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Comparison of Low Back Pain Recovery and Persistence: A Descriptive Study of Characteristics at Pain Onset

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Abstract

Background—Persistent low back pain is a significant problem worldwide. Early identification and treatment of individuals at high risk for persistent low back pain have been suggested as strategies to decrease the rate of disability associated with this condition.

Purpose—To examine and compare demographic, pain-related, psychological, and somatosensory characteristics in a cohort of participants with acute low back pain who later went on to experience persistent low back pain or whose pain resolved within the first 6 weeks after initial onset.

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Author Contribution

Angela R. Starkweather contributed to conception and design; contributed to acquisition, analysis, and interpretation; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Debra E. Lyon contributed to conception and design; contributed to interpretation; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Patricia Kinser contributed to design; contributed to interpretation; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Amy Heineman contributed to design; contributed to acquisition; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Jamie L. Sturgill contributed to design; contributed to acquisition; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Xiaoyan Deng contributed to design; contributed to analysis; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Umaporn Siangphoe contributed to design; contributed to analysis; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. R. K. Elswick contributed to design; contributed to analysis; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Joel Greenspan contributed to design; contributed to analysis and interpretation; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy. Susan G. Dorsey contributed to conception and design; contributed to interpretation; drafted the manuscript; critically revised the manuscript; gave final approval; and agreed to be accountable for all aspects of work ensuring integrity and accuracy.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Methods—A descriptive study was conducted among men and women 18–50 years of age who had an acute episode of low back pain. Study questionnaires were administered to collect demographic information and measures of pain, coping, reactivity, mood, work history and satisfaction, and disability. A standardized protocol of quantitative sensory testing was performed on each participant at the painful area of their low back and at a remote site on their arm.

Results—The sample consisted of 48 participants, of whom 19 went on to develop persistent low back pain and 29 resolved. Compared to the resolved group, the persistent low back pain group was significantly older and had a lower level of educational attainment, a higher body mass index, and higher mean "least" pain score on the Brief Pain Inventory–Short Form. Significantly higher thermal detection thresholds at the painful and remote sites as well as signs of central sensitivity differentiated the persistent pain group from the resolved group during the acute stage of low back pain.

Keywords

low back pain; symptoms; quantitative sensory testing; chronic pain

Persistent low back pain (PLBP) is one of the most expensive medical conditions in the United States and has contributed significantly to the increase in health-care spending, owing in part to its increased prevalence (Institute of Medicine, 2011; Martin et al., 2012). As the most common site of pain in young and middle-aged adults, LBP is one of the most frequent reasons for sick leave and long-term time out of employment (Hoy et al., 2012). With a substantial increase in the prevalence of PLBP over the past decade, there has also been a rise in the use of health-care services, particularly for spinal injections, surgery, and opioid medications (Fritz, Brennan, & Hunter, 2015). Due to the escalating use of health-care resources as well as the detrimental effects on health and quality of life, the Agency for Healthcare Research and Quality listed PLBP as one of the most costly public health issues of the 21st century (Soni, 2011).

Early identification and treatment of individuals at high risk for PLBP have been suggested as strategies to decrease the rate of disability associated with this condition. Although a major research focus has been identifying the psychosocial factors that contribute to PLBP, there is lack of consensus regarding which factors truly predict a chronic trajectory (Von Korff et al., 2014). Cumulatively, the factors that have been consistently associated with an increased risk of PLBP include high levels of maladaptive pain coping behaviors, increased somatization, mood disturbances, high baseline functional impairment, and low general health status (Webster & Markman, 2014).

Another factor that may help to identify individuals at risk of a PLBP trajectory is altered somatosensory function measured by quantitative sensory testing (QST; Courtney, Kavchak, Lowry, & O'Hearn, 2010). A noninvasive examination of somatosensory perception, QST uses the application of mechanical and thermal stimuli at controlled intensities (Rolke et al., 2006). Clinicians or researchers can use QST to enhance the traditional clinical exam of LBP to detect somatosensory aberrations that may contribute to the individual's experience of pain and disability. The battery of tests involved in QST can be used to evaluate the function of large (A-beta) and small (A-delta and C) nerve fibers as well as central pathways

of sensory perception. Although it remains unclear whether QST measures provide prognostic value in the early acute phase of LBP, research has shown that peripheral sensitivity and central sensitivity are associated with pain severity and disability in populations with persistent pain (Kasch, Qerama, Bach, & Jensen, 2005; Yarnitsky et al., 2008).

