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A QST-based Pain Phenotype in Adults with Sickle Cell Disease: Sensitivity and Specificity of Quality Descriptors

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Abstract

Background: We sought to refine a screening measure for discriminating a sensitized or normal sensation pain phenotype among African American adults with sickle cell disease (SCD).

Objective: To develop scoring schemes based on sensory pain quality descriptors; evaluate their performance on classifying patients with SCD who had sensitization or normal sensation, and compare with scores on the Self-report Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS) and the Neuropathic Pain Symptom Inventory (NPSI).

Methods: Participants completed PAINReportIt®, quantitative sensory testing (QST), S-LANSS, and NPSI. Conventional binary logistic regression and lasso (least absolute shrinkage and selection operator) regression were used to obtain two sets of weights resulting in two scores: PR-Logistic and PR-Lasso. Performance of the proposed scores and the existing scores were evaluated.

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Results: Lasso regression resulted in a parsimonious model with non-zero weights assigned to two neuropathic descriptors, cold and spreading. We found positive correlations between the PR-Lasso and other scores: S-LANSS ($r=.22$, $p<.01$), NPSI ($r=.22$, $p<.01$), and PR-Logistic ($r=.35$, $p<.01$). The NPSI and PR-Lasso performed similarly at different levels of required specificity and outperformed the S-LANSS and PR-Logistic at the various specificity points.

Conclusion: The PR-Lasso offers a way to discriminate a SCD pain phenotype.

Keywords

Pain; Sickle Cell Disease; Neuropathic Pain; Pain Measurement; Pain Assessment Tools; Sensitivity; Specificity

Introduction

A validated screening measure is needed to discriminate a pain phenotype of sensitization versus normal sensation.^{1,2} One such measure derived from PAINReport®,³ a computerized version of the McGill Pain Questionnaire (MPQ),⁴ was a subscale scored by simply counting the number of neuropathic pain descriptors (PR-NNP) chosen from among a set of both neuropathic and nociceptive descriptors.⁵ Investigators found an association between some of the MPQ sensory pain quality descriptors and quantitative sensory testing (QST)-derived classifications in adults with sickle cell disease (SCD).⁶ Additional research, however, is needed to refine the screening measure. The purpose of this study was to evaluate two scoring schemes for aggregating data from PR sensory pain quality descriptors (both neuropathic and nociceptive) on screening performance for pain sensitization in adults with SCD.

Background

Sensitization to non-noxious (allodynia) or noxious (hyperalgesia) stimuli is a well-known indicator of neuropathic pain. As recently redefined, neuropathic pain is the response to nerve injury caused by a lesion or disease of the central (CNS), the peripheral (PNS) somatosensory nervous system, or both the CNS and PNS.⁷ The hallmark symptom of SCD is pain that can be persistent and so severe that many patients require hospitalization to manage it at an annual cost of over \$2 billion.^{8–12} In the recent past, pain of SCD was not considered to arise from a neuropathic mechanism.^{5,12} Pain of SCD, however, is complex and may vary by underlying etiology that involves some dysfunction of the nervous system such as peripheral and central sensitization.^{8,9,12–14} Studies have revealed altered peripheral nerve architecture in animal models of SCD and evidence of sensitization in humans with SCD.^{1,2,12,15–21} Neuropathic pain is associated with pain of increased duration and intensity that is less responsive than nociceptive pain to typical doses of opioid analgesics.^{12,13,15,19,22} The prevalence of neuropathic pain in SCD is unknown; however, an efficient screening tool with adequate sensitivity and specificity would assist in the identification of the underlying pain mechanisms, which could lead to innovative research and targeted treatment with improved outcomes.^{23–25}

QST and self-report questionnaires are useful to characterize sensitization and neuropathic pain experiences of patients with SCD.^{1,5,16–18,20,26,27} In particular, QST results in African Americans with SCD reveal the presence of abnormal thermal pain threshold (sensitivity) and/or reduced mechanical pain threshold (sensitivity).^{1,2,12,20–22} Specifically they report lower heat pain thresholds than the published norms^{1,12} and higher cold pain thresholds.^{2,12,20,28} There also are significant differences in heat pain tolerance between SCD and healthy control participants.¹ Abnormal results of mechanical QST included findings of significantly reduced mechanical pain threshold in both adults¹ and children²⁰ with SCD when compared to healthy controls. The discriminatory properties of QST for pain type is important, however, QST protocol complexity, specialized skill and time required to conduct QST, and access to QST equipment may limit its general availability in all clinical settings.^{29–31} Therefore, accurate self-report questionnaires with discriminatory value could be useful resources for researchers and clinicians as they screen for pain types.

