Profiles of Risk and Resilience in Chronic Pain: Loneliness, Social Support, Mindfulness, and Optimism Coming out of the First Pandemic Year

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Abstract

Objective. Individuals experience chronic pain differently, not only because of different clinical diagnoses, but also because of differing degrees of influence from biopsychosocial pain modulators. We aimed to cluster patients with chronic pain into distinct subgroups based on psychosocial characteristics and pain intensity, and we subsequently examined group differences in pain-related interference approximately 1 year later.

Methods. In this observational, longitudinal study, patients with chronic pain (n = 94) completed validated assessments of psychosocial characteristics and pain intensity at the beginning of COVID-19–related social distancing (April to June 2020). One year later (May to June 2021), patients completed a follow-up survey with assessments of pain interference, loneliness, social support, mindfulness, and optimism.

Results. A cluster analysis, using psychosocial factors and pain intensity, empirically produced three patient groups: 1) psychosocial predominant (PSP), characterized by high psychosocial distress and average pain intensity; 2) pain intensity predominant (PIP), characterized by average psychosocial distress and high pain intensity; and 3) less elevated symptoms (LES), characterized by low psychosocial distress and low pain intensity. At the 1-year follow-up, patients in the PSP and PIP clusters suffered greater pain interference than patients in the LES cluster, while patients in the PSP cluster also reported greater loneliness and lower mindfulness and optimism.

Conclusions. An empirical psychosocial-based clustering of patients identified three distinct groups that differed in pain interference. Patients with high psychosocial modulation of pain at the onset of social distancing (the PSP cluster) suffered not only greater pain interference but also greater loneliness and lower levels of mindfulness and optimism, which suggests some potential behavioral targets for this group in the future.

Key Words: Chronic Pain; Psychosocial; Loneliness; Mindfulness; Optimism; Clustering; Pain Interference

Introduction

Protocolization vs. Personalization of Care

Although diagnostic categories are a core tenet of clinical care and guide a reasonable range of treatment choices, individuals who share a common diagnosis are not the same, and some might respond more favorably to one treatment than to another. This is perhaps particularly true in the case of chronic pain [1]. In treating a patient, it is important to consider not only the underlying diagnosis (e.g., arthritis) and predominant presumed mechanism (e.g., neuropathic, inflammatory, nociceptive) but also demographic, social, and psychological factors, as these potentially modulate both the degree of pain [2] and how the patient responds to a proposed treatment.
Ultimately, a move toward more personalized medicine will require that distinct treatment choices fit the “person type” as much as the diagnosis [3, 4].

Biopsychosocial Model
To this end, a consideration of the biopsychosocial model of pain in approaching patients is helpful. The biopsychosocial model of pain implicates a broad array of characteristics as important modulators of pain [2, 5], most commonly including factors such as depression, anxiety, emotional distress, pain catastrophizing, and sleep disturbance, as these factors might meaningfully contribute to the development, maintenance, and impact of persistent pain states [6]. Patients with chronic pain report elevated levels of psychosocial distress compared with pain-free controls [7, 8]. Among individuals with chronic pain, the degree of psychosocial distress is also associated with worse pain-related outcomes [9–12]. Several prospective studies have suggested that psychosocial distress could precede and serve to predict the subsequent development of chronic pain [5, 13, 14]. In addition, there is a strong association of psychosocial factors with pain-related physical, mental, and emotional dysfunction [15–18], beyond their association with pain severity.

Pain Patient Clustering
Recognizing the modulatory role of psychosocial factors in pain, researchers have begun to employ systematic measurement of them to understand how psychosocial modulators interact with and potentially predict pain-related outcomes and disability or response to treatment. In particular, cluster analysis can be used to identify different patterns of patient responses and to distinctively subgroup patients whose pattern of responses is similar [19]. Cluster analysis and similar approaches harness sample heterogeneity on measures of interest to understand how these variables operate differently among individuals, as well as the extent to which variables combine within persons [20, 21]. Identifying subgroups has both theoretical and practical clinical implications for better management of pain.

Recently, models using concurrent assessments of psychosocial factors and pain intensity have allowed for a more nuanced understanding of interpatient variability and an improved prediction of pain outcomes. In particular, the addition of psychosocial variables to the derivation of clustering, including negative affect (depression, anxiety), has resulted in the identification of a group that has both relatively high pain intensity and high levels of psychosocial distress. For example, one study clustered patients on the basis of assessments of psychosocial factors (depression, sleep disturbance, fatigue, illness burden) and pain intensity and identified three subgroups. Specifically, the study identified a group characterized by high psychosocial distress and high pain intensity; a group low in pain intensity and sleep disturbance but with average levels of psychosocial distress; and a group high in sleep disturbance, average in pain intensity, and low in psychosocial distress [22]. Other research has also identified a similar subgroup with both high pain intensity and high levels of psychosocial distress [23, 24] and shown that this subgroup in particular tends to report worse pain outcomes (pain-related interference) [22, 25, 26]. Furthermore, there is some evidence that patient demographic characteristics also differ across clusters, such that a higher frequency of women than men have been found within the subgroup characterized by high pain intensity and high psychosocial distress [26].

Taken together, prior research suggests that clustering based on a more complete picture of patients’ characteristics allows identification of clinically meaningful groupings, which may have clinical utility in both identifying underlying predominant pain mechanisms and suggesting the most effective treatments for patients presenting with particular characteristics or risk factors. Although prior research has used cross-sectional designs to focus on how pain-related outcomes differ between clusters, it remains unknown how pain-related interference experienced by these subgroups, identified at one time point, could change over time. Additionally, these subgroups have been clustered by a few well-known psychosocial factors that are typically related to pain outcomes, but less work has investigated how these subgroups might then differ by resilience or coping factors, especially during times of heightened distress, such as living with chronic pain.

Coping During the Pandemic and Pain
The social distancing measures used during the coronavirus 2019 (COVID-19) pandemic have led to widespread and prolonged social isolation [27–29]. Investigating factors that could worsen pain’s impact during this time of prolonged social distancing among patients with chronic pain might give insight into areas of challenge, resilience, and opportunity for intervention during subsequent rounds of social distancing or in cases of social isolation generally. Patients living with chronic pain might be at variable, but relatively higher, risk of loneliness [30] and have reduced access to social support, both of which could impact pain interference and pain intensity [31, 32], as well as psychological distress [33, 34]. Additionally, psychosocial traits such as mindfulness and optimism could be severely taxed during times of increased stress but are particularly salient to the experience of pain. Dispositional mindfulness is associated with less pain interference and pain intensity [35, 36], as a well as lower levels of psychological distress [35, 37]. Optimism is also inversely associated with pain intensity [38] and psychological distress [39].

The Present Study
In this study, we used cluster analysis to identify distinct subgroups of patients with chronic pain, using commonly
assessed and salient psychosocial characteristics and pain intensity, which were assessed at the beginning of COVID-19–related social distancing from April to June of 2020. On the basis of prior research, we first aimed to identify unique clusters within our sample and hypothesized that the identified clusters would be distinguished by different levels of psychosocial characteristics (depression, sleep disturbance, stress, and catastrophizing) and pain intensity. Second, we aimed to longitudinally investigate the degree of pain-related interference experienced by these subgroups approximately 1 year into social distancing (May to June 2021). Third, we explored whether these identified subgroups meaningfully differed in terms of negative (e.g., loneliness) and positive (e.g., social support, mindfulness, optimism) psychosocial characteristics, assessed 1 year into social distancing.

Methods

Study Design

This was an observational, longitudinal study of adults with chronic pain from Massachusetts. Patients had to be ≥18 years of age, be English speaking, have had self-reported persistent pain for ≥3 months, and be a current Massachusetts resident. Patients were required to currently reside in Massachusetts in an attempt to ensure similar social distancing mandates and a consistent message from local health authorities [40]. Patients were recruited from Rally, a Partners Healthcare online platform, and by contacting patients from previous studies. The Partners Human Research Committee / Institutional Review Board approved this study. Patients interested in participating were first emailed a link to complete an electronic screening questionnaire via REDCap, a secure online database. The screening questionnaire asked interested participants, “Have you had chronic pain for 3 months or longer?,” and it asked them to rate the severity of their pain and to identify the type(s) of chronic pain they had (e.g., back pain, fibromyalgia, postsurgical pain, or other). Eligible patients were subsequently emailed a new link to complete the actual study survey. All patients provided electronic informed consent before participating. This multistep process required participants to complete several interactive steps before having access to the actual study survey, as opposed to clicking on a single link from an online platform, to reduce the risk of online bots (rather than patients) completing the online survey.

Patients completed the first survey from April 28 to June 17, 2020 (Time 1) during the early weeks of the COVID-19 pandemic (Supplementary Data Figure S1) [40]. The majority of patients (147/150) indicated that they were willing to be contacted for future studies and were invited to participate in a follow-up survey. Roughly two thirds of patients (n = 94, 64%) completed the second survey approximately a year later from May 21 to June 7, 2021 (Time 2), after 1 year of living in the pandemic. Each survey took approximately 30–45 minutes to complete, and patients received a $20 Amazon gift code for each survey.

Measures

Variables Used for Patient Cluster Derivation

On the basis of previous research [9, 11, 12], we measured four well-known psychosocial modulators of pain interference, several of which have also been used to cluster pain patients [22], as well as pain intensity. All instructions for questionnaires at Time 1 were prefaced with a clarification that participants should answer the questions in the context of the time frame since they had started social distancing.

Pain catastrophizing. The Pain Catastrophizing Scale (PCS) was used to assess the extent to which patients had catastrophic thoughts associated with pain [41]. The PCS consists of 13 items (e.g., “The pain is terrible, and I think it’s never going to get any better”) rated on a scale from 0 (”not at all”) to 4 (“all the time”). All items are summed for a total score, and higher scores indicate greater pain catastrophizing. The PCS has been validated in pain samples [41, 42] and demonstrated adequate reliability in the present study (α = 0.96).

Depression. The Patient Reported Outcome Measurement Information System (PROMIS) eight-item depression short form was used to assess depressive symptoms [43]. Each item (e.g., “I have felt helpless”) was rated on a scale from 1 (”never”) to 5 (“always”). All items are summed for a total score, and higher scores reflect greater depression. The PROMIS depression short form has been validated in pain samples [43] and showed good reliability in the present study (α = 0.96).

Stress. The four-item Perceived Stress Scale (PSS) was used to assess the extent to which patients felt their lives had been uncontrollable [44]. Each item (e.g., “Felt that you were unable to control the important things in your life”) was rated on a scale from 0 (”never”) to 4 (“very often”). Appropriate items are reverse-scored, and all items are summed for a total score. Higher scores indicate greater perceived stress. The PSS demonstrated adequate reliability (α = 0.73) and has been used in pain samples [45].

