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Biopsychosocial Typologies of Pain in a Cohort of Patients with Systemic Sclerosis

Erin L. Merz, MA, MPH[1], **Vanessa L. Malcarne, PhD**[1,2], **Shervin Assassi, MD, MS**[3], **Deepthi K. Nair, MS**[3], **Tiffany A. Graham, MD**[3], **Brayden P. Yellman, MD**[3], **Rosa M. Estrada-Y-Martin, MD, MS**[4], and **Maureen D. Mayes, MD, MPH**[3]

[1]SDSU/UCSD Joint Doctoral Program in Clinical Psychology, San Diego, California

[2]Department of Psychology, San Diego State University, San Diego, California

[3]Division of Rheumatology, University of Texas Health Science Center at Houston, Houston, Texas

[4]Divisions of Critical Care, Pulmonary and Sleep Medicine, University of Texas Health Science Center at Houston

Abstract

Objective—Despite being a common problem in Systemic Sclerosis (SSc), the extant literature on pain has primarily focused on biomedical correlates, or bivariate relationships with a few psychological characteristics. There is a need to investigate the more heuristic biopsychosocial model, which incorporates the simultaneous contributions of medical, psychological, and social variables in understanding pain.

Methods—Patients with SSc (*N* = 333) received clinical exams and completed self-report surveys at enrollment to the *Genetics versus ENvironment In Scleroderma Outcome Study* (GENISOS). Latent profile analysis was used to derive biopsychosocial profiles of patients using skin thickening, percent predicted forced vital lung capacity, perceived physical health, health worry, mental health, and social support. The profiles were examined in relation to pain and pain medication usage.

Results—A 3-profile solution provided the best fit to the data. Based on the biopsychosocial indicators, the profiles were characterized as *Managing* (*n* = 217), *Resilient* (*n* = 86), and *Distressed* (*n* = 30). Between-group differences for pain emerged, with the *Distressed* group, whose disease was less severe than the *Resilient* group, reporting the highest pain and the greatest utilization of pain medication.

Conclusion—Clinicians should consider biopsychosocial characteristics as contributing factors to the experience of pain in patients with SSc. Patients who are similar to those in the *Distressed* profile may be at an increased risk for pain and would likely benefit from a referral to a behavioral health or other ancillary service provider for pain management, rather than relying solely on pharmacological therapies.

Systemic Sclerosis (SSc) is a rheumatic disease characterized by skin thickening and fibrosis of internal organs due to a buildup of collagen and other extracellular matrix proteins [1]. There are two general classifications: limited cutaneous SSc (lcSSc), which has skin involvement only distal to the elbows and knees and is characterized by slow fibrosis and

Corresponding Author: Vanessa L. Malcarne, SDSU/UCSD Joint Doctoral Program in Clinical Psychology, 6363 Alvarado Court, Suite 103, San Diego, CA 92120-4913, (619) 594-6495 office, (619) 594-6780 fax, vmalcarne@mail.sdsu.edu.

milder internal organ involvement [1-2], and diffuse cutaneous SSc (dcSSc), which has a worse prognosis, extensively affects the skin and internal organs, and is characterized by rapidly progressing fibrosis [1-2]. Clinical care for SSc is complicated by a lack of effective treatments for many manifestations of disease. Therefore, the primary goals of care are to preserve functioning, relieve symptoms, and improve quality of life.

Pain is a virtually ubiquitous problem in SSc. Indeed, 83% of patients in a large, recent sample reported significant pain [3], which is similar to previous rates [4-6]. Early in the disease process, patients report nonspecific muscle pain and stiffness [1], while other symptoms (e.g., difficulty swallowing, gastrointestinal discomfort) emerge as the disease progresses [7]. In SSc, pain has been typically conceptualized according to the biomedical model, which suggests that pain is a symptom secondary to disease activity and previously sustained tissue damage [8]. However, the level of pain one experiences is not always relative to disease severity [4, 9]. For example, although lcSSc patients typically report less pain than dcSSc patients, the differences are generally small and not clinically meaningful [3-4, 10-12]. Alternatively, a biopsychosocial framework for understanding pain, which has been widely accepted across disciplines and diseases, suggests that pain is not a purely physical phenomenon [13]. This model highlights interconnections among the disease, person, and environment, and postulates that none of these factors can independently explain pain. Instead, biological, psychological, and social factors work together in complex ways to shape pain perceptions [13].