Self-report questionnaires that have potential for discrimination of pain include a version of the Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS), the Neuropathic Pain Symptom Inventory (NPSI), and the MPQ.^{26,32–35} However, these tools are not without limitations. The S-LANSS is known to accurately classify only 75% of patients,²³ and for inconsistent agreement between clinicians regarding clinical diagnosis.²³ Although the NPSI is validated for assessment of central and peripheral neuropathic pain in patients with neuropathic etiology, it has not been validated for discrimination of pain type.²⁸ The MPQ is a well-known, valid tool that can be used to discriminate between pain types using a list of pain quality descriptors.^{31–35} The descriptors from the MPQ have been used to discriminate pain type,³⁴ and have been classified as neuropathic and nociceptive pain^{21,36} from which the PR-NNP was proposed.¹¹ There was a moderate positive correlation between the PR-NNP and the NPSI ($r=.43$, $p<.01$) and S-LANSS ($r=.41$, $p<.01$)⁵ in a sample where the NPSI and S-LANSS showed only a slightly stronger correlation ($r=.57$, $p<.01$).⁵ These findings show promise for the pain quality descriptors, but it is possible that another scoring approach could produce a better screening tool to discriminate patients with SCD who have allodynia or hyperalgesia that defines neuropathic pain. Use of an appropriate self-report screening tool for neuropathic pain in adults with SCD would help clinicians identify a neuropathic component to their patients' pain. Identification of probable neuropathic pain components to the patient's pain phenotype would provide the basis for further assessment and selection of appropriate non-opioid analgesics.

Aim

The specific aim of this study was to develop a new score based on PR pain quality descriptors that maximizes the accuracy of classifying known groups of patients with SCD who had sensitization or normal sensation based on QST findings and evaluate its associations with the self-report version of the S-LANSS and the NPSI. We expected that the new score would have adequate sensitivity and specificity. Findings could provide a valuable self-report pain screening tool that is convenient for adults with SCD and aids researchers and clinicians in pain management and treatment decision making.

Methods

Design

This cross-sectional, single-session, exploratory study was approved by the institutional review board (IRB) and written signed consent of the participants was obtained. Approval to conduct the analysis of existing data was obtained from the University IRB prior to request for the de-identified dataset.

Setting

The primary setting for collection of the data occurred at a College of Nursing located in the Midwestern US. The setting for the analysis of existing data was at a College of Nursing located in the Southeastern US.

Participants

Eligibility criteria required that the participant (a) was diagnosed with SCD, (b) had chronic SCD pain, defined as patient-reported pain > 0 on at least one half of the days for about 3 months during the previous 12 months, (c) was at least 18 years of age, (d) had moderate to severe level of pain (≥ 3 on 0–10 scale) within the last 12 months or currently on routine pain medications without which would have pain ≥ 3 , (e) reported African ancestry, and (f) was able to speak and read English. Exclusion criteria included patients who were (a) legally blind, (b) physically or cognitively unable to complete the study procedures, or (c) diagnosed with polyneuropathy or diabetes mellitus. Of the 186 consented participants, we excluded three due to missing measures of interest to this study, leaving 183 participants available for analysis.