Sleep disturbance. The PROMIS four-item sleep short form was used to assess sleep disturbance [43]. Each item (e.g., “I had difficulty falling asleep”) was rated on a scale from 1 (“never”) to 5 (“always”). All items are summed for a total score, and higher scores reflect greater sleep disturbance. The PROMIS sleep short form has been validated in pain samples [43] and showed good reliability in the present study (α = 0.87).
Pain intensity. The Brief Pain Inventory (BPI) was used to assess patients’ pain intensity [46]. Three items measured patients’ worst, least, and average pain. One item measured patients’ current pain. All four items were rated on a scale from 0 (“no pain”) to 10 (“worst pain imaginable”). A mean score is computed with all four items, and higher scores reflect greater pain intensity. The BPI pain intensity showed good reliability in the present study ($\alpha = 0.89$) and has been validated in pain samples [47, 48].

Outcomes Compared Between Patient Clusters

Pain interference. Seven items from the BPI assessed the extent to which pain interfered with patients’ daily activities (e.g., “walking”) [46]. All items were rated on a scale from 0 (“my pain has not interfered at all”) to 10 (“my pain has completely interfered”). At Time 1, instructions asked patients to reflect on the interference experienced within the prior day, during social distancing. A total pain interference score was computed by summing all seven items, with higher scores indicating greater pain interference. The BPI interference has been validated in pain samples [47, 48] and demonstrated adequate reliability in the present study ($\alpha = 0.91$) at Time 1. At Time 2, patients again answered the seven-item BPI interference, but they were instructed to reflect on the interference experienced over the prior week. A total pain interference score ($\alpha = 0.94$) was created.

Loneliness. The 20-item UCLA Loneliness Scale questionnaire measured how often patients felt lonely [49]. Each item (e.g., “Feel that you lack companionship”) was rated on a scale from 1 (“rarely / not at all”) to 4 (“almost always”). Appropriate items were reverse-coded, and all items were averaged for a total score. Higher scores indicate greater levels of trait mindfulness. The CAMS-R showed good reliability in the present study ($\alpha = 0.82$) and has been demonstrated to be a reliable measure in prior pain samples [45, 53].

Optimism. The 10-item Life Orientation Test-Revised (LOT-R) was used to measure patients’ optimism [55]. Each item (e.g., “I’m always optimistic about my future”) was rated on a scale from 0 (“strongly disagree”) to 4 (“strongly agree”). A total score is created by summing all items, and higher scores reflect higher levels of trait optimism. The LOT-R demonstrated adequate reliability in the present study ($\alpha = 0.79$) and has been used in pain samples [56].

Data Analyses

To investigate Aim 1, a cluster analysis was conducted in SPSS version 28.0 (IBM Corp., Armonk, NY, USA) to identify groups of patients with similar scoring patterns on depression, stress, sleep disturbance, pain catastrophizing, and pain intensity. As this was an empirical and exploratory statistical approach, we did not define a priori the number of emergent clusters. As recommended by Henry et al. [57], a two-step clustering approach was conducted. First, Ward’s hierarchical technique with squared Euclidean distance as the similarity–dissimilarity between clusters was used. Examination of the dendrogram and changes in the agglomeration coefficients was used to determine the number of clusters present in the data [58], a method that is suitable for exploratory cluster derivation [59]. Second, an iterative, K-means clustering technique was used with the specified number of clusters determined from the Ward’s hierarchical technique. These clustering approaches have previously been used to identify subgroups of pain patients [60, 61]. After subgroups of patients had been identified, chi-squared analyses and analyses of variance (ANOVA) explored how patients’ demographic characteristics differed among the derived clusters.

To address Aim 2, ANOVAs were used to determine whether clusters differed on pain-related interference after participants had lived in the pandemic for 1 year. To address Aim 3, a multivariate analysis of variance (MANOVA) was conducted to determine whether the clusters differed on positive (social support, mindfulness, optimism) and negative psychosocial characteristics (loneliness) 1 year into social distancing. For the MANOVA, cluster membership was entered as the independent variable, and the psychosocial measures were entered as the dependent variables.
Results

Patient Characteristics
Participants had a mean age of 40.8 ± 16.1 years and were predominantly female (79%) and White (82%). Marital status was 53% single / never married, and 84% of participants reported an educational attainment of a college degree or higher. All participants reported at least one type of chronic pain, with 43% reporting more than one type of pain, most commonly back pain (60%), fibromyalgia (23%), postsurgical pain (6%), or “other” pain (63%).

Clustering Patients
Candidate clustering factors (depression, stress, sleep disturbance, pain catastrophizing, and pain intensity) assessed at the beginning of social distancing (Time 1, 2020) were standardized as z-scores. Patients with chronic pain were then clustered by their z-scores on candidate variables. The two-stage clustering approach produced three emergent clusters with distinct patterns of derivative factor scores (Figure 1). Group mean raw scores for each derivative factor are depicted in Supplementary Data Figure S2.

Cluster 1 comprised 28.7% of the sample (n = 27) and on the basis of z-scores was descriptively named the psychoSocial predominant (PSP) cluster. Patients in this PSP cluster scored relatively high on psychosocial factors (z-scores ranging from 0.86 to 1.42) and reported average levels of pain intensity (z = 0.18). Cluster 2 comprised 27.7% of the sample (n = 26) and was labeled the pain intensity predominant (PIP) cluster, as patients scored high on pain intensity (z = 0.83) but had average levels of psychosocial factors (z scores ranging from −0.18 to 0.25). Cluster 3 comprised of 43.6% of the sample (n = 41) and was labeled the less elevated symptoms (LES) cluster. Patients in the LES cluster scored relatively low on all psychosocial factors and pain intensity (z-scores ranging from −0.62 to −0.84).

Demographic Characteristics of Clusters
Table 1 shows demographic characteristics of patients within each cluster. There were significant differences based on age and income between the three clusters. Patients in the PIP and LES clusters were older than were patients in the PSP cluster. Additionally, patients in the LES cluster reported higher income than patients in the PSP cluster. The three clusters did not significantly differ according to gender, race/ethnicity, marital status, or education.

Pain Interference Across Patient Clusters
To determine whether pain interference differed across the three clusters, ANOVAs were conducted. At Time 1 (May 2020), there was a significant overall difference in pain interference between patient clusters (Table 1; Figure 2). Patients in the LES cluster reported significantly less pain interference than patients in the PSP and
PIP clusters, which had similar levels of pain interference. The pattern of findings was similar for levels of pain interference at Time 2 (May 2021) (see Table 1; Figure 2), despite pain interference being generally lower at this time point.

Exploration of Cluster Characteristics
In addition to assessing differences in pain interference, we explored differences in a set of other salient psychosocial characteristics (loneliness, mindfulness, optimism, and social support) by comparing patients’ scores among the three identified clusters of patients after they had lived in the pandemic for 1 year (May 2021). A MANOVA revealed a significant main effect for cluster membership, $F(8,88) = 3.38$, Wilks’ $\lambda = 0.75$, $P = 0.001$, partial $\eta^2 = 0.13$. Follow-up ANOVAs revealed a significant group effect for loneliness, mindfulness, and optimism but not for social support (Figure 3).

Table 1. Demographic, psychosocial, and pain characteristics for the full sample and by patient cluster

| Variables                          | Full Sample Mean (SD) or n (%) | PSP (n = 27) Mean (SD) or n (%) | PIP (n = 26) Mean (SD) or n (%) | LES (n = 41) Mean (SD) or n (%) | $P$ |
|-----------------------------------|-------------------------------|---------------------------------|---------------------------------|---------------------------------|-----|
| Demographics                      |                               |                                 |                                 |                                 |     |
| Age, years *‡                      | 40.83 (16.05)                 | 33.52 (12.91)                   | 43.88 (15.37)                   | 43.71 (17.10)                   | 0.018|
| Gender                            |                               |                                 |                                 |                                 |     |
| Male                              | 16 (17%)                      | 3 (11%)                         | 2 (8%)                          | 11 (27%)                        | 0.052|
| Female                            | 74 (8%)                       | 21 (78%)                        | 23 (89%)                        | 30 (73%)                        |     |
| Other                             | 4 (4%)                        | 3 (11%)                         | 1 (4%)                          | –                               | 0.103|
| Race                              |                               |                                 |                                 |                                 |     |
| White                             | 77 (82%)                      | 19 (70%)                        | 22 (85%)                        | 36 (89%)                        |     |
| Black                             | 7 (7%)                        | 1 (4%)                          | 3 (12%)                         | 3 (7%)                          |     |
| Asian                             | –                             | –                               | –                               | –                               |     |
| American Indian                   | –                             | –                               | –                               | –                               |     |
| Native Hawaiian / Pacific Islander| –                             | –                               | –                               | –                               |     |
| Other                             | 9 (10%)                       | 6 (22%)                         | 1 (4%)                          | 2 (5%)                          |     |
| Prefer not to say                 | 1 (1%)                        | 1 (4%)                          | –                               | –                               | 0.175|
| Ethnicity                         |                               |                                 |                                 |                                 |     |
| Not Hispanic or Latino            | 91 (96.8%)                    | 25                              | 36                              | 40                              | 0.772|
| Hispanic or Latino                | 2 (2.1%)                      | 2                               | –                               | –                               |     |
| Prefer not to say                 | 1 (1.1%)                      | –                               | –                               | 1                               |     |
| Marital status                    |                               |                                 |                                 |                                 | 0.102|
| Single, never married             | 50 (53%)                      | 17 (63%)                        | 12 (46%)                        | 21 (51%)                        |     |
| Married or in partnership         | 34 (36%)                      | 7 (26%)                         | 11 (42%)                        | 16 (39%)                        |     |
| Separated or divorced             | 6 (6%)                        | 1 (4%)                          | 2 (8%)                          | 3 (7%)                          |     |
| Widowed                           | 4 (4%)                        | 2 (7%)                          | 1 (4%)                          | 1 (2%)                          |     |
| Education                         |                               |                                 |                                 |                                 |     |
| High school                       | 6 (6%)                        | –                               | 4 (15%)                         | 2 (5%)                          |     |
| Trade school                      | 4 (4%)                        | 1 (4%)                          | 3 (2%)                          | –                               |     |
| Technical/associate’s degree      | 5 (5%)                        | 1 (4%)                          | 1 (4%)                          | 3 (7%)                          |     |
| Bachelor’s degree                 | 46 (49%)                      | 17 (63%)                        | 9 (35%)                         | 20 (49%)                        |     |
| Graduate/professional degree      | 33 (35%)                      | 8 (30%)                         | 9 (35%)                         | 16 (39%)                        |     |
| Income ‡                         | $30–74,999 $35–49,999 $50–74,999 $50–74,999 | $50–74,999 $50–74,999 | $50–74,999 $50–74,999 | $50–74,999 $50–74,999 | 0.047|
| Clustering variables (T1)         |                               |                                 |                                 |                                 |     |
| Pain catastrophizing *†‡          | 17.99 (14.48)                 | 31.71 (12.26)                   | 21.26 (12.28)                   | 6.87 (5.89)                     | <0.001|
| Depression *†‡                    | 20.39 (9.10)                  | 31.44 (6.30)                    | 18.19 (5.75)                    | 14.51 (5.00)                    | <0.001|
| Perceived stress *†‡              | 7.71 (2.98)                   | 10.31 (2.50)                    | 7.96 (1.91)                     | 5.85 (2.49)                     | <0.001|
| Sleep disturbance *†‡             | 12.83 (4.25)                  | 16.67 (3.05)                    | 13.69 (2.88)                    | 9.76 (3.25)                     | <0.001|
| Pain intensity *†‡                 | 5.06 (1.78)                   | 5.39 (1.49)                     | 6.55 (1.46)                     | 3.90 (1.31)                     | <0.001|
| Main outcome variables            |                               |                                 |                                 |                                 |     |
| Pain interference (T1) †‡          | 31.66 (16.57)                 | 42.09 (14.75)                   | 39.16 (12.03)                   | 20.23 (12.67)                   | <0.001|
| Pain interference (T2) †‡          | 27.01 (18.02)                 | 31.63 (16.51)                   | 36.33 (17.62)                   | 18.05 (15.19)                   | <0.001|
| Exploratory outcome variables     |                               |                                 |                                 |                                 |     |
| Mindfulness (T2) ‡                | 2.65 (0.54)                   | 2.42 (0.44)                     | 2.70 (0.61)                     | 2.78 (0.51)                     | 0.018|
| Optimism (T2) ‡                   | 13.28 (4.62)                  | 10.04 (3.82)                    | 13.72 (4.97)                    | 15.15 (3.73)                    | <0.001|
| Loneliness (T2) ‡                 | 43.48 (10.75)                 | 48.97 (9.39)                    | 42.31 (10.70)                   | 40.61 (10.49)                   | 0.005|
| Social support (T2) ‡             | 63.48 (15.97)                 | 57.75 (19.52)                   | 64.19 (16.80)                   | 66.80 (12.65)                   | 0.069|