At the broadest level, emotional health and pain share a significant connection, with up to half of chronic pain patients also reporting depression and/or anxiety [13]. Symptoms of depression [14] and anxiety [15] are common in SSc, and psychological health has been broadly linked with pain in this population [3-5, 10, 16-17]. For example, depressive [3] and anxious [17] symptomatology, and mental health-related quality of life [10] have demonstrated relationships with pain, even after accounting for other disease and psychosocial variables.

The way a person thinks about his/her health has also been linked with pain in clinical [13] and rheumatic [9, 18] populations. Illness cognitions can range from general concerns to more severe responses and preoccupation, with more extreme responses being of the greatest significance to pain. Research suggests that thinking about the serious consequences of SSc [12], castastrophizing thoughts [6], and maladaptive disease cognitions [19] are all associated with greater pain. Other variables have also been shown to influence the cognition-pain relationship; patients with less education and social support who engage in catastrophic cognitions report greater pain [6].

A great deal of research has supported a link between social support and pain both directly, and via mood [13]. Research in the rheumatic diseases has also largely supported this connection [9, 20]. For example, in a study of patients with rheumatoid arthritis, osteoarthritis, or ankylosing spondylitis, lower satisfaction with social support was correlated with greater pain [20]. To date, only one study of SSc patients has evaluated the social support-pain relationship. In this study, patients with poor social adjustment reported worse pain; although this relationship was accounted for by depression, suggesting that emotional health was the conduit for this association [4].

There is a growing appreciation for the biopsychosocial model of pain in SSc, however, a better understanding of how these factors interact is needed. A number of the reviewed studies included biopsychosocial variables, but these constructs were typically included in adjusted models, rather than considering heterogeneity among them. Alternatively, these variables may be modeled as multiplicative (combined) effects to understand general

patterns at the level of the person. Although no analysis can capture all individual differences, the goal of this study was to determine whether general typologies that incorporate biological, psychological, and social characteristics could be identified to enhance understanding of SSc-related pain. The first aim was to evaluate the interrelationships of these factors by deriving homogeneous biopsychosocial trait profiles of SSc patients, and to interpret the response patterns that cluster together. The indicator variables (skin thickening, percent predicted forced vital lung capacity, perceived physical health, health worry, mental health, social support) were selected given the substantive reasoning that they may conjointly relate to pain. The second aim was to evaluate the predictive utility of each profile with respect to pain ratings and pain medication utilization. It was hypothesized that profiles characterized by poorer subjective ratings of perceived physical health, health worry, mental health, and social support would be related to pain and medication, whereas skin thickening and percent predicted forced vital lung capacity within the profiles would be less relevant.

Methods

Participants and Procedure

The sample (N = 333) was comprised of individuals who completed the baseline examination of the *G*enetics versus *EN*vironment *I*n Scleroderma *O*utcome *S*tudy (GENISOS), an ongoing, prospective, early-disease (within 5 years of onset) cohort study aimed at understanding morbidity and mortality in SSc. Patients with SSc who lived within the geographic catchment area of one of the three centers (University of Texas Health Science Center at Houston, University of Texas Medical Branch at Galveston, University of Texas-Health Science Center at San Antonio) were recruited from the rheumatology faculty clinics, the county hospital, and chapters of the Scleroderma Foundation [21].

Baseline visits were conducted during outpatient appointments and inpatient services at facilities staffed by the clinician-investigators. During this visit, data from medical records were clarified. Patients received a standardized clinical exam which included an evaluation of skin thickening and pulmonary function and were administered a packet of psychosocial measures. All participants gave written informed consent. Institutional Review Board approval was obtained at all participating institutions.

Variables

Skin Thickening—The modified Rodnan Skin Score (mRSS [22]), an objective indicator of skin disease severity, is calculated by measuring the extent and severity of skin thickening on 17 body surfaces by palpation on a 4-point scale (0 = uninvolved to 3 = severe thickening). Scores range from 0-51.

Forced Vital Lung Capacity—Percent predicted forced vital lung capacity (%FVC) is an objective, validated measure for severity of SSc-related interstitial lung disease [23] indicating the ratio of the volume of air that the subject can forcibly exhale after a maximum inspiration to the same volume in age, gender, weight, height, and ethnicity matched unaffected controls. All pulmonary measurements met criteria outlined by the American Thoracic Society/European Respiratory Society, and were reviewed by a pulmonologist (R.M.E-Y-M.). Lower scores indicate greater severity of SSc-related interstitial lung disease.

Perceived Physical Health[1]—The Physical Functioning subscale from the Medical Outcomes Study Short-Form Health Survey (SF-36 [24]), was used to evaluate self-reported overall physical health. Scores are transformed into a 0-100 scale; lower scores indicate

greater difficulties performing activities due to physical functioning. Internal consistency was α = .920.

Health Worry—Five items from the Illness Behavior Questionnaire (IBQ [25]) were used to generate the Health Worry scale for SSc [26]. An example item is, "Do you worry a lot about your health?" Scores range from 0-5; higher scores indicate greater worry and concern regarding one's health. Internal consistency was α = .721.

Mental Health—The SF-36 [24] Mental Health Component Summary Score measures global emotional health and related functional impairment. It is comprised of four subscales (Mental Health, Role Limitations Due To Emotional Problems, Social Functioning, Vitality) which are transformed into a 0-100 scale; lower scores indicate greater psychological distress and more limitations due to emotional problems. Internal consistency was α = .807.

Social Support—The 40-item Interpersonal Support Evaluation List (ISEL [27]) was used to derive a measure of perceived social support. Respondents rate whether a statement is "probably true" or "probably false" based on their experience. An example item is, "There is at least one person I know whose advice I really trust." The ISEL yields four subscales and an overall support score that is calculated by averaging the 4 subscales. Overall support scores range from 0-10; higher scores indicate better social support. Internal consistency was α = .870.

Pain—The Pain subscale from the SF-36 [24] was used to evaluate self-reported severity and impact of pain. Scores are transformed into a 0-100 scale; lower scores indicate greater pain severity and interference. Internal consistency was α = .884.

Pain Medication—Participants were asked whether they had taken acetominophen, non-steroidal anti-inflammatory drugs (NSAIDs), tramadol, and narcotics over the past month[2]. A variable with four categories (*No medication, Acetaminophen/NSAIDs, Tramadol, Narcotics*) was created to represent typical pain medication usage. Respondents taking multiple medications (11.1% of the sample; two medications: $n = 34$; three medications: $n = 3$) were coded with the strongest drug being taken (i.e., an individual taking both acetaminophen and tramadol was coded as *Tramadol*; an individual taking both tramadol and narcotics was coded as *Narcotics*).

Data Analysis

Latent Profile Analysis (LPA [28]), an empirically driven statistical technique that defines taxonomies (classes) of people based on common characteristics, was used to derive categorical latent variables representing classes of SSc patients with similar biopsychosocial profiles. Because it is difficult to interpret interactions with more than three variables, and because traditional analytic methods are at the level of the variable, not the person, LPA is a preferred technique for making inferences about individuals. This method summarizes complicated relationships among variables, similar to the way in which symptom clusters are categorized in medical settings to help inform diagnosis and treatment, and to make predictions about an individual. LPA uses all observations of the continuous indicator variables to define these classes via maximum likelihood estimation [29]. The probability

[1]The Physical Functioning scale score was used instead of the Physical Component score because the Component score includes an indicator of pain.

[2]Participants were also asked about aspirin and muscle relaxers, but these were not included in the pain medication variable given that aspirin is usually taken as an anti-platelet agent, and muscle relaxers ($n = 4$) are typically taken for fibromyalgia and are not considered pain medication. The 4 individuals taking muscle relaxers were also taking narcotics and were coded as such.

that an individual was properly classified, which enables each person to be categorized into the best-fitting class, is estimated simultaneously with the overall model [30]. Models are estimated with classes added iteratively to determine which model is the best fit. It is recommended that the sample size for LPA be large because class solutions produced from smaller samples may be unstable [31]. Recommendations mirror that of Structural Equation Modeling, with sample sizes of 200 being adequate [32].