Measurements

McGill Pain Questionnaire—PAINReportIt®, a computerized version of the 1975 MPQ, is a measure of pain perception that has test-retest reliability and content validity for adults with SCD.^{5,12,32} PAINReportIt® consists of 24 screens in total, 13 screens are for the MPQ items.^{15,37,38} The four screens relevant to this report include those that contain the sensory pain quality descriptors (Figure 1). Demographic information and the valid and reliable Pain Intensity Number Scale (0 = no pain to 10 = pain as bad as it could be, Figure 1) are embedded within PAINReportIt®.³⁷

Neuropathic Pain Symptom Inventory—The NPSI is a 12-item self-report tool designed to measure the quality and severity of neuropathic pain and to examine patient response to treatment. Items on the NPSI capture data related to subject-reported neuropathic pain using pain quality descriptors and temporal descriptors of their pain.³² Currently, no established cut-off score exists for the NPSI, however, higher scores are positively associated with neuropathic pain.³⁰ The NPSI has validity and reliability in patients with neuropathic pain related to peripheral and central sensitization.²⁹ There is test-retest reliability of the NPSI between baseline and one-month follow-up response with a very high (>0.90) intraclass correlation coefficient (ICC) on almost all items during the same visit, and out of 111 patients 37% reported unchanged symptoms after one month.³⁰ Items

on the NPSI related to evoked pain (brushing, pressure, and cold) were moderately correlated to the researchers' estimations.²⁷

Self-administered Leeds Assessment of Neuropathic Symptoms and Signs—

The S-LANSS, a modified version of the LANSS, is a valid 7-item measure for pain of neuropathic origin.²⁶ The LANSS requires clinician examination while the S-LANSS allows patient self-report. To complete the S-LANSS, patients respond yes/no to the five symptom questions and two self-examination tests of clinical signs to test for altered sensation.^{26,31} Each item on the S-LANSS is weighted similar to LANSS using the odds ratio of each item when predicting whether pain is neuropathic in origin to produce a total score between 0 and 24. A score of 12 or higher in the unaided S-LANSS is indicative of a neuropathic mechanism of pain. Expert clinician opinion and comparisons with the Neuropathic Pain Scale established the cut-off scores for the unaided and interview S-LANSS. The validity and reliability of the S-LANSS in a clinical setting was obtained with comparisons between self-report scores and clinician opinion.²⁶

Quantitative Sensory Testing—Mechanical and thermal QST detect experimentally induced sensation, including normal neural function and response to non-painful stimuli (allodynia) and response to painful stimuli (hyperalgesia).¹² Participants were asked to click a computer mouse to indicate thermal pain threshold (first perceived as painful). Mechanical allodynia and hyperalgesia were assessed using 7 calibrated von Frey filaments (0.6g, 1.4g, 4.0, 6.0g, 10g, 26g, and 60g).^{12,39} We were interested in understanding ascending peripheral fiber function, to detect the sensitization of the A- δ fibers (cold sensation), C fibers (heat sensation), and A β fibers (mechanical sensation), QST thermal and mechanical pain thresholds and pain intensity levels were compared to pre-defined thresholds. We focused on participants exhibiting extreme sensitivity to stimuli. More specifically, sensitization of A β fibers was defined as pain reported at the lowest pressure (0.6g) or moderately severe pain (0–10 pain intensity scores rated 6 or higher) in response to other pressure stimuli; thermal sensitization as pain reported within 0.5° C of baseline (32° C) for upper body sites or within 1.5° C of baseline for lower body sites or moderately severe 0–10 pain intensity scores (6 or higher) in response to the thermal stimuli was utilized for the synthesis of QST findings for heat (C fibers), cold (A- δ fibers), (thermal) and mechanical pain thresholds (A- β fibers) across test sites that included two pain sites and one non-painful site.⁴¹ They were selected from the following 12 priority test sites (left and right sides for each area): forearm anterior, forearm posterior, upper arm, leg lateral, leg medial, and leg posterior. We used the anterior forearm as the non-painful site if possible. The two painful sites were selected from painful areas close to the 12 priority areas described above, as reported by the patients on the PAINReport® Body Outline drawing.

Participants able to sense the stimuli and with QST findings negative for allodynia or hyperalgesia at all test sites were classified as having normal sensation. QST findings positive for allodynia or hyperalgesia at non-painful test sites resulted in participants classified with central sensitization. Participants were classified as peripheral sensitization with findings negative for allodynia or hyperalgesia at the non-painful test sites (A- δ , and C-fiber) and A- δ or C-fiber findings positive for allodynia or hyperalgesia at both painful sites.

