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ARTICLE

Relationship of psychosocial factors and musculoskeletal pain among individuals with newly acquired spinal cord injury

Margaret Finley[1] · Elizabeth Euiler[1] · Laura Baehr[1] · Edward Gracely[2] · Mary Brownsberger[3] · Mary Schmidt-Read[4] · Sara Kate Frye[5] · Marni Kallins[5] · Amanda Summers[5] · Henry York[5,6] · Paula Richley Geigle[5,7]

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Abstract

Study design Cross-sectional analysis of baseline data of a longitudinal cohort study.

Objectives Little evidence exists on pain-related psychosocial factors in individuals with newly acquired spinal cord injury (SCI). To understand a biopsychosocial model of pain, we must first understand the presenting psychological pain-related factors at injury onset. Therefore, we assessed musculoskeletal pain and pain-related psychological constructs in a group of individuals with newly acquired SCI. We hypothesized that individuals with new SCI would report musculoskeletal shoulder pain with elevated levels of kinesiophobia and pain catastrophizing.

Setting Data were collected in three rehabilitation hospitals located in urban and suburban communities.

Methods Thirty-five individuals with newly acquired SCI participated. Demographics, Musculoskeletal Pain Survey shoulder subscale, Tampa Kinesiophobia Scale-11, Pain Catastrophizing Scale, Fear of Pain Questionnaire, Chronic Pain Coping Inventory-42, and Subjective Quality of Life Questionnaire were administered. Descriptive analysis of all measures was determined and relationships between pain and psychosocial measures determined.

Results Moderate shoulder pain existed in 40% of people with new SCI along with clinically elevated kinesiophobia, pain catastrophizing, fear of pain, and reduced quality of life. Shoulder pain was statistically associated with pain catastrophizing ($\rho = 0.41$, $p = 0.01$). Kinesiophobia positively correlated with fear of pain ($\rho = 0.38$, $p = 0.02$) with an inverse relationship to quality of life ($\rho = -0.47$, $p = 0.01$).

Conclusions Elevated pain, and pain-related psychological characteristics, such as catastrophizing and kinesiophobia exist during the early stages after SCI. Early identification of pain-related factors can guide clinical intervention potentially ameliorating pain-linked functional impairments.

Trial registry This trial is registered with ClinTrial.gov ID NCT03137394.

✉ Margaret Finley
maf378@drexel.edu

[1] Department of Physical Therapy and Rehabilitation Science, Drexel University, Philadelphia, PA, USA

[2] School of Public Health, Drexel University, Philadelphia, PA, USA

[3] Good Shepherd Rehabilitation Network, Allentown, PA, USA

[4] Magee Rehabilitation Hospital/Jefferson Health, Philadelphia, PA, USA

[5] University of Maryland Rehabilitation and Orthopaedic Institute, Baltimore, MD, USA

[6] Department of Neurology, University Maryland School of Medicine, Baltimore, MD, USA

[7] Department Physical Therapy, South College, Knoxville, TN, USA

Introduction

Spinal cord injury (SCI) is a sudden, unexpected, life-altering event. Nearly 275,000 people in the United States live with SCI, and more than 12,500 new injuries occur annually [1]. The average age at initial injury increased from 29 years in the 1970s to 42 years as of 2010, and life expectancy has reached into the eighth decade [1]. Following a newly acquired SCI, many individuals rely on their upper extremities for wheelchair propulsion, transfers, pressure relief, and activities of daily living. This reliance on upper extremities not designed for heavy repetitive loading predisposed individuals with SCI to musculoskeletal shoulder pain. Individuals with SCI who develop shoulder pain are more likely to experience loss of function and independence, and experience significant participation

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restrictions in self-care, work, and leisure activities leading to decreased quality of life (QoL) [2]. Individuals with SCI present with a bimodal distribution of shoulder pain: peaks are typically reported in the initial year and >15 years post injury [3]. Pain-related psychological constructs have been identified as significant predictors of pain persistence and rehabilitation outcomes [4, 5]. While many individuals with SCI report significant musculoskeletal pain, no known research exists regarding pain-related psychological constructs in the early stages following injury.

In persons with chronic SCI, pain catastrophizing is a strong predictor of QoL and is associated with disability and kinesiophobia [6]. Pain catastrophizing is one of the most important psychological variables to explain pain responses [7]. Pain catastrophizing scores are predictive of pain sensitivity, physical and mental disability, coping, and QoL [8]. Catastrophizing is linked with pain occurrence in individuals with chronic musculoskeletal back pain, increased pain-related behavior, increased health care services use, longer hospital stays, and increased use of medication in numerous patient populations (chronic lower back pain, fibromyalgia, sickle cell disease, cancer) [9]. Among veterans with SCI, a higher level of catastrophizing related to lower levels of productive activity (e.g., work, education), lower social integration, greater pain interference, and higher pain intensity. Increased catastrophizing appeared to be a confounder between pain and function [10]. Minimal evidence exists regarding these pain-related factors in individuals with newly acquired SCI. These findings support the importance of early identification and management of negative psychological factors, in the presence of pain, to prevent functional limitations.

Pain-related fear is described in several dimensions. The "fear-avoidance" model describes how and why some individuals develop a stronger psychological reaction to their pain than others [11]. Studies have investigated pain catastrophizing to determine the relationship among catastrophizing, pain, and activity intolerance [12]. The propensity to catastrophize about pain is associated with an increased rate of chronic pain development and muscle dysfunction [12]. Kinesiophobia addresses an excessive and often debilitating fear of physical movement and activity [13]. Kinesiophobia and pain catastrophizing are the most important predictors of upper extremity-specific disability [14]. One study investigated kinesiophobia in individuals with chronic SCI [15]. In addition to physical etiologies, pain catastrophizing and kinesiophobia were associated with the development of chronic shoulder musculoskeletal pain and dysfunction in the general population [12]. Furthermore, catastrophizing and other fear-avoidance pain constructs predicted pain persistence and poorer clinical outcomes [16]. Conversely, reduction in catastrophizing and improved control over pain contributed significantly to diminished pain interference and improved psychological function for individuals with chronic SCI. However, this evidence is limited [17]. In addition, no known evidence exists relating musculoