
PAINQU41	How intense was your stinging pain?	0.49	0.02	0.02	−0.08	0.20	0.11
PAINQU13	How intense was your itchy pain?	0.49	−0.00	−0.11	0.21	0.00	−0.02
PAINQU2	How intense was your cool pain?	0.47	−0.05	0.03	0.05	−0.20	0.31
PAINQU35	How intense was your hot pain?	0.42	−0.04	0.23	0.03	0.00	0.05
PAINQU12	How intense was your aching pain?	−0.05	0.64	0.11	0.07	−0.07	−0.03
PAINQU33	How intense was your sore pain?	−0.06	0.60	0.06	0.07	−0.05	0.09
PAINQU49	How intense was your annoying pain?	0.09	0.57	0.08	−0.11	0.09	0.02
PAINQU53	How often did you experience nagging pain?	−0.05	0.53	−0.05	−0.06	0.11	−0.01
PAINQU19	How intense was your tender pain?	0.30	0.42	−0.07	−0.03	−0.10	0.08
PAINQU1	How intense was your dull pain?	−0.03	0.38	−0.05	0.10	−0.11	0.18
PAINQU50	How intense was your radiating pain?	0.18	0.32	0.00	0.11	0.12	0.01

ID	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
PAINQU47	How often did you experience unbearable pain?	−0.01	−0.04	0.86	−0.05	0.09	−0.01
PAINQU45	How often did you experience torturing pain?	0.04	−0.06	0.84	−0.03	0.05	0.02
PAINQU28	How often did your pain feel intolerable?	0.01	0.12	0.73	−0.08	0.08	−0.07
PAINQU54	How often did you experience vicious pain?	0.08	−0.01	0.72	0.10	0.05	−0.08
PAINQU38	How often did you experience cruel pain?	0.04	0.09	0.70	0.04	−0.05	−0.01
PAINQU26	How often did you experience sickening pain?	0.05	0.02	0.48	0.39	−0.12	−0.01
PAINQU23	How intense was your heavy pain?	−0.10	0.04	0.44	0.12	0.00	0.19
PAINQU46	How intense was your pounding pain?	0.02	−0.00	0.06	0.76	−0.01	−0.02
PAINQU39	How intense was your throbbing pain?	0.02	0.17	0.09	0.64	0.08	−0.10
PAINQU30	How intense was your pulsing pain?	−0.01	−0.01	−0.07	0.55	0.20	0.15
PAINQU52	How intense was your splitting pain?	−0.01	−0.13	−0.02	0.45	0.19	0.23
PAINQU3	How intense was your cramping pain?	0.15	0.07	−0.02	0.28	0.01	0.15
PAINQU36	How intense was your sharp pain?	0.11	0.05	−0.00	0.04	0.70	−0.05
PAINQU10	How intense was your stabbing pain?	0.02	−0.07	0.08	0.12	0.68	0.02
PAINQU51	How intense was your shooting pain?	0.13	0.06	0.01	0.14	0.60	−0.03
PAINQU24	How intense was your piercing pain?	−0.06	−0.06	0.24	−0.01	0.58	0.16
PAINQU11	How intense was your pulling pain?	−0.01	0.12	−0.02	−0.09	0.07	0.77
PAINQU18	How intense was your tugging pain?	0.02	0.03	−0.05	0.10	0.02	0.76
PAINQU37	How intense was your squeezing pain?	0.22	−0.04	−0.02	0.16	0.00	0.37
PAINQU42	How often did you experience tearing (ripping) pain?	0.17	0.05	0.18	−0.02	0.15	0.33
PAINQU48	How intense was your pressing pain?	−0.10	0.19	0.10	0.15	0.07	0.33

Table 1

Descriptive Statistics for 37 Pain Quality Items for Pooled PROMIS General Population Sample and ACPA Sample (N=1,434)