Participants that did not fit either central or peripheral sensitization or normal sensation criteria were classified as mixed sensitization.⁴⁰ For this study, participants classified by QST as having central, peripheral, or mixed sensitization were grouped as sensitized.⁴¹

Analysis

In this exploratory study with the goal of determining the best scoring method for aggregating the pain quality descriptor data, we examined weighted scoring methods that assigned unequal weights to different pain descriptors. We first considered using the coefficient estimates from a conventional binary logistic regression model of sensitization (normal vs. sensitized) as weights for corresponding pain quality descriptors (both neuropathic and nociceptive). These weight coefficients are therefore the log odds associated with the pain quality descriptors and descriptors more predictive of sensitization are weighted more heavily in the score. Conventional regression models can be susceptible to overfitting as the number of parameters increases, as the high degree of freedom in a model allows it to adjust to both signal (useful information) and the noise in a given set of data. Overfitting often results in models that fit the current training data well but perform badly when presented with new data, namely there will be a large gap (optimism in machine learning terminology) in model performance applying to training data and to new data. As an alternative, we assigned to pain descriptors weight coefficients obtained from lasso (least absolute shrinkage and selection operator) regression, which shrinks regression coefficients and force many to become zero when there are a large number of coefficients.⁴² Lasso therefore reduces overfitting by reducing the effective degree of freedom of a model and often results in models with good performance when presented with new data. An added benefit of shrinking many coefficients to zero is that it leads to more parsimonious models with better interpretability and in our case also reduces patient burden. To determine the optimal effective degree of freedom in lasso, we utilized 10-fold cross validation (CV).

We set three benchmarks for comparison with the new scoring system, which included the original PR-NNP scored by using a count of the number of neuropathic words chosen and two other neuropathic pain measures, the S-LANSS and the NPSI. The descriptive statistics for various scores were obtained for patients with and without sensitization. Independent t tests were used to compare the scores of these two groups of patients. Correlations between different scores were calculated. The level of significance was set at $p < .05$.

To evaluate classification performance of various scoring schemes, we generated the receiver operating characteristics (ROC) curve for each.^{39,43} The ROC curve is a plot of sensitivity of a classifier versus the complement of specificity (i.e., 1-specificity) as the cutoff threshold changes. For the two weighted scoring schemes that utilized weights generated from the data, we used leave-one-out CV to obtain estimates of their performance.⁴⁴ This means that we used a nested CV for lasso, an inner loop of 10-fold CV to determine the optimal effective degree of freedom and an outer loop of leave-one-out CV to estimate its performance when applied to new data.

Results

Demographics.

The 183 study participants were aged 19 years to 66 years (mean age 36.5 ± 11.4), most were female (59%), and single or widowed (77%). They had education up to high school (43%) or some college (46%) and had an annual income lower than \$30,000 (81%). Fifty-eight individuals (32%) had sensitization. Descriptive statistics by patient sensitization group appear in Table 1. Compared with patients in the normal sensation group, patients in the sensitized group had lower educational attainment ($p < .01$).

PR-Logistic and PR-Lasso scoring schemes.

The weights assigned to each pain quality descriptors under PR-Logistic and PR-Lasso scoring schemes are shown in Figure 2 and Figure 3, respectively. As expected, lasso regression resulted in a much more parsimonious model with non-zero weights assigned to only two descriptors, cold and spreading, both of which are neuropathic descriptors. The implication is that the PR-Lasso scoring scheme requires a patient to indicate only whether these two descriptors, cold and spreading, apply to their pain sensation (Figure 3).

Normal versus sensitized.

Descriptive statistics by sensitization group are presented in Table 2 for the new weighted scores (PR-Logistic and PR-Lasso) and the existing scores, (PR-NNP, S-LANSS, and NPSI). There were statistically significant differences in scores between QST classification groups. Specifically, the sensitized group scored significantly higher on the new weighted scores and one existing score, the NPSI.

Classification performance.