Several authors have reported altered somatosensory function in people with PLBP. However, these studies reported limited assessment of somatosensory function at one or two sites such as the forehead, thumbnail, and/or forearm (Clauw et al., 1999; Giesecke et al., 2004). Other studies have included more comprehensive assessments including the painful area of the lumbar region. Blumenstiel et al. (2011) used the QST protocol of the German Research Network on Neuropathic Pain in a group of 21 patients with fibromyalgia (mean duration = 13.4 years), 23 individuals with PLBP (mean duration = 15.9 years), and 20 healthy controls. In the PLBP group, researchers evaluated the paraspinal muscles at the site of pain, using the dorsum of the hand as a control site. The fibromyalgia group had increased sensitivity for different pain modalities at all measured body areas, whereas the PLBP group showed localized alterations of higher sensitivity to pressure pain and lower sensitivity to vibration detection within the affected segment possibly due to peripheral sensitization. In another study, investigators used responses to pressure pain of the infraspinatus muscle, cold pressor test, and mechanically induced conditioned pain modulation to compute a composite score of pain sensitivity in adults with PLBP, finding that sensitivity was associated with LBP severity and disability (O'Neill, Manniche, Graven-Nielsen, & Arendt-Nielsen, 2014). More recently, Puta et al. (2013) compared the QST profiles of individuals with PLBP and healthy (no-pain) controls. They reported hyposensitivity to warm/cold detection at the painful site and decreased pain thresholds at the painful and distant sites in PLBP compared to controls. While these studies provide some evidence of altered somatosensory function once PLBP occurs, they do not address the possibility of a unique somatosensory signature during the acute stage of LBP that may differentiate those who are more likely to experience PLBP.

In the clinical setting, nurses are often heavily involved in both the assessment of pain and provision of symptom management strategies. A deeper understanding of the psychological and physiological factors related to PLBP that are present when the pain first occurs could assist nurses in identifying high-risk patients and may allow for the development of tailored strategies to mitigate LBP severity and pain-related disability. Thus, the aim of this study was to examine and compare baseline demographic, pain, psychological, and somatosensory characteristics of a cohort of participants with acute LBP enrolled in an ongoing clinical investigation. Participants enrolled in the study during an acute phase of LBP and were categorized either as "recovered" (recovered group) if their pain resolved in the first 6 weeks after onset or as "persistent" (PLPB group) if their pain continued for 6 months. The present analysis focuses only on the baseline values collected when participants were in the acute stage of LBP.

Method

We invited men and women between the age of 18 and 50 years diagnosed with an acute episode of LBP to participate. An acute LBP episode was defined as pain anywhere in the region of the low back bound superiorly by T12 and inferiorly by the buttock crease that had been present for more than 24 hr but less than 4 weeks and was preceded by at least 1 pain-free month (de Vet et al., 2002). We selected this age range to provide a more homogeneous sample in terms of general health, work status, and factors contributing to persistent LBP. Recruitment took place at an urban university health system in the mid-Atlantic region after approval from the institutional review board. Recruitment and data collection took place from September 2013 to December 2014. We screened 550 individuals and enrolled 106 participants with acute LBP who met the inclusion criteria. Of these, 29 had resolution of pain, defined as pain severity of 2 or less on the numeric pain scale by 6 weeks after initial onset, and 19 continued to have pain at 6 months after initial onset.

Participants

Aside from the age and LBP diagnosis criteria described above, eligible participants should also be able to read and write in English. Patients were excluded for the following conditions: (a) chronic pain at another site or associated with a painful condition (e.g., fibromyalgia, neuropathy, and rheumatoid arthritis); (b) previous spinal surgery; (c) presence of neurological deficits such as weakness of the extremities or difficulty ambulating; (d) history of comorbidities that affect sensorimotor function (e.g., multiple sclerosis, spinal cord injury, and diabetes); (e) history of psychological disorders (e.g., major depression, bipolar disorder, and schizophrenia); (f) current treatment with opioid, antidepressant, or anxiolytic medication; or (g) current pregnancy or within 3 months postpartum.

Procedures

After obtaining informed consent, we scheduled participants to undergo baseline data collection as soon as possible and no longer than 1 week from the time of consent. Data collection, including completion of questionnaires on TeleForms and QST, took place in a private research suite. We then scheduled participants for follow-up data collection at 6 weeks from the time of LBP onset and followed them until their LBP resolved or 6 months had passed. At the completion of the data collection visit, participants received a gift card (US$25) as compensation for their time.

Study Measures

Demographics—We collected data on age, gender, socioeconomic status, educational attainment, lifestyle behaviors (e.g., smoking and exercise), body mass index (BMI), comorbidities, past episodes of LBP, and family history of LBP at baseline.