To achieve the first aim, LPA was conducted using MPlus 6.1 [33]. Models were evaluated using the Lo-Mendell-Rubin Adjusted Likelihood Ratio Test (LMRT [34]), the Bootstrapped Likelihood Ratio Test (BLRT [35]), Akaike information criteria (AIC [36]), sample size-adjusted Bayesian information criteria (sBIC [37]), and Entropy [38] to determine the optimal number of classes. The LMRT and the BLRT compare the fit of a target model (e.g., 2-class model) to a comparison model specifying one less class (e.g., 1-class model). The *p*-value generated for the LMRT and BLRT indicates whether the solution with more ($p < .05$) or fewer ($p > .05$) classes fits better. The AIC and sBIC are descriptive fit indices wherein smaller values indicate better model fit. Entropy describes the accuracy of classification of individuals into a class; bigger values (i.e., closer to 1) indicate greater accuracy. Models were also evaluated on interpretability to determine whether the classes truly represented different categories, rather than being an artifact of a nonnormal distribution [39]. Given that small classes (i.e., those with less than 5% of the sample) are typically considered spurious, a condition often associated with extracting too many classes/profiles [40], the number of patients categorized into each class was also considered. The overall sample means (and SDs) and conditional response means (and SDs) of each indicator variable from the best-fitting solution were compared for interpretation. The classes were then related to disease and demographic characteristics. For the second aim, ANOVA and chi-square tests were conducted to evaluate potential differences in pain and pain medication usage as a function of class. To identify between-class differences, Bonferroni post-hoc tests were conducted and adjusted standardized residuals were examined using a familywise error rate of .05.

Results

Sample characteristics are described in Table 1. Most participants were women, married, and had at least a high school diploma or General Education Development certificate. Ages ranged from 16 to 86. Age of disease onset ranged from 14 to 84. Disease duration ranged from 0 to 5 years. Individuals with dcSSc had greater skin thickening (t [330] = -15.22, $p < .001$; dcSSc = 21.98 ± 10.95; lcSSc = 6.82 ± 5.10) and lower forced vital lung capacity (t [309] = 2.54, $p = .011$; dcSSc = 80.07 ± 20.74; lcSSc = 86.33 ± 22.37).

Development of Biopsychosocial Classes Using Latent Profile Analysis

Intercorrelations among the indicator variables were nonsignificant or small/moderate in size which allowed for more differentiation between classes[3]. Latent profile models containing 1-4 classes were fit to the data. Fit indices for each LPA are presented in Table 2. The LMRT and BLRT indicated that the 2-class solution fit better than the 1-class solution ($p = .005$). The 3-class solution was superior to the 2-class solution according to the LMRT ($p = .05$) and BLRT values ($p < .0001$), and lower AIC and sBIC values. Although the 4-class solution revealed slightly lower AIC and sBIC values, and a statistically significant BLRT value ($p < .0001$), Entropy was lower, and the LMRT indicated that it was not statistically different from the 3-class solution ($p = .32$). Therefore, the 3-class solution was considered the best fit to the data.

[3]A table of these relationships is available from the study authors upon request.

The overall sample means and conditional response means used to substantively interpret each class are available in Table 3. Figure 1 presents the *z*-transformed conditional response means (*M*s = 0, *SD*s = 1) for the purposes of illustration. To facilitate interpretation of the profiles, the *z* scores for the figure were set such that higher scores represented better functioning. Class 1 is comprised of 65.2% of the sample and represents individuals with relatively less severe skin thickening and forced vital lung capacity, better perceived physical health, fewer health worries, better mental health, and more social support. Accordingly, this profile was referred to as *Managing*. Class 2 is comprised of 25.8% of the sample and was termed *Resilient* because it represents individuals with relatively more severe skin thickening and forced vital lung capacity and poorer perceived physical health, but fewer health worries, better mental health, and more social support. Class 3, labeled *Distressed*, is comprised of 9.0% of the sample and is characterized by individuals with relatively less severe skin thickening and forced vital lung capacity, but poorer perceived physical health, more health worries, poorer mental health, and lower social support.

In sum, the *Managing* and *Distressed* classes were similar with regard to skin thickening and percent predicted forced vital lung capacity; however, they differed on their perceived physical health and their psychosocial characteristics. Specifically, the *Distressed* class had the poorest psychosocial functioning of the three groups. *Resilient* patients had more severe skin thickening and percent predicted forced vital lung capacity than the other groups, and accordingly, their perceived physical health was poorer. However, the *Resilient* class reported better psychosocial functioning, with scores equivalent to the healthier *Managing* patients. The profiles differed somewhat on how much they worried about their health: *Distressed* patients reported the most worry, *Managing* patients reported the least worry, and the *Resilient* class, which was the sickest class, reported moderate worry.