The ROC curves of the existing scores, PR-NNP, S-LANSS, and NPSI and the new scores PR-Logistic and PR-Lasso are plotted in Figure 4. In Table 3, we list the sensitivity of different scoring schemes at specificity ranging from 50% to 90%.

The NPSI and PR-Lasso performed similarly at different levels of required specificity as can be seen in both Figure 4 and Table 3. They outperformed the other scores (S-LANSS, PR-NNP, PR-Logistic) at the various specificity points. The PR-Logistic score weighted by conventional binary logistic regression coefficients had the worst performance at specificity levels less than 90%.

Correlations between scores.

Correlations between the various scores are shown in Table 4. We found a moderate positive correlation between the original PR-NNP score and the NPSI score ($r = .31$, $p < .001$), and between the original PR-NNP score and the S-LANSS score ($r = .40$, $p < .01$). A weak positive correlation was found between the PR-Logistic score and NPSI score ($r = .24$, $p < .01$). We found a weak positive correlation between the PR-Lasso score and the S-LANSS score ($r = .22$, $p < .01$), and between the PR-Lasso and the NPSI ($r = .22$, $p < .01$). We found a moderate positive correlation between the PR-Lasso and the original PR-NNP ($r = .50$, $p < .01$) and between the PR-Lasso and PR-Logistic ($r = .35$, $p < .01$) (Table 4).

Discussion

Our study is the first to examine sensory pain quality descriptors along with QST results to develop a screening measure for sensitization in adults with SCD. The main finding was that two pain quality descriptors, cold and spreading, could serve as a screening tool with good sensitivity to discriminate between sensitization and normal sensation. This tool seems to perform similarly to NPSI and delivers diagnostic data for clinical and research purposes in a computerized format that is easy for patients to use.

Some of the neuropathic sensory pain quality descriptors on the MPQ also appear on other neuropathic pain measures, such as the S-LANSS, and the NPSI.^{23–24} Although the PR-NNP contained only the 28 neuropathic sensory pain quality descriptors, we included all 54 sensory pain quality descriptors to derive our new scores. Our purpose for inclusion of all 54 sensory pain quality descriptors was to provide a wide range of word choices and test this as a measure that would discriminate between sensitization and normal sensation.

Identification of the underlying pain mechanism provides important information for: a) researchers to investigate SCD pain, b) clinicians to make decisions for pain interventions, and c) patient education to improve understanding of their condition. Therefore, it was logical to use the valid and reliable MPQ with a group of patients with pain that was classified by QST as sensitized or normal sensation and to refine a scoring system that would differentiate pain mechanisms in adults with SCD.

Of the two scoring methods tested, we found that the PR-Lasso provided the best performance when compared to the PR-Logistic. Our decision was based on the performance, namely the sensitivity and specificity, of various scores in classifying sensitized and normal sensation groups using the classification of sensitization as the “gold standard”. A perfect measure would correctly identify 100% of those with and without neuropathic pain. Our proposed screening measure, the PR-Lasso would reduce clinician burden as two sensory pain quality descriptors (cold and spreading) become the most important descriptors to look for when suspecting the presence of neuropathic pain.

We theorize that the PR-Lasso score performs more similarly to NPSI than S-LANSS because S-LANSS does not include questions about cold whereas the NPSI does and patients with SCD are especially responsive to measures of cold detection.^{2, 10, 17, 25} Similar to the findings of other researchers in a different sample of adults with SCD, we found a strong positive correlation between the S-LANSS and NPSI, which are both self-report measures of neuropathic pain.⁵ Ezenwa and colleagues found that 40% of their sample of adults with SCD scored above the S-LANSS cut-off point >12. In our sample of adults with SCD, 47% that were classified by QST as sensitized scored above the S-LANSS cut-off point >12, meaning they were likely to have neuropathic pain.

Treatment goals and appropriate selection of analgesics are dependent upon accurate classification of pain.²² Since our data were collected at one time point, an area for future research would be to test the PR-Lasso score using repeated measures of the self-reported sensory pain quality descriptors to determine if there are changes in the descriptors selected over time.

Limitations of our findings include the fact that the participants were enrolled from only one geographic location in the Midwestern US and therefore, findings may not be generalizable to the population of adults with SCD. In addition, as we did not perform nerve conduction studies or neuroimaging, we are not able to state from our findings that adults with SCD definitively suffer from neuropathic pain. Indeed, non-neuropathic pain conditions often exhibit allodynia and hyperalgesia. Continued research in discrimination of pain mechanisms in patients with SCD is needed to determine the contribution of neuropathic pain to the pain experience of patients with SCD.

In summary, our work built on previous research, but was more robust in the inclusion of QST classifications of adults with SCD with either sensitization or normal sensation. Two descriptors, cold and spreading, combined to provide a parsimonious indicator of sensitization among adults with SCD. PR-Lasso has a good sensitivity, can discriminate between sensitization and normal sensation, and delivers diagnostic data for clinical and research purposes in a computerized format that is easy for participants to use. These findings will be helpful for planning future research to refine and strengthen the PR-Lasso.

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The figure displays four screenshots of the PAINRelieveIt web application interface, arranged in a 2x2 grid. Each screenshot shows the application's header with the logo and navigation links (HOME, SIGN OUT). The current user is identified as 'jdest'.

Top Left Screenshot (Word(1)): The breadcrumb trail is 'PCOR(Hospice) > Pain Assessment > Word(1)'. The page number is 7/29. The instruction reads: "Some of the words below describe how your pain usually feels or its 'nature'. Touch as many words as you need to describe how your pain feels. Remember to include all your areas of pain when selecting words." Below this, it says "1 of 5 Word Pages". A grid of 20 pain descriptors is shown, each with a checkbox: Flickering, Jumping, Pricking, Sharp, Pinching, Quivering, Flashing, Boring, Cutting, Pressing, Pulsing, Shooting, Drilling, Lacerating, Gnawing, Throbbing, Stabbing, Cramping, Beating, Lancinating, Crushing, and Pounding. Electric shock is also listed.

Top Right Screenshot (Word(2)): The breadcrumb trail is 'PCOR(Hospice) > Pain Assessment > Word(2)'. The page number is 8/29. The instruction reads: "Here are more words to describe how your pain usually feels or its 'nature'. Touch as many words as you need to describe how the pain feels." Below this, it says "2 of 5 Word Pages". A grid of 15 pain descriptors is shown, each with a checkbox: Tugging, Hot, Tingling, Dull, Tender, Pulling, Burning, Itchy, Sore, Taut, Wrenching, Scalding, Smarting, Hurting, Rasing, Searing, Stinging, Aching, Splitting, and Heavy.

Bottom Left Screenshot (Word(4)): The breadcrumb trail is 'PCOR(Hospice) > Pain Assessment > Word(4)'. The page number is 10/29. The instruction reads: "Here are more words to describe how your pain usually feels or its 'nature'. Touch as many words as you need to describe how the pain feels." Below this, it says "4 of 5 Word Pages". A grid of 15 pain descriptors is shown, each with a checkbox: Annoying, Spreading, Tight, Cool, Nagging, Troublesome, Radiating, Numb, Cold, Nauseating, Miserable, Penetrating, Drawing, Freezing, Agonizing, Intense, Piercing, Squeezing, Dreadful, Unbearable, Tearing, and Torturing. Navigation links: « Previous, Main Menu, Next » are at the bottom.

Bottom Right Screenshot (Pain Now): The breadcrumb trail is 'PCOR(Hospice) > Pain Assessment > Pain Now'. The page number is 4/29. The instruction reads: "We need to know how much pain you have to help you relieve it. Because we can't feel your pain, you need to use a scale to let us know how much discomfort you have. The numbers between 0 and 10 represent ALL the pain a person can have. 0 means no pain and 10 means pain as bad as it could be. You can use ANY number, including fractions, between 0 and 10 to let us know how much pain you have RIGHT NOW. Call your pain a number to let us know the intensity of the pain you feel NOW." Below this is a numeric keypad with buttons for 0-9, a decimal point, and a CLR button. Navigation links: « Previous, Main Menu, Next » are at the bottom.

At the bottom of each screenshot, there is a footer with the text: "Home | Sign Out" and "Sep 15, 2014". The copyright notice at the bottom of the page is: "Copyright © 2014 Nursing Consult LLC".