Note. T1 = Time 1 (May 2020); T2 = Time 2 (May 2021). ANOVAs were conducted for continuous variables and chi-squares for categorical variables.
* Significant difference between PSP and PIP clusters ($P < 0.05$).
† Significant difference between PSP and LES clusters ($P < 0.05$).
‡ Significant difference between PIP and LES clusters ($P < 0.05$).
Post hoc comparisons were then conducted to determine pairwise differences among the clusters on these psychosocial outcomes (Table 1). Patients in the PSP cluster reported greater feelings of loneliness than patients in the LES and PIP clusters. Interestingly, despite these differences in loneliness, there were no significant differences among the three clusters in terms of social support. Patients in the PSP cluster also reported less optimism than the LES and PIP clusters. Patients in the PSP cluster reported lower levels of trait mindfulness than patients in the LES cluster.

### Discussion

We used patients’ ratings on a set of well-known psychosocial modulators of pain (depression, stress, sleep disturbance, pain catastrophizing) and their pain intensity to empirically characterize distinct clusters within a group of individuals with chronic pain at the beginning of COVID-19 pandemic-imposed social distancing. Three unique subgroups were identified through the use of cluster analysis: PSP, PIP, and LES. The clusters significantly differed in the amount of pain interference they experienced, both at the time of cluster derivation and 1 year later, such that patients in the LES cluster reported lower levels of pain interference than patients in the PSP and PIP clusters. In addition, we found that patients in the PSP cluster reported greater feelings of loneliness and lower levels of trait mindfulness and optimism 1 year into social distancing. Our findings suggest that patients in the PSP subgroup are at particularly high risk of experiencing a constellation of worse outcomes, including greater pain interference and loneliness and lower optimism and mindfulness.

Previous research has used both self-reported pain intensity [22] and psychophysical assessments of pain sensitivity [25, 26], in combination with psychosocial factors, to categorize patients. Given the socially distanced conditions of the pandemic that prevailed when we conducted these studies, we included pain intensity rather than psychophysical assessments of pain. Thus, patients in our PIP cluster, who reported high pain intensity, might be different from those identified as pain sensitive by psychophysical assessments. However, as in previous studies that used either self-reported pain intensity or formal psychophysical assessments, three clusters emerged, with characteristics approximately similar to those reported previously.

Patients in the LES cluster reported significantly less pain interference than patients in the PSP and PIP clusters. Surprisingly, patients in the PIP cluster, who reported the highest levels of pain intensity (and average psychosocial scores), did not score higher in pain interference than patients in the PSP cluster (who reported average levels of pain intensity but high psychosocial scores). The equivalence of pain interference between these
groups highlights the important modulatory role that psychosocial factors might play in influencing patients’ pain interference, in line with the biopsychosocial model of pain [15–18]. If elevations in the functional impact of pain are driven by different factors in different subgroups (e.g., high pain intensity could be the primary contributor...
to pain interference in the PIP subgroup, whereas high levels of psychological distress, poor sleep, and other auxiliary biopsychosocial factors could be stronger contributors to pain interference in the PSP subgroup), this might have important implications for optimizing treatment regimens across subgroups.

We also explored the demographic characteristics of patients in each of the three identified clusters. Patients in the PSP cluster were younger than were patients in the PIP and LES clusters, which identifies younger age as a potential risk factor for both greater pain interference and distress. Indeed, research has shown that younger patients with chronic pain report greater negative affect than do older patients [62, 63]. Additionally, patients in the LES cluster reported higher income than that of patients in the PSP cluster, with potentially more access to resources to better manage their pain and psychosocial distress than those in the PSP cluster had [64, 65].