Disease Characteristic and Sociodemographic Group Differences

Follow-up analyses suggested that the classes differed by disease type, χ^2 (2) = 75.77, $p < .0001$. The proportions of lcSSc and dcSSc patients were similar to the overall sample for the *Distressed* class (60.0% lcSSc, 40.0% dcSSc) and the *Managing* class (55.6% lcSSc, 44.4% dcSSc). However, the *Resilient* class had more dcSSc (97.7%) than lcSSc (2.3%) patients than would be expected due to chance. There was a significant difference for income (χ^2 [8] = 21.44, p =.006), with *Distressed* patients reporting a higher proportion of lower income than would be expected by chance (51.9% reported an annual income lower than $14,999). The classes did not differ on history of digital ulcers, arthritis, disease duration, age, gender, race/ethnicity, or education (*p*s > .05).

Association of Biopsychosocial Profiles with Pain and Pain Medication

Figure 2 provides a graphic depiction of pain and medication use between the classes. ANOVA results suggested overall group differences in pain, F (2, 290) = 16.47, $p < .001$, partial η^2 = .102. Post-hoc comparisons revealed a large difference (d = 1.00, $p < .001$) between the *Managing* (54.91 ± 26.26) and *Distressed* classes (29.48 ± 24.38), such that *Distressed* patients reported greater pain[4]. A moderate significant difference (d = .52, $p < .001$) suggested that *Resilient* patients (41.44 ± 25.36) reported more pain than *Managing* patients. Although the difference between the *Distressed* and *Resilient* classes was not statistically significant, there was a trend and medium-sized effect suggesting that *Distressed* patients had greater pain than *Resilient* patients (d = .48, p = .103).

[4]Note that on the SF-36, lower scores indicate greater pain severity and interference, whereas higher scores indicate less pain severity and interference.

Chi-square test results suggested that pain medication usage was not equal among the classes, χ^2 (6) = 14.88, p = .021. These relationships are described in Table 4. Inspection of the standardized residuals for each class by pain medication category revealed that the *Managing* class (62.67%) was significantly more likely to *not* be taking pain medication whereas the *Distressed* class (36.67%) was significantly less likely to *not* be taking pain medication than would be expected based on the total sample. Additionally, the *Managing* class (2.76%) was significantly less likely to be taking tramadol, whereas the *Distressed* class (13.33%) was significantly more likely to be taking tramadol.

Discussion

Skin thickening, percent predicted forced vital lung capacity, perceived physical health, health worry, mental health, and social support were used to identify biopsychosocial profiles of patients with SSc. Three classes emerged and were termed *Managing*, *Resilient*, and *Distressed*. One remarkable finding was that while the *Managing* and *Distressed* groups were similar with regard to skin thickening and percent predicted forced vital lung capacity, they differed on perceived physical health, mental health, and social support. Specifically, the *Managing* group was functioning well psychosocially; the *Distressed* group was not. The *Resilient* group had a much more severe disease manifestation; however, *Resilient* patients mirrored the *Managing* group psychosocially.

When the groups were evaluated in relation to other clinical variables that cause persistent pain (i.e., digital ulcers, arthritis), there were no differences. Moreover, it is significant that the proportion of lcSSc and dcSSc patients in the *Managing* and *Distressed* typologies was roughly equivalent to the overall sample, but that the *Resilient* typology was predominantly comprised of dcSSc patients. This suggests that disease severity is not the key factor for differentiating between patients who are at risk for decreased quality of life, consistent with previous findings [5, 11]. Indeed, when the classes were evaluated in relation to pain and medication, the *Distressed* group, which was less severely affected, reported greater pain and medication usage.

One interesting finding from this study was that social support in the *Distressed* group was approximately two standard deviations lower than the other profiles. The health benefits of social support from family, friends and other informal groups (as opposed to health professional or therapeutic support), have been recognized across disease populations [13, 41], including rheumatic diseases [9, 42]. The current findings suggest that social support is of great interest in understanding the experience of SSc patients, particularly given that SSc patients may avoid socializing due to appearance concerns [43], and that over half of patients with rheumatic disorders report moderate to high levels of loneliness [44]. It is also worth mentioning that, social support is not characterized by the number of relationships one has, but rather the perceived availability and quality of support [27]. A person may have many social contacts but not feel supported by them, or, conversely, a person may derive adequate support from just one relationship.