Perceived pain—To collect general data on pain, we used the Brief Pain Inventory–Short Form (BPI-SF), a pain assessment tool that has well-established reliability and validity for adult patients with persistent pain (Cleeland, 1991) and is sensitive to change over time (Keller et al., 2004). The BPI assesses the severity of pain, location of pain, pain medications, amount of pain relief in the past 24 hr and the past week, and the impact of

pain on daily functions. To measure the affective and sensory descriptors of pain, we also used the McGill Pain Questionnaire–Short Form (MPQ-SF), a reliable self-report measure of pain perception (Melzack, 1987; Melzack & Katz, 1991). It comprises 15 verbal descriptors of sensory and affective dimensions of pain and is scored on a 4-point scale (0 = *none* to 3 = *severe*) by summing the numeric values of the pain dimensions. Higher scores indicate higher levels of sensory and affective components of pain (range 0–45). In this sample, the Cronbach's α for each instrument was .91 and .92, respectively.

Coping—To evaluate participants' pain coping strategies, we used the Coping Strategies Questionnaire–Revised (CSQ-R; Robinson et al., 1997), a 27-item self-report questionnaire designed to assess six cognitive coping responses to pain. Subjects rate the frequency of using each coping strategy and perceived control over their pain on a 7-point Likert-type scale, from *never do that* to *always do that*. The subscales have shown adequate internal consistency, with Cronbach's α ranging from .72 to .91 (Hastie, Riley, & Fillingim, 2004), and stable factor structure in patients with chronic pain and healthy populations (Hastie et al., 2004; Riley & Robinson, 1997). In this sample, the Cronbach's α for each subscale ranged from .91 to .93.

Reactivity—We also administered the Kohn Reactivity Scale (Kohn, 1985), which consists of 24 items that assess an individual's level of reactivity or central nervous system (CNS) arousability (McDermid, Rollman, & McCain, 1996). Individuals respond to each item on a 5-category scale ranging from *disagree strongly* to *agree strongly*. The Kohn yields a single summary score created by summing all of the items, after reverse scoring half of the items. It has adequate internal consistency, ranging from α of .73 to .83 (Kohn, 1985). The Kohn correlates negatively with pain tolerance (Dubreuil & Kohn, 1986). In the present sample, Cronbach's α was .92.

Mood disturbance—Participants also completed the Profile of Mood States (POMS), which was designed to measure general distress and mood (McNair & Lorr, 1964; McNair, Lorr, & Droppleman, 1971, 1992). The POMS has 65 total items and 6 subscales: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Fatigue, Vigor, and Confusion-Bewilderment. Respondents indicate the extent to which each of the items (descriptions of mood) describe the way they had been feeling during the past week on a 5-point scale ranging from 1 (*not at all*) to 5 (*extremely*). A total mood disturbance score is derived by summing each of the subscales (Vigor is weighted negatively), with the possible score ranging from −40 through 192. Internal consistency αs range from .87 to .95; test–retest coefficients are .65–.74 (McNair & Lorr, 1964; McNair et al., 1971, 1992). In the present sample, the POMS total Cronbach's α was .91.

Work history and satisfaction—We also assessed questions related to the following areas of work (Jones et al., 2006): (1) number of days the participant has been unable to perform work due to LBP during the last 3 months and (2) satisfaction with work. We scored work satisfaction on a numeric rating scale where 0 is *completely unsatisfied* and 10 is *completely satisfied*. Work could include family caregiving or other types of noncommercial activity that occupied the individual's time.

Functional status—To measure functional status, we used the Roland Disability Questionnaire (RDQ), the most widely used instrument to assess perceived LBP-associated disability (Roland & Morris, 1983), which is more sensitive to changes in pain severity and disability than the Oswestry LBP Questionnaire (Kopec & Esdaile, 1995). The RDQ consists of 24 items that refer to different ways LBP may impact activities. Participants are asked to check the box next to items that apply to him or her, and the score is the number of checked boxes. In the present sample, Cronbach's α was .92.

Perceived stress—We measured levels of stress using the Perceived Stress Scale (PSS; Cohen, 1994). The PSS measures the degree to which respondents appraise situations in their lives as stressful. The 10 items are general in nature and focus on the past month. The PSS has well-documented reliability and validity (Kain, Sevarino, Alexander, Pincus, & Mayes, 2000). In the present sample, Cronbach's α was .92.

QST—We used QST to measure sensitivity to experimental pain. This method uses standardized stimuli to test both nociceptive and nonnociceptive systems (Belfer & Dai, 2010). We strictly followed a standardized protocol of administration, including examination room conditions and instructions provided to the participant (Starkweather et al., 2016). Participants underwent a practice run on their dominant forearm so that we could verify their understanding of the protocol.