Figure 1.
PAINReportIt's Pain Quality and Intensity Screens: From the PAINRelieveIt Suite of Pain Management Programs

Figure 2.
Weights Based on Binary Logistic Regression

Figure 3.
Weights Based on Lasso Regression

Figure 4.
ROC: Classification Performance of Various Scores

Table 1.

Demographic Characteristics of Participants

Variable		Normaln=125	Sensitizedn=58	P
Age	Mean (SD)	35.4 (10.9)	38.9 (12.1)	.07
Sex	Female	68 (54%)	40 (69%)	.08
	Male	57 (46%)	18 (31%)	
Race	African American	122 (98%)	55 (95%)	.38
	Other African heritage	3 (2%)	3 (5%)	
Marital Status ^a	Married/Partnered	30 (25%)	12 (21%)	.71
	Single/Widowed/Divorced	92 (75%)	46 (79%)	
Education ^a	College or higher	19 (15%)	0 (0%)	<.01
	Some college	53 (43%)	30 (53%)	
	Up to high school	51 (41%)	27 (47%)	
Income ^b	Less than \$10k	45 (38%)	28 (51%)	.25
	\$10k-\$30k	49 (41%)	19 (35%)	
	30k or higher	25 (21%)	8 (15%)	

Note: data are frequencies (percentages), unless otherwise specified;

^a3 missing;

^b9 missing.

Table 2.

Descriptive Statistics for the PAINReportIt® Scores and Benchmark Scores

Variable	Normal	Sensitized	p Value
S-LANSS	10.3 (6.4)	11.8 (6.8)	.15
NPSI	32.2 (17.9)	43.9 (22.9)	<.01
PR-NNP	4.7 (3.5)	5.7 (4)	.08
PR-Logistic	−0.7 (1.1)	0.1 (0.5)	<.01
PR-Lasso	0.3 (0.5)	0.6 (0.6)	<.01

Definition of abbreviations: S-LANSS: self-report version of the Leeds Assessment of Neuropathic Symptoms and Signs; NPSI: Neuropathic Pain Symptom Inventory; PR-NNP: PAINReportIt® number of neuropathic words; PR-Logistic, PAINReportIt® score weighted by conventional binary logistic regression coefficients; PR-Lasso, PAINReportIt® score weighted by lasso regression coefficients. The scores of sensitized are compared with not sensitized participants.

Table 3.

Sensitivity for all scores at different levels of required specificity

Measure	Required Specificity				
	90%	80%	70%	60%	50%
PR-NNP	14%	27%	38%	53%	62%
S-LANSS	15%	31%	38%	47%	59%
NPSI	25%	50%	59%	66%	71%
PR-Logistic	14%	17%	22%	35%	45%
PR-Lasso	23%	46%	60%	66%	71%

Definition of abbreviations: PR-NNP: PAINReportIt number of neuropathic words; S-LANSS: self-report version of the Leeds Assessment of Neuropathic Symptoms and Signs; NPSI: Neuropathic Pain Symptom Inventory; PR-Logistic, PAINReportIt® score weighted by conventional binary logistic regression coefficients; PR-Lasso, PAINReportIt® score weighted by lasso regression coefficients.

Table 4.

Correlations between Scores

Measure	S-LANSS	NPSI	PR-NNP	PR-Logistic
S-LANSS	1.00			
NPSI	0.51 *	1.00		
PR-NNP	0.40 *	0.31 *	1.00	
PR-Logistic	0.08	0.24 *	0.02	1.00
PR-Lasso	0.22 *	0.22 *	0.50 *	0.35 *

* Correlation is significant at the 0.01 level (2-tailed). Definition of abbreviations: S-LANSS: self-report version of the Leeds Assessment of Neuropathic Symptoms and Signs; NPSI: Neuropathic Pain Symptom Inventory; PR-NNP: PAINReportIt® number of neuropathic words; PR-Logistic, PAINReportIt® score weighted by conventional binary logistic regression coefficients; PR-Lasso, PAINReportIt® score weighted by lasso regression coefficients.