Effective pain management is a primary goal of patient care, although it has not been well investigated in SSc [45]. Because not all patients respond well to pharmacological pain management [46], other methods that target modifiable psychosocial factors (i.e., emotional health, cognitions, social support) should be considered. Approaches such as cognitive-behavioral therapy (which involves skill building in areas such as mindfulness, relaxation, coping, social support, changing maladaptive beliefs), have already been identified and used in other pain populations [9, 13, 47-48]. While outcomes to these treatments are less straightforward (e.g., successful treatment may mean that pain is partially ameliorated, a

patient is experiencing their pain differently, healthcare costs have decreased), they may be promising as an adjunct for patients who are not benefiting from pharmacological therapy.

However, prior to implementing and evaluating interventions for individuals with characteristics similar to the *Distressed* profile, it is important to determine whether such patients can be feasibly identified within clinical settings. To this end, researchers and clinicians are encouraged to assess for perceived physical health, health worry, mental health, and social support in addition to disease severity of the skin and lungs, which are routinely evaluated.

Limitations of this study include limited generalizability to late-stage patients, who typically experience greater pain. Also, because the data were cross sectional, it is not possible to know whether *Distressed* patients were functioning poorly prior to their diagnosis, or these characteristics emerged during the disease process. Because the medication question did not specify that the medication must be for SSc discomfort, it is possible that acetaminophen/NSAIDs taken for other pain (e.g., headaches) may have been erroneously captured in that response category. It is also important to note that other variables likely relate to SSc pain, and the six indicators selected for the current study are not exhaustive. Rather, the choices were guided by theoretical rationale, as the goal of the current study was not to investigate all potential corollaries of pain, but to evaluate whether biopsychosocial variables could be modeled synergistically. This study was the first to use a person-centered approach to model biopsychosocial traits in relation to pain in SSc. The results suggest that psychosocial functioning is fundamental to understanding pain in this population. Clinicians are encouraged to take a holistic approach in assessments and to make referrals for ancillary pain management services when indicated.

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Significance and Innovations

- Researchers and clinicians have rarely considered how medical, psychological, and social traits are synergistically linked with pain in SSc patients.
- Although disease severity is a risk factor for increased pain, psychological and social characteristics are important corollaries of pain, particularly in those with less severe disease.
- The current findings facilitate better identification of patients who may benefit from referrals to ancillary services for alternative treatments of pain.