Item	Frequency	Mean (SD)	Median	Range	Floor (%)	Ceiling (%)
How intense was your cool pain?	1434	1.2 (0.70)	1.0	1.0–5.0	1268 (88.4%)	9 (0.6%)
How intense was your tugging pain?	1434	1.4 (0.87)	1.0	1.0–5.0	1177 (82.1%)	14 (1.0%)
How intense was your itchy pain?	1434	1.4 (0.82)	1.0	1.0–5.0	1120 (78.1%)	11 (0.8%)
How often did you experience freezing pain?	1434	1.4 (0.88)	1.0	1.0–5.0	1099 (76.6%)	11 (0.8%)
How intense was your squeezing pain?	1434	1.5 (1.04)	1.0	1.0–5.0	1081 (75.4%)	24 (1.7%)
How intense was your pulling pain?	1434	1.5 (1.00)	1.0	1.0–5.0	1079 (75.2%)	24 (1.7%)
How intense was your splitting pain?	1434	1.6 (1.16)	1.0	1.0–5.0	1067 (74.4%)	51 (3.6%)
How intense was your pricking pain?	1434	1.7 (1.14)	1.0	1.0–5.0	992 (69.2%)	42 (2.9%)
How intense was your hot pain?	1434	1.8 (1.27)	1.0	1.0–5.0	955 (66.6%)	80 (5.6%)
How intense was your pounding pain?	1434	1.8 (1.21)	1.0	1.0–5.0	940 (65.6%)	54 (3.8%)
How intense was your pressing pain?	1434	1.8 (1.22)	1.0	1.0–5.0	935 (65.2%)	55 (3.8%)
How intense was your stinging pain?	1434	1.8 (1.25)	1.0	1.0–5.0	931 (64.9%)	67 (4.7%)
How intense was your pulsing pain?	1434	1.8 (1.17)	1.0	1.0–5.0	913 (63.7%)	41 (2.9%)
How intense was your heavy pain?	1434	2.0 (1.44)	1.0	1.0–5.0	875 (61.0%)	129 (9.0%)
How often did you experience tearing (ripping) pain?	1434	1.8 (1.11)	1.0	1.0–5.0	874 (60.9%)	24 (1.7%)
How intense was your numb pain?	1434	1.9 (1.20)	1.0	1.0–5.0	855 (59.6%)	56 (3.9%)
How intense was your cramping pain?	1434	1.9 (1.24)	1.0	1.0–5.0	823 (57.4%)	59 (4.1%)
How intense was your piercing pain?	1434	2.1 (1.43)	1.0	1.0–5.0	792 (55.2%)	119 (8.3%)
How often did you experience cruel pain?	1434	2.1 (1.36)	1.0	1.0–5.0	768 (53.6%)	69 (4.8%)
How intense was your tingling pain?	1434	2.0 (1.24)	1.0	1.0–5.0	760 (53.0%)	64 (4.5%)
How often did you experience torturing pain?	1434	2.1 (1.30)	1.0	1.0–5.0	757 (52.8%)	51 (3.6%)
How often did you experience vicious pain?	1434	2.1 (1.30)	1.0	1.0–5.0	749 (52.2%)	47 (3.3%)
How intense was your stabbing pain?	1434	2.3 (1.44)	2.0	1.0–5.0	714 (49.8%)	121 (8.4%)
How intense was your radiating pain?	1434	2.3 (1.42)	2.0	1.0–5.0	709 (49.4%)	118 (8.2%)
How often did you experience sickening pain?	1434	2.0 (1.17)	2.0	1.0–5.0	708 (49.4%)	26 (1.8%)
How intense was your tender pain?	1434	2.2 (1.35)	2.0	1.0–5.0	687 (47.9%)	109 (7.6%)
How intense was your throbbing pain?	1434	2.2 (1.37)	2.0	1.0–5.0	683 (47.6%)	101 (7.0%)

Item	Frequency	Mean (SD)	Median	Range	Floor (%)	Ceiling (%)
How often did you experience unbearable pain?	1434	2.2 (1.31)	2.0	1.0–5.0	672 (46.9%)	46 (3.2%)
How intense was your shooting pain?	1434	2.3 (1.42)	2.0	1.0–5.0	665 (46.4%)	124 (8.6%)
How often did you experience burning pain?	1434	2.4 (1.46)	2.0	1.0–5.0	656 (45.7%)	150 (10.5%)
How often did your pain feel intolerable?	1434	2.4 (1.34)	2.0	1.0–5.0	595 (41.5%)	64 (4.5%)
How intense was your sharp pain?	1434	2.5 (1.48)	2.0	1.0–5.0	569 (39.7%)	177 (12.3%)
How intense was your dull pain?	1434	2.3 (1.22)	2.0	1.0–5.0	505 (35.2%)	68 (4.7%)
How intense was your sore pain?	1434	2.5 (1.34)	2.0	1.0–5.0	468 (32.6%)	121 (8.4%)
How often did you experience nagging pain?	1434	3.0 (1.54)	3.0	1.0–5.0	406 (28.3%)	314 (21.9%)
How intense was your annoying pain?	1434	2.7 (1.36)	3.0	1.0–5.0	370 (25.8%)	172 (12.0%)
How intense was your aching pain?	1434	2.8 (1.36)	3.0	1.0–5.0	343 (23.9%)	181 (12.6%)