To gain a deeper understanding of the three subgroups identified, we conducted an exploratory analysis using additional psychosocial characteristics of the subgroups, which we measured approximately 1 year into the pandemic and social distancing. Interestingly, there were no meaningful differences in perceived social support across the three clusters. However, patients in the PSP cluster reported greater feelings of loneliness. Patients in the PSP cluster also reported lower trait levels of mindfulness and optimism. Mindfulness involves awareness and nonjudgment of experiences and is inversely related to psychological distress [37]. Similarly, optimism involves having a positive and hopeful outlook and is associated with less psychological distress [39]. Those who have low levels of trait mindfulness and optimism tend to have negatively biased cognitions (e.g., tendency to interpret negative events as internal or stable) [66], which are associated with negative affective states (depression) and could explain why patients in the PSP cluster scored the lowest on these psychosocial measures. However, more research is necessary to identify directionality in the relationship of these factors.

Phenotypic classification could potentially help clinicians apply personalized interventions based on a patient’s characteristics. For example, this could include the determination of differential efficacy in trials of novel therapeutics, which traditionally determine efficacy only in the entire group. Using patient-type stratification might allow more nuanced subgroup testing of novel therapeutics, but it could also give insight into differential mechanisms that are of particular importance within individual patients. This differential testing of novel analgesics could lay the groundwork for a personalized pain medicine approach, where determination of a patient’s particular pain phenotype might aid in the decision about what treatment to apply [6, 67]. Several trials of opioid analgesics have noted that elevated pretreatment scores on measures of psychosocial distress (e.g., presumably comparable to the PSP cluster) are associated with reduced opioid analgesic benefit [68–70]. In addition, higher baseline depression scores also predicted higher rates of medication misuse [70]. Similarly, risk factors such as catastrophizing and positive “resilience” factors can independently predict inter-patient variation in the outcomes of multidisciplinary treatment programs; specifically, higher baseline pain resilience was associated with better quality-of-life outcomes, whereas higher baseline catastrophizing was associated with poorer outcomes [71]. Within the perioperative context, there is some evidence that stratifying for high-risk characteristics (such as pain catastrophizing) could allow more sensitive assessment of postsurgical pain prevention by regional anesthesia [72], although future studies are needed to test this principle. It is noteworthy that, in a surgical context, higher catastrophizing is associated with greater benefit from some treatments (e.g., regional anesthesia, open-label placebo) and reduced benefit from other treatments (such as transcutaneous electrical nerve stimulation [TENS]) [73]. Such findings suggest that psychosocial variables, or cluster/subgroup membership based on psychosocial variables, could be important in shaping precision pain medicine approaches.

Limitations and Future Directions
Strengths of this study included the early assessment after the onset of social distancing and the longitudinal design, which allowed assessments of pain-related interference and psychosocial characteristics during a time of social isolation and heightened distress. However, some limitations should be recognized. First, all measures were self-reported online. Future work including laboratory-based psychophysical pain assessment would allow comparison with additional previous cluster solutions. Second, the size of the sample was small, which limits the reliability of the clusters identified and raises concerns about the potential for Type I error in group comparisons. However, previous cluster analyses with small sample sizes (n = 81 patients; e.g., [60]) have proved useful for informing future patient-oriented research. Third, the majority of participants identified as female, White, and highly educated, which limits the generalizability of these findings. Future research will benefit from recruiting a larger, more demographically diverse sample to replicate and strengthen the reliability of the clusters identified. Indeed, researchers have demonstrated differences in catastrophizing and pain-related outcomes reported by White vs Black individuals, as well as women vs men [74–76]. Fourth, although we assessed several social determinants of health, future work should aim to explore how patient clusters might differ on the basis of other social determinants of health, such as occupational status or rurality, particularly among a more demographically diverse sample [77–79]. Fifth, questionnaires were slightly altered at Time 1, with a clarifying clause asking participants to reflect on items with respect to the time frame “since social distancing started” in place of the original language used in each measure (e.g., “in the past
7 days . . .”), which could impact the ability of questionnaires to be compared with results in previous studies. Lastly, because we did not collect details about the actual social distancing practices followed by each participant, it is possible that the burden was unequally felt among participants. However, all participants resided in the same state, which had relatively tight restrictions and adherence, and participants reported that they experienced a large shift in perceived social isolation, as reported previously [40].

Conclusion
Using systematic brief evaluations of psychosocial factors and pain intensity at the onset of COVID-19–related social isolation, patients with chronic pain clustered into three distinct groups: PSP, PIP, and LES. Patients in the PSP cluster (high psychosocial modulation of pain at the beginning of social distancing) reported the highest levels of pain interference, as well as greater loneliness and lower levels of mindfulness and optimism, after 1 year of social distancing. Understanding and considering which cluster a patient might belong to could help differentially direct targeted therapeutic interventions and inform a more personalized approach to managing pain.

Supplementary Data
Supplementary Data may be found online at http://pain-medicine.oxfordjournals.org.