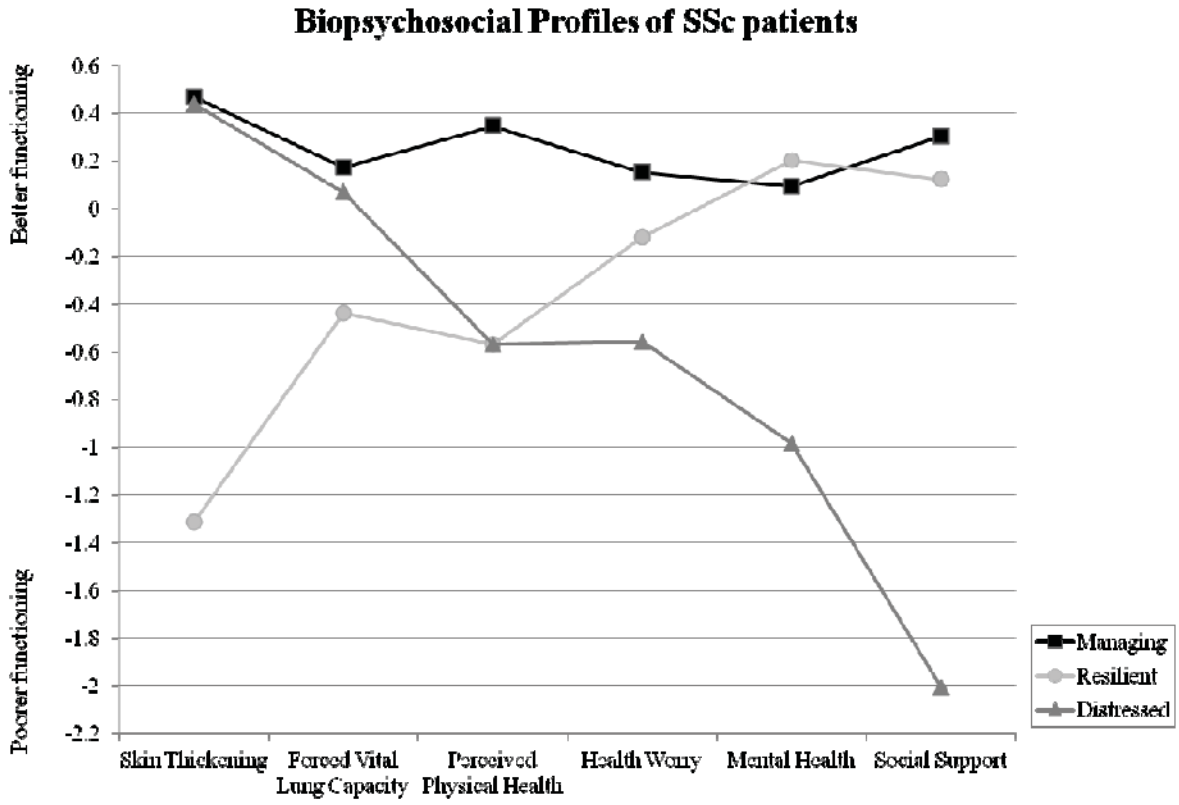

Figure 1.

z transformed conditional response means of the 3-class solution

Note. For illustrative purposes, *z* scores were set so that higher scores represented better functioning

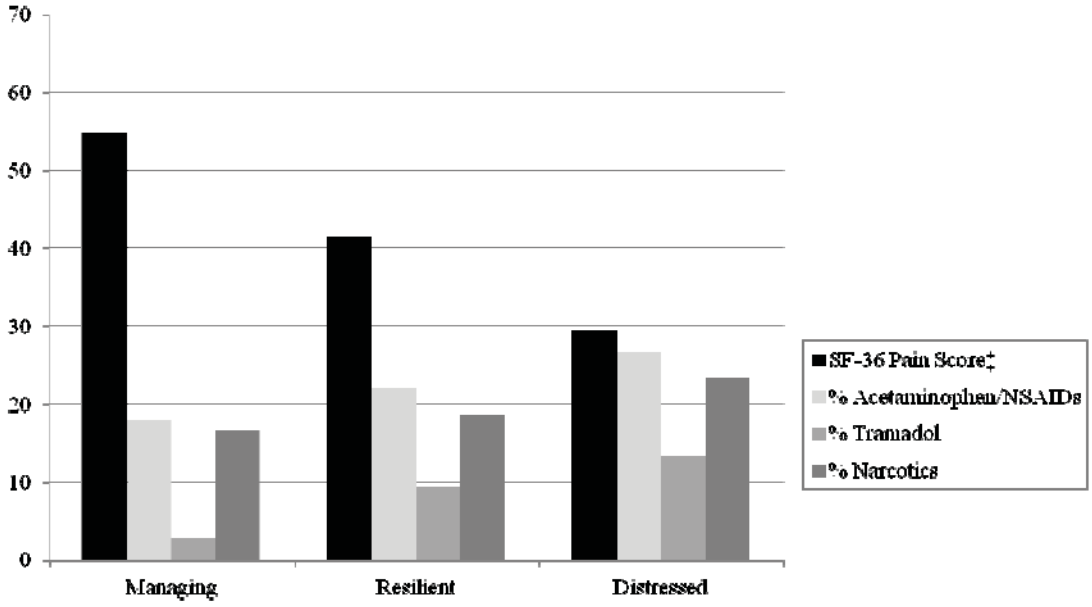

Figure 2.
Self-reported pain (SF-36) and pain medication usage for each biopsychosocial class
Note. ‡higher scores on the SF-36 indicate better functioning (i.e., less pain); Significant between-group differences were observed for pain, F (2, 290) = 16.47, $p < .001$, and pain medication usage, χ^2 (6) = 14.88, $p = .021$.