We measured mechanical detection threshold with a standard set of von Frey hairs (Optihair2-Set; Marstock Nervtest, Aesthesio, San Jose, CA, Germany) that exert forces between 0.25 and 512 mN and have a rounded tip that is 0.5 mm in diameter. The final threshold is calculated as the geometric mean of five series of ascending and descending stimuli intensities. We assessed mechanical pain threshold and mechanical pain sensitivity using monofilament stimuli in an adaptive staircase method. To assess temporal summation (TS), we had participants rate their level of pain on a 0–100 numerical rating scale (0 indicating *no pain* and 100 indicating *most intense pain imaginable*) after applying a single stimulus for 0.5 s and then again after applying a series of 10 stimuli at 1-s intervals. TS is calculated as the difference between the rating of the series of 10 stimuli and the rating of the single stimulus. We determined windup ratio (WUR) by performing this series of stimuli 3 times and dividing the mean pain rating of the series by the mean pain rating of single stimuli. We tested dynamic mechanical allodynia using a single stroke with a standardized brush applied 3 times.

We performed thermal testing using the Medoc Pathway System™ (Ramat Yishai, Israel). We placed the Medoc thermode, with contact area of 7.84 cm^2, in contact with the participant's skin in the area to be tested. The Medoc software guided the examiner through a series of thermal testing procedures in the following order: cold detection threshold, warm detection threshold, cold pain threshold, and heat pain threshold. We calculated the mean threshold temperature of three consecutive measurements to use for analysis. We obtained all thresholds with ramped stimuli (1°C/s) that were terminated when the participant pressed a button attached to the Medoc device. Cutoff temperatures were 0°C and 50°C with a baseline temperature of 32°C.

For pressure pain threshold (PPT), the examiner used an algometer (range of 50–600 kPa) attached to the Medoc Pathway System to increase the pressure at a steady rate (30 kPa/s) until the participant indicated first pain sensation by pressing the button. We determined the PPT by repeating the procedure at the same site until we either recorded two values within 20 kPa of one another or administered three trials. In either case, we recorded the mean of the two closest values as the threshold estimate. During the testing, we positioned the computer screen so that the participant was not able to watch temperature and pressure fluctuations.

Statistical Analysis

We conducted statistical analyses using JMP Version 11.1 (Cary, NC) and SAS Version 9.4 (Cary, NC). For each study variable, we examined distributional properties to assess normality. Descriptive statistics (means and standard errors for continuous variables and frequencies for categorical variables) were used to characterize the study sample. We have indicated the number of participants with missing data in Tables 1 and 2 for each variable of interest. We used a likelihood ratio test for contingency tables to compare demographic categorical variables in Table 1 and two-sample *t*-tests to compare the continuous demographic variables (Table 1) and pain and symptom variables (Table 2). Analysis of variance with covariates for age, sex, and race was performed for all QST parameters in Table 3. Reference values for healthy (no-pain) controls acquired at the same study site are noted to the far right in Table 3. Due to the exploratory nature of this analysis, we used no adjustment for multiplicity and set our overall significance level at $\alpha = .05$.

Results

Table 1 shows demographic and clinical data for the participants. Of note, the mean age of participants in the PLBP group was significantly higher than that of participants in the recovered group ($p < .05$). The recovered group had a significantly higher rate of college or higher educational attainment ($p < .01$) and a lower BMI ($p < .05$) compared to the persistent group. In addition, a higher percentage of participants in the recovered group had a family history of LBP ($p < .05$). Expectations of pain resolution or persistence, litigation cases (only one), work absences due to pain, and work satisfaction were not significantly different between groups (data not shown).

Mean scores of the questionnaires administered appear in Table 2. Pain severity, measured by the BPI-SF “least” pain score, was significantly higher in the PLBP group compared to the recovered group ($p < .05$). The CSQ-R Praying subscale was significantly higher in the PLBP group compared to the recovered group ($p < .05$). No other pain, mood, or stress scores differed significantly between groups.

We performed QST in the location of pain and in a location without pain (remote site) at baseline (see Table 3). The PLBP group required a significantly lower temperature to detect cold sensation compared to the recovered group in both locations ($p < .05$ for both locations). Likewise, the PLBP group required a significantly higher temperature for the warm detection test in both the pain and control locations compared to the recovered group ($p < .05$ in both locations). The differences in thermal detection thresholds for cold and

warmth at the painful and remote sites suggest a generalized hyposensitivity in the PLBP group. At the remote site, the WUR was significantly higher in the PLBP group compared to the recovered group ($p < .05$).