References
1. Carnago L, O’Regan A, Hughes JM. Diagnosing and treating chronic pain: Are we doing this right? J Prim Care Community Health 2021;12:21501327211008055.
2. Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: Scientific advances and future directions. Psychol Bull 2007;133(4):581–624.
3. Gewandter JS, McDermott MP, Mbowe O, et al. Navigating tri- als of personalized pain treatments: We’re going to need a bigger boat. Pain 2019;160(6):1235–9.
4. Schreiber KL, Muehlschlegel JD. Personalization over protocolization: Embracing diversity of pain trajectories after surgery. Anesthesiology 2021;134(3):363–5.
5. Fillingim RB, Ohrbach R, Greenspan JD, et al. Psychological factors associated with development of TMD: The OPPERA prospective cohort study. J Pain 2013;14(Suppl 12):T75–90.
6. Edwards RR, Dworkin RH, Sullivan MD, Turk DC, Wasan AD. The role of psychosocial processes in the development and maintenance of chronic pain. J Pain 2016;17(Suppl 9):T70–92.
7. Burke AL, Mathias JL, Denson LA. Psychological functioning of people living with chronic pain: A meta-analytic review. Br J Clin Psychol 2015;54(3):345–60.
8. Howe CQ, Robinson JP, Sullivan MD. Psychiatric and psychosocial perspectives on chronic pain. Phys Med Rehabil Clin 2015;26(2):283–300.
9. Hung C-I, Liu C-Y, Fu T-S. Depression: An important factor associated with disability among patients with chronic low back pain. Int J Psychiatry Med 2015;49(3):187–98.
10. Campbell CM, Kronfl T, Buenaaver LF, et al. Situational versus dispositional measurement of catastrophizing: Associations with pain responses in multiple samples. J Pain 2010;11(5):443–53.e2.
11. Edwards RR, Mensing G, Cahalan C, et al. Alteration in pain modulation in women with persistent pain after lumpectomy: Influence of catastrophizing. J Pain Symptom Manage 2013;46(1):30–42.
12. Azizoddin DR, Schreiber K, Beck MR, et al. Chronic pain severity, impact, and opioid use among patients with cancer: An analysis of biopsychosocial factors using the CHOIR learning health care system. Cancer 2021;127(17):3254–63.
13. Diatchenko L, Fillingim RB, Smith SB, Maimner W. The phenotyptic and genetic signatures of common musculoskeletal pain conditions. Nat Rev Rheumatol 2013;9(6):340–50.
14. Linton SJ, Nicholas MK, MacDonald S, et al. The role of depression and catastrophizing in musculoskeletal pain. Eur J Pain 2011;15(4):416–22.
15. Hall AM, Kamper SJ, Maher CG, et al. Symptoms of depression and stress mediate the effect of pain on disability. Pain 2011;152(5):1044–51.
16. Ross C, Juraskova I, Lee H, et al. Psychological distress mediates the relationship between pain and disability in hand or wrist fractures. J Pain 2015;16(9):836–43.
17. Kadam UT, Thomas E, Croft PR. Is chronic widespread pain a predictor of all-cause morbidity? A 3 year prospective population based study in family practice. J Rheumatol 2005;32(7):1341–8.
18. Smith D, Wilkie R, Urhman O, Jordan JL, McBeth J. Chronic pain and mortality: A systematic review. PLoS One 2014;9(6):e99048.
19. Aldenderfer MS, Flashbird RK. A Review of Clustering Methods. London: SAGE Publications Ltd; 1984:33–61.
20. Howard MC, Hoffman ME. Variable-centered, person-centered, and person-specific approaches: Where theory meets the method. Organ Res Methods 2018;21(4):846–76.
21. Laursen B, Hoff E. Person-centered and variable-centered approaches to longitudinal data. Merrill-Palmer Q (1982-2020) 2015;61(3):242–53.
22. Murphy SL, Lyden AK, Phillips K, Clauw DJ, Williams DA. Subgroups of older adults with osteoarthritis based upon differing comorbid symptom presentations and potential underlying pain mechanisms. Arthritis Res Ther 2011;13(4):R135–8.
23. Miaskowski C, Paul SM, Cooper B, et al. Identification of patient subgroups and risk factors for persistent arm/shoulder pain following breast cancer surgery. Eur J Oncol Nurs 2014;18(3):242–53.
24. Lotsch J, Sipišiūtė D, Dimova V, Kalso E. Machine-learned selection of psychological questionnaire items relevant to the development of persistent pain after breast cancer surgery. Br J Anaesth 2018;121(5):1123–32.
25. Bair E, Gaynor S, Slade GD, et al. Identification of clusters of individuals relevant to temporomandibular disorders and other chronic pain conditions: The OPPERA study. Pain 2016;157(6):1266–78.
26. Gaynor SM, Bortssov A, Bair E, et al. Phenotypic profile clustering pragmatically identifies diagnostically and mechanistically informative subgroups of chronic pain patients. Pain 2021;162(5):1528–38.
27. Elran-Barak R, Mozeikov M. One month into the reinforcement of social distancing due to the COVID-19 outbreak: Subjective health, health behaviors, and loneliness among people with chronic medical conditions. Int J Environ Res Public Health 2020;17(15):5403.
28. Killgore WD, Cloonan SA, Taylor EC, Miller MA, Dailey NS. Three months of loneliness during the COVID-19 lockdown. Psychiatry Res 2020;293:113392.

29. Killgore WD, Cloonan SA, Taylor EC, Lucas DA, Dailey NS. Loneliness during the first half-year of COVID-19 lockdowns. Psychiatry Res 2020;294:113551.

30. Karos K, McParland JL, Bunzli S, et al. The social threats of COVID-19 for people with chronic pain. Pain 2020;161(10):2229–35.

31. Jensen MP, Moore MR, Bockow TB, Ehde DM, Engel JM. Psychosocial factors and adjustment to chronic pain in persons with physical disabilities: A systematic review. Arch Phys Med Rehabil 2011;92(1):146–60.

32. Wolf LD, Davis MC. Loneliness, daily pain, and perceptions of interpersonal events in adults with fibromyalgia. Health Psychol 2014;33(9):929–37.