Table 1

Sample characteristics

Variable		*M* ± *SD* or n (%)
Age		48.00 ± 13.04
Sex	Women	278 (83.5%)
	Men	55 (16.5%)
Race/Ethnicity	White	157 (47.2%)
	Hispanic	97 (29.1%)
	Black	68 (20.4%)
	Asian	10 (3.0%)
	American Indian	1 (0.3%)
Marital status	Married/Partnered	180 (56.6%)
	Never married	42 (13.2%)
	Divorced/Separated	80 (25.2%)
	Widowed	16 (5.03%)
Education	Less than high school	49 (15.3%)
	High school diploma/GED	166 (51.7%)
	Associate's degree	32 (10.0%)
	Bachelor's degree	47 (14.6%)
	Post-graduate	27 (8.4%)
Family income	< $14,999	78 (25.0%)
	$15,000 - $29,999	71 (22.8%)
	$30,000-$49,999	64 (20.5%)
	$50,000-$99,999	60 (19.2%)
	≥ $100,000	39 (12.5%)
Disease subtype	Diffuse cutaneous	192 (57.8%)
	Limited cutaneous	140 (42.2%)
Age of disease onset		46.02 ± 13.20
Disease duration (years)		1.20 ± 1.40
Skin thickening (MRSS)		15.62 ± 11.67
Forced Vital Lung Capacity		82.70 ± 21.63
History of digital ulcers		200 (60.1%)
Arthritis		101 (30.3%)
IBQ	Health Worry Scale	2.19 ± 1.63
ISEL	Total Social Support Scale	8.20 ± 1.63
SF-36	Mental Health Composite Score	45.51 ± 12.91
	Physical Functioning Scale	43.32 ± 28.66
	Pain Scale	48.81 ± 27.18
Pain medication use	Not taking pain medication	190 (57.1%)
	Acetaminophen/NSAIDs	66 (19.8%)
	Tramadol	18 (5.41%)
	Narcotics	59 (17.7%)

Table 2

Model fit indices for skin thickening, forced vital lung capacity, perceived physical health, health worry, mental health, total social support

Solution	LMRT (*p*)	BLRT (*p*)	AIC	sBIC	Entropy
1 class			12802.40	12810.04	
2 class	118.590 (.005)	121.507 (<.0001)	12694.90	12706.98	.806
3 class	95.834 (.05)	98.191 (<.0001)	12610.71	12627.24	.799
4 class	35.530 (.32)	35.530 (<.0001)	12589.18	12610.17	.695

Note. LMRT = Lo-Mendell-Rubin Test, BLRT = Bootstrapped Lo-Mendell Rubin Test, AIC = Akaike Information Criterion, sBIC = sample size-adjusted Bayesian Information Criterion

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Table 3

Overall sample means ± SD and Biopsychosocial profile conditional response means ±SD

	n	Skin Thickening‡	Forced Vital Lung Capacity†	Perceived Physical Health†	Health Worry‡	Mental Health†	Social Support†
Sample	333	15.62 ± 11.67	82.70 ± 21. 63	43.32 ± 28.66	2.19 ± 1.63	45.51 ± 12.91	8.20 ± 1.63
3-class solution							
Class 1 (*Managing*)	217	10.17 ± 20.08	86.38 ± 23.63	53.22 ± 31.54	1.94 ± 1.97	46.72 ± 15.36	8.70 ± 1.92
Class 2 (*Resilient*)	86	30.96 ± 13.20	73.19 ± 33.22	26.95 ± 51.30	2.38 ± 2.64	48.10 ± 15.17	8.40 ± 2.32
Class 3 (*Distressed*)	30	10.53 ± 12.25	84.17 ± 28.11	26.94 ± 35.78	3.10 ± 1.81	32.78 ± 16.60	4.92 ± 1.75

Note.

†higher scores indicate better functioning;

‡lower scores indicate better functioning

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Table 4

Percentage of patients within each biopsychosocial group regularly taking pain medication

	Not taking pain medication	Acetaminophen/NSAIDS	Tramadol	Narcotics
Managing (n = 217)	62.67%*	17.97%	2.76%**	16.59%
Resilient (n = 86)	50.00%	22.09%	9.30%	18.60%
Distressed (n = 30)	36.67%*	26.67%	13.33%*	23.33%

Note. Overall model, χ^2 (6) = 14.88, p = .021;

* $p < .05$;

** $p < .01$