Discussion

This study provides a unique view of factors present at the initial episode of acute LBP that may influence the pain trajectory. These preliminary findings suggest that age, educational attainment, BMI, and the BPI-SF least pain score are important demographic, psychological, and pain-related factors to consider when evaluating patients during the acute stage of LBP. Although the mean ages of both groups were well below the age of reported peak incidence of PLBP (44 years; Soni, 2011), the higher mean age in the PLBP group appears consistent with the population at large in regard to the increased risk of acquiring a persistent painful musculoskeletal condition (Institute of Medicine, 2011). However, it is worth noting that prior studies focusing on first episode of LBP (mean ages varying from 31 years to 46 years) have found that the risk of chronicity is fairly stable across decades in people over 30 years of age (Grotle et al., 2005; Heymans et al., 2010; Wahlgren et al., 1997). Taken together with the current findings, the data suggest that PLBP occurs frequently at a relatively young age. Therefore, nurses and other health-care clinicians should be focusing on preventive strategies to reduce PLBP occurrence prior to the third decade and throughout the adult life span. This imperative may entail greater attention given to promoting evidence-based health behavior strategies to maintain musculoskeletal functioning, which include posture/body mechanics, musculoskeletal conditioning, and core strengthening exercises (Fritz et al., 2015).

In the present sample, there were more participants in the resolved group with a college-level education and a lower BMI than in the persistent group. The Centers for Disease Control and Prevention and National Center for Health Statistics (2010) had previously cited a lower level of formal educational attainment as a factor commonly associated with persistent pain. Lower educational attainment has been associated with other behavioral risk factors of PLBP, including smoking, obesity, and lack of exercise, as well as comorbid conditions such as psychiatric illness and multiple medical problems (Manchikanti, Singh, Falco, Benyamin, & Hirsh, 2014). While there has not been consensus regarding the relationships among these factors, college education has been consistently identified as a protective demographic predictor of LBP outcome (Mehling, Ebell, Avins, & Hecht, 2015).

In contrast, passive coping strategies have been linked with PLBP in prior LBP studies (Costa et al., 2009; Jones et al., 2006). Consistent with our findings, previous research has shown higher levels of prayer–coping predict persistent pain (Alschuler, Molton, Jensen, & Riddle, 2013; Basinski, Stefaniak, Stadnyk, Sheikh, & Vingerhoets, 2013; Crisson & Keefe, 1988), whereas other studies of back pain populations have found no significant correlations between prayer and pain (Keefe, Crisson, Urban, & Williams, 1990; Woby, Watson, Roach, & Urmston, 2005). Shuster, McCormack, Pillai Riddell, and Toplak (2009) hypothesized that prayer, as a passive coping strategy, is more common in those with an external locus of control whereby the individual feels more dependent upon an “other” to decrease pain rather than engaging in active pain management. On the other hand, individuals who report higher

religiosity, involving prayer, tend to endorse a higher quality of life, despite high levels of pain (Basinski et al., 2013). Future research should evaluate the role of these two variables, locus of control and quality of life, in the relationship between prayer and pain persistence. Knowledge of these variables and of use of common passive coping strategies such as prayer may help clinicians develop individualized plans of care and enhance the success of pain management.

Researchers have previously reported a high pain severity score, measured by the Pain Now subscale on the BPI-SF or Visual Analog Scale, to be a predictor of future PLBP (Grotle et al., 2005; Heymans et al., 2010). However, in the present study, we found that the Pain Now, “average,” and “worst” pain scores did not differ between the PLBP and recovered group at baseline. Instead, we found the “least” pain severity score to be significantly higher in the PLBP group, suggesting that this group had less variability in pain severity over time. While this finding may appear subtle, the inability to significantly reduce pain severity during the acute period may be an important precursor of persistent pain. Aligned with this finding was a marginally significant finding of a higher score on Kohn’s Reactivity Scale in the PLBP group, indicating greater CNS arousability in response to sensory stimuli. Although this scale has been used to distinguish between patients with chronic pain and healthy (no-pain) controls (Veldhuijzen, Noordermeer, van Jijck, Snijders, & Geenen, 2013), this is the first study, to our knowledge, to examine reactivity in patients with acute LBP, and this finding may warrant further study to explore the relationship between reactivity and pain severity during the initial consult.

Somatosensory alterations in the persistent group included significantly different thermal detection thresholds compared to the resolved group, with more extreme temperatures required to detect cold and warmth (innocuous) sensation at both painful and nonpainful locations. Previous studies have reported generalized hyposensitivity to innocuous stimuli in participants with PLBP (median duration of 158 months; Puta et al., 2013); however, in the present study, we observed similar alterations at the initial onset of LBP. Recently, Hubscher, Moloney, Rebbeck, Traeger, and Refshauge (2014) examined thermal pain threshold and tolerance, as opposed to thermal detection threshold, in the painful back region and remote site of participants with acute LBP and found no differences in comparison with a PLBP and normal control group. In addition, LeResche, Turner, Saunders, Shortreed, and Von Korff (2013) reported that PPTs, cold pressor pain ratings, conditioned pain modulation, and mechanical TS in participants presenting with acute LBP (mean 65 days) did not predict PLBP 4 months later. Unfortunately, because neither of these studies measured thermal detection thresholds, we cannot make any comparisons with the current study findings. Evidence from these prior studies, however, indicates that pain thresholds and measures of conditioned pain modulation do not differentiate the clinical course of LBP during the acute stage.