33. Jaremka LM, Andridge RR, Fangunders CP, et al. Pain, depression, and fatigue: Loneliness as a longitudinal risk factor. Health Psychol 2014;33(9):948–57.

34. López-Martínez AE, Esteve-Zarazaga R, Ramírez-Maestre C. Perceived social support and coping responses are independent variables explaining pain adjustment among chronic pain patients. J Pain 2008;9(4):373–9.

35. McCracken LM, Gauntlett-Gilbert J, Vowles KE. The role of mindfulness in a contextual cognitive-behavioral analysis of chronic pain-related suffering and disability. Pain 2007;131(1-2):63–9.

36. Schütze R, Rees C, Preece M, Schütze M. Low mindfulness predicts pain catastrophizing in a fear-avoidance model of chronic pain. Pain 2010;148(1):120–7.

37. Brown KW, Ryan RM. The benefits of being present: Mindfulness and awareness in the prevention and treatment of psychological, emotional, and physical problems. The Guilford Press, New York; 2003.

38. Allison PJ, Guichard C, Gilain L. A prospective investigation of dispositional optimism as a predictor of health-related quality of life in head and neck cancer patients. Qual Life Res 2000;9(8):951–60.

39. Kiken LG, Shook NJ. Mindfulness and emotional distress: The role of negatively biased cognition. Pers Individ Dif 2012;52(3):329–33.

40. Hruschak V, Flowers KM, Azizoddin DR, et al. Cross-sectional study of psychosocial and pain-related variables among patients with chronic pain during a time of social distancing imposed by the coronavirus disease 2019 pandemic. Pain 2021;162(2):619–29.

41. Sullivan MJ, Bishop SR, Pivik J. The Pain Catastrophizing Scale: Development and validation. Psychol Assess 1995;7(4):524–32.

42. Van Damme S, Crombez G, Bijttebier P, Goubert L, Van Peer GA. Mindfulness and symptom reports in chronic pain patients. J Psychosom Res 2011;70(6):541–7.

43. Cohen S, Kamarck T, Mermelstein R. Perceived stress scale. In: Menlo Park, CA: Mind Garden, Inc.; 1994:235–83.

44. Van Damme S, Crombez G, Bijttebier P, Goubert L, Van Peer GA. Mindfulness and symptom reports in chronic pain patients. J Psychosom Res 2011;70(6):541–7.

45. Hasselhorn H, Büssing A, Leibing E, et al. The role of mindfulness in chronic pain rehabilitation: A prospective study. J Psychosom Res 2011;70(6):541–7.

46. Skinner MA, Zautra AJ, Reich JW. Financial stress predictors and the emotional and physical health of chronic pain patients. Cognit Ther Res 2004;28(5):695–713.
65. Bao Y, Sturm R, Croghan TW. A national study of the effect of chronic pain on the use of health care by depressed persons. Psychiatr Serv 2003;54(5):693–7.
66. Abramson LY, Metalsky GI, Alloy LB. Hopelessness depression: A theory-based subtype of depression. Psychol Rev 1989;96(2):358–72.
67. Gewandter JS, Eisenach JC, Gross RA, et al. Checklist for the preparation and review of pain clinical trial publications: A pain-specific supplement to CONSORT. Pain Reports 2019;4(3):e621.
68. Jamison RN, Edwards RR. Risk factor assessment for problematic use of opioids for chronic pain. Clin Neuropsychol 2013;27(1):60–80.
69. Wasan AD, Davar G, Jamison R. The association between negative affect and opioid analgesia in patients with discogenic low back pain. Pain 2005;117(3):450–61.
70. Wasan AD, Michna E, Edwards RR, et al. Psychiatric comorbidity is associated prospectively with diminished opioid analgesia and increased opioid misuse in patients with chronic low back pain. Anesthesiology 2015;123(4):861–72.
71. France CR, Ysidron DW, Slepian PM, French DJ, Evans RT. Pain resilience and catastrophizing combine to predict functional restoration program outcomes. Health Psychol 2020;39(7):573–9.
72. Zinboonyahgoon N, Vlassakov K, Lirk P, et al. Benefit of regional anaesthesia on postoperative pain following mastectomy: The influence of catastrophising. Br J Anaesth 2019;123(2):c293–302.
73. Rakel BA, Zimmerman MB, Geasland K, et al. Transcutaneous electrical nerve stimulation for the control of pain during rehabilitation after total knee arthroplasty: A randomized, blinded, placebo-controlled trial. Pain 2014;155(12):2599–611.
74. Fillingim RB, Doleys DM, Edwards RR, Lowery D. Clinical characteristics of chronic back pain as a function of gender and oral opioid use. Spine (Phila PA 1976) 2003;28(2):143–50.
75. Meints SM, Miller MM, Hirsh AT. Differences in pain coping between black and white Americans: A meta-analysis. J Pain 2016;17(6):642–53.
76. Meints SM, Stout M, Abplanalp S, Hirsh AT. Pain-related rumination, but not magnification or helplessness, mediates race and sex differences in experimental pain. J Pain 2017;18(3):332–9.
77. Day MA, Thorn BE. The relationship of demographic and psychosocial variables to pain-related outcomes in a rural chronic pain population. Pain 2010;151(2):467–74.
78. Saastamoinen P, Leino-Arjas P, Laaksonen M, Lahelma E. Socio-economic differences in the prevalence of acute, chronic and disabling chronic pain among ageing employees. Pain 2005;114(3):364–71.
79. Fuentes M, Hart-Johnson T, Green CR. The association among neighborhood socioeconomic status, race and chronic pain in black and white older adults. J Natl Med Assoc 2007;99(10):1160–9.