Table 2

GEOMIN Rotated Factor Loadings of Exploratory Factor Analysis with 37 Pain Quality Items for Training Sample from Pooled PROMIS General Population and ACPA Sample (N=725)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
How intense was your tugging pain?	0.77	0.02	0.09	0.14	0.11	-0.12
How intense was your pulling pain?	0.69	0.05	0.10	0.20	0.01	-0.06
How intense was your squeezing pain?	0.46	0.14	0.09	-0.03	0.28	0.12
How intense was your pressing pain?	0.37	0.02	0.00	0.06	0.29	0.26
How intense was your tingling pain?	-0.06	0.71	0.21	0.15	0.12	-0.03
How intense was your numb pain?	-0.07	0.70	0.09	0.23	0.12	-0.02
How intense was your cool pain?	0.46	0.62	-0.22	-0.15	0.08	0.19
How often did you experience freezing pain?	0.28	0.52	-0.10	0.00	0.07	0.29
How intense was your pricking pain?	0.15	0.52	0.33	-0.02	0.03	0.08
How intense was your itchy pain?	0.16	0.42	0.12	0.08	0.10	-0.13
How intense was your sharp pain?	0.04	0.06	0.66	0.14	0.13	0.14
How intense was your stabbing pain?	0.07	0.06	0.62	0.05	0.22	0.14
How intense was your piercing pain?	0.09	0.06	0.57	0.03	0.17	0.20
How intense was your shooting pain?	0.08	0.20	0.52	0.12	0.21	0.01
How intense was your stinging pain?	0.21	0.31	0.44	0.05	0.05	0.05
How often did you experience tearing (ripping) pain?	0.22	0.10	0.38	0.02	0.14	0.25
How often did you experience burning pain?	0.13	0.31	0.36	0.20	-0.11	0.26
How intense was your hot pain?	0.21	0.27	0.33	0.07	-0.01	0.22
How intense was your dull pain?	0.10	0.04	0.01	0.64	0.14	0.02
How intense was your aching pain?	0.04	0.09	0.05	0.60	0.21	0.13
How intense was your sore pain?	0.14	0.12	0.01	0.56	0.16	0.06
How often did you experience nagging pain?	0.16	0.02	0.16	0.55	0.02	0.22
How intense was your annoying pain?	0.12	0.09	0.12	0.52	0.10	0.17
How intense was your tender pain?	0.20	0.12	0.05	0.47	0.07	0.10
How intense was your radiating pain?	0.18	0.16	0.16	0.37	0.14	0.16

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
How intense was your pounding pain?	0.07	0.04	−0.01	0.04	0.79	0.05
How intense was your pulsing pain?	0.06	0.11	0.11	0.09	0.66	0.00
How intense was your throbbing pain?	−0.03	0.12	0.04	0.22	0.62	0.14
How intense was your splitting pain?	0.23	0.01	0.24	−0.03	0.55	−0.03
How intense was your cramping pain?	0.28	0.11	0.10	0.08	0.31	−0.00
How often did you experience unbearable pain?	−0.10	0.14	0.16	0.17	0.17	0.64
How often did you experience vicious pain?	0.12	0.11	0.16	0.10	0.09	0.62
How often did you experience torturing pain?	0.10	0.06	0.24	0.10	0.10	0.61
How often did your pain feel intolerable?	−0.12	0.14	0.14	0.26	0.15	0.60
How often did you experience cruel pain?	0.19	0.09	0.07	0.16	0.09	0.59
How often did you experience sickening pain?	0.19	0.03	0.12	0.17	0.24	0.41
How intense was your heavy pain?	0.26	0.01	0.09	0.24	0.15	0.31

Table 3

GEOMIN Rotated Factor Loadings of Confirmatory Factor Analysis with 37 Pain Quality Items; Random Split-half Sample from Pooled Wave 1 and ACPA Data (N=725); 6-factor Solution

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
How intense was your tugging pain?	0.86					
How intense was your pulling pain?	0.85					
How intense was your squeezing pain?	0.79					
How intense was your pressing pain?	0.88					
How intense was your tingling pain?		0.89				
How intense was your numb pain?		0.83				
How intense was your cool pain?		0.75				
How often did you experience freezing pain?		0.86				
How intense was your pricking pain?		0.90				
How intense was your itchy pain?		0.55				
How intense was your sharp pain?			0.92			
How intense was your stabbing pain?			0.89			
How intense was your piercing pain?			0.89			
How intense was your shooting pain?			0.90			
How intense was your stinging pain?			0.82			
How often did you experience tearing (ripping) pain?			0.85			
How intense was your hot pain?			0.78			
How often did you experience burning pain?			0.84			
How intense was your dull pain?				0.71		
How intense was your aching pain?				0.91		
How intense was your sore pain?				0.84		
How often did you experience nagging pain?				0.89		
How intense was your annoying pain?				0.91		
How intense was your tender pain?				0.81		
How intense was your radiating pain?				0.89		
How intense was your pounding pain?					0.87	

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
How intense was your pulsing pain?					0.88	
How intense was your throbbing pain?					0.92	
How intense was your splitting pain?					0.80	
How intense was your cramping pain?					0.72	
How often did you experience unbearable pain?						0.96
How often did you experience vicious pain?						0.95
How often did you experience torturing pain?						0.95
How often did your pain feel intolerable?						0.95
How often did you experience cruel pain?						0.91
How often did you experience sickening pain?						0.90
How intense was your heavy pain?						0.84