The overall lack of any significant differences in pain thresholds during the acute stage of LBP between the persistent and recovered group is consistent with previous studies (Agostinho et al., 2009; O’Neill et al., 2014; Puta et al., 2013). In the current study, the only indicator of central sensitization in the PLBP group was the WUR at the remote site compared to the recovered group. WUR is a measure of TS of C-fiber-evoked responses that

generate an increase in action potential discharge in second-order neurons. However, the reason for finding increased WUR only at the remote site remains unclear and should be further examined in future studies.

When interpreting these results, it is of interest to consider the findings of Slade et al. (2014) who reported that PPTs modestly predict the incidence of persistently painful temporomandibular disorder (TMD). They suggest that the onset of pain, mediated by peripheral mechanisms, may represent a trigger that facilitates central sensitization in vulnerable individuals. Thus, the difference in thermal detection thresholds observed in the present study may reflect peripherally mediated adaptations in somatosensory information processing, which facilitate central sensitization in PLBP-susceptible individuals. Due to the time course of these adaptations, thermal detection thresholds and WUR at the remote site may be the only indicators of PLBP vulnerability during the acute stage of LBP, whereas more obvious manifestations of central sensitivity (measured by tests of conditioned pain modulation) occur at later time periods. Alternatively, because we could not test premorbid thermal detection thresholds, it is possible that these differences were present in PLBP-vulnerable participants before the episode of acute LBP. However, as premorbid somatosensory values did not predict persistent TMD in the Slade et al. (2014) study, this scenario appears unlikely.

In summary, in the present study, we observed generalized hyposensitivity to thermal stimuli and increased WUR at a remote site during the acute stage of LBP in individuals who continued to have pain 6 months later. Our preliminary findings suggest that alterations in thermal detection thresholds may reflect increased vulnerability to PLBP, and we will investigate these results further in a larger sample. We will also conduct further analyses of QST measures at later time points to characterize somatosensory changes over time in the PLBP group and compare values with participants whose pain eventually resolved.

Limitations of the study include the use of volunteers, which could present selection bias. The study was performed at one academic medical center in the United States, and although the study sample was reflective of the racial/ethnic mix of the surrounding recruitment area, it may not be representative of other populations with acute LBP. In addition, the study sample was relatively small, and due to the number of variables involved in this exploratory design, it may not have been powered adequately to detect more subtle differences between the PLBP and resolved groups.

Conclusion

In this prospective study of individuals with acute LBP, we compared baseline demographic, pain, psychological, and somatosensory characteristics between patients who continued to have persistent pain (PLBP group) and those whose pain resolved within the first 6 weeks from onset. We identified several characteristics that differentiated the PLBP group from those whose pain resolved: age, educational attainment, BMI, “lowest” pain score, and coping–praying. We also identified somatosensory measures that were significantly different in the PLBP group compared to the recovered group, including hyposensitivity at the painful back area and remote site as well as higher WUR at the remote site. As this study is the first

to report these differences in a sample of individuals with acute LBP, further research in clinical populations is needed to determine whether the QST measures identified can predict future PLBP.

As nurses are often at the front lines of patient care, they are in an ideal position to promote musculoskeletal health and assist individuals to engage in strategies to reduce PLBP occurrence. While preliminary, the findings from the present study suggest that there are factors that may increase vulnerability to a PLBP trajectory, including adaptations in somatosensory information processing. Nursing research to further characterize somatosensory changes that occur during the pain experience may provide evaluative data to help guide development of nursing interventions and personalized strategies to mitigate the risk of persistent LBP.

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Table 1

Summary of Demographic and Clinical Characteristics of the Study Sample.

Characteristic	Persistent *n* = 19	Recovered *n* = 29	Total *N* = 48	*p* Value
Gender, female, *n* (%)	10 (53)	16 (55)	26 (54)	.8628
Age, years, mean (*SE*)	39.4 (1.9)	31.8 (2.0)	34.8 (1.5)	.0112*
Ethnicity, *n* (%)				.0743
Hispanic or Latino	2 (11)	0 (0)	2 (4)	
Not Hispanic or Latino	17 (89)	29 (100)	46 (96)	
Race, *n* (%)				.2636
African American	14 (74)	15 (52)	29 (60)	
Caucasian	3 (16)	6 (21)	9 (19)	
Other	2 (11)	8 (28)	10 (21)	
Marital status, *n* (%)				.9806
Divorced/widowed	3 (16)	4 (14)	7 (15)	
Married/partner	5 (26)	8 (28)	13 (27)	
Single	11 (58)	17 (59)	28 (58)	
Income, *n* (%)				.6092
<US$60K	15 (79)	21 (72)	36 (75)	
>US$60K	4 (21)	8 (28)	12 (25)	
Employment, *n* (%)				.1611
Full-time/part-time	10 (53)	21 (72)	31 (65)	
Unemployed	9 (47)	8 (28)	17 (35)	
Education, highest level, *n* (%)				.0023*
High school/technical or lower	13 (68)	7 (24)	20 (42)	
Start college or higher	6 (32)	22 (76)	28 (58)	
BMI, kg/m^2, mean (*SE*)	30.2 (1.88)	28.7 (1.25)	29.3 (1.06)	.4920*
Exercise frequency, *n* (%)				.7954
1–3 days/week	8 (42)	14 (48)	22 (46)	
4–7 days/week	7 (37)	8 (28)	15 (31)	
None	4 (21)	7 (244)	11 (23)	
Current smoker, yes, *n* (%)	12 (63)	10 (34.48)	22 (45.83)	.0512
Number of comorbidities, *n* (%)				.7669
1–2	6 (35)	10 (38.46)	16 (37.21)	
>3	1 (6)	3 (11.54)	4 (9.30)	
None	10 (59)	13 (50.00)	23 (53.49)	
Prior episodes of LBP, *n* (%)				.1648
0–6 months ago	4 (21)	12 (41)	16 (33)	
>6 months ago	11 (58)	9 (31)	20 (42)	
None	4 (21)	8 (28)	12 (25)	
Current episode of LBP duration, days, mean (*SE*)	9.5 (1.61)	24.2 (12.42)	18.4 (7.55)	.3455
Current pain frequency, *n* (%)				.2859
Daily basis	5 (26)	12 (41)	17 (35)	

Characteristic	Persistent n = 19	Recovered n = 29	Total N = 48	p Value
Nondaily basis	14 (74)	17 (59)	31 (65)	
Family history of LBP, n (%)				.0407*
No	6 (46)	3 (14)	9 (26)	
Yes	7 (54)	18 (86)	25 (74)	
General health, n (%)				.6527
Good/excellent	13 (68)	18 (62)	31 (65)	
Poor/fair	6 (32)	11 (38)	17 (35)	

Note. Number of participants for each variable does not all add up to total N due to missing values. BMI = body mass index; LBP = lower back pain.

* $p < .05$ using t-test or likelihood ratio.

Table 2

Baseline Pain and Symptom Measures by Group.

Measure	Persistent *n* = 19	Recovered *n* = 29	Total *N* = 48	*p* Value
BPI, mean (*SE*)				
Average	4.95 (0.50)	4.46 (0.37)	4.66 (0.30)	.4354
Worst	6.37 (0.56)	5.38 (0.43)	5.77 (0.35)	.1648
Least	3.58 (0.53)	2.03 (0.36)	2.65 (0.32)	.0151*
Now	4.68 (0.58)	3.83 (0.41)	4.17 (0.34)	.2197
Interference	4.40 (0.57)	3.60 (0.45)	3.91 (0.36)	.2753
McGill, mean (*SE*)				
Affective	1.84 (0.38)	2.48 (0.53)	2.23 (0.35)	.3817
Sensory	9.16 (1.24)	10.10 (1.43)	9.73 (0.99)	.6438
VAS	44.66 (6.40)	38.06 (4.78)	40.85 (3.85)	.4031
McGill pain intensity, *n* (%)				.8775
Distressing-excruciating	3 (15.79)	6 (20.69)	9 (18.75)	
Mild-discomforting	15 (78.95)	21 (72.41)	36 (75.00)	
None	1 (5.26)	2 (6.90)	3 (6.25)	
Coping strategies, mean (*SE*)				
Praying	15.53 (1.10)	12.14 (1.11)	13.48 (0.83)	.0440*
Self-statement	22.37 (0.77)	20.93 (1.05)	21.50 (0.70)	.3237
Distancing	11.84 (1.48)	10.79 (1.25)	11.21 (0.95)	.5933
Ignoring	19.37 (1.81)	18.69 (1.19)	18.96 (1.00)	.7447
Catastrophizing	17.79 (2.18)	14.72 (1.46)	15.94 (1.24)	.2310
Distraction	22.74 (1.73)	21.86 (1.17)	22.21 (0.98)	.6660
POMS, mean (*SE*)				
Tension-anxiety	9.89 (1.00)	10.32 (1.32)	10.15 (0.89)	.8147
Depression-dejection	8.61 (2.12)	8.14 (1.97)	8.33 (1.44)	.8763
Anger-hostility	7.22 (2.10)	7.68 (1.90)	7.50 (1.40)	.8759
Fatigue-inertia	8.74 (1.27)	9.18 (1.19)	9.00 (0.87)	.8056
Confusion-bewilderment	6.58 (0.97)	7.18 (1.11)	6.94 (0.76)	.7036
Vigor-activity	14.53 (1.55)	13.04 (0.80)	13.64 (0.78)	.3568
Total	25.16 (7.33)	29.46 (7.27)	27.72 (5.20)	.6892
PSS, mean (*SE*)	17.32 (1.44)	16.28 (1.09)	16.69 (0.86)	.5642
Reactivity, mean (*SE*)	77.74 (2.30)	70.48 (2.52)	73.35 (1.83)	.0514
Disability, mean (*SE*)	8.32 (0.92)	9.15 (1.17)	8.80 (0.78)	.6040

Note. BPI = Brief Pain Inventory; Coping Strategies = Coping Strategies Questionnaire–Revised; Disability = Roland Disability Questionnaire; McGill = McGill Pain Questionnaire–Short Form; POMS = Profile of Mood States; PSS = Perceived Stress Scale; Reactivity = Kohn's Reactivity Scale; VAS = Visual Analog Scale.

* $p < .05$ using two-sample *t*-test.

Table 3

Baseline Quantitative Sensory Testing Between Groups.

Test	Persistent *n* = 19	Recovered *n* = 29	Total *N* = 48	*p* Value	Normal[a] *N* = 69
Cold detection threshold (°C)					
Remote site	26.31 (1.02)	28.63 (0.24)	27.71 (0.45)	.0126*	28.66 (0.19)
Back	26.66 (0.94)	28.92 (0.22)	28.03 (0.42)	.0131*	29.13 (0.14)
Warm detection threshold (°C)					
Remote site	36.68 (0.68)	35.25 (0.26)	35.81 (0.32)	.0448*	35.20 (0.22)
Back	36.67 (0.46)	34.95 (0.19)	35.63 (0.24)	.0024*	34.76 (0.21)
Cold pain threshold (°C)					
Remote site	19.81 (1.33)	20.28 (1.33)	20.09 (0.95)	.9356	14.93 (1.30)
Back	22.28 (1.15)	22.36 (1.33)	22.33 (0.92)	.7731	16.84 (1.35)
Heat pain threshold (°C)					
Remote site	40.30 (0.82)	38.66 (0.68)	39.31 (0.53)	.2602	39.96 (0.76)
Back	39.30 (0.64)	37.28 (0.59)	38.08 (0.46)	.1753	38.52 (0.70)
Pressure pain threshold (KPa)					
Remote site	197.77 (27.75)	162.80 (18.59)	176.65 (15.73)	.6185	199.06 (13.50)
Back	196.97 (40.89)	145.09 (19.38)	165.63 (20.06)	.5417	284.90 (22.65)
Mechanical pain threshold (mN)					
Remote site	6.06 (0.19)	5.95 (0.16)	6.00 (0.12)	.2260	6.47 (0.11)
Back	5.76 (0.19)	5.41 (0.21)	5.54 (0.15)	.1695	6.37 (0.11)
Mechanical pain sensitivity (pain rating 0–100)					
Remote site	2.16 (0.48)	2.22 (0.35)	2.19 (0.28)	.8788	0.72 (0.15)
Back	3.52 (0.64)	3.51 (0.48)	3.51 (0.38)	.9876	1.02 (0.16)
Windup ratio (multiple average/single average)					
Remote site	1.37 (0.16)	1.09 (0.08)	1.21 (0.08)	.0271*	0.59 (0.15)
Back	1.41 (0.15)	1.50 (0.22)	1.47 (0.14)	.5258	1.00 (0.19)
Mechanical detection threshold (mN)					
Remote site	3.42 (0.15)	3.28 (0.10)	3.34 (0.09)	.5019	3.13 (0.08)
Back	3.42 (0.18)	3.52 (0.12)	3.48 (0.10)	.8737	3.36 (0.08)

Test	Persistent $n = 19$	Recovered $n = 29$	Total $N = 48$	p Value	Normal[d] $N = 69$
Dynamic mechanical allodynia (numbers exhibiting PHS)					
Remote site	0.36 (0.19)	0.64 (0.25)	0.53 (0.17)	.4342	0.21 (0.06)
Back	2.01 (0.59)	1.33 (0.39)	1.60 (0.33)	.2192	0.47 (0.10)

Note. Values are mean (*SE*). PHS = paradoxical heat sensation.

[d] Reference values for healthy (no-pain) controls acquired at the same study site.

[*] Analysis of covariance adjusting for the covariates of age, gender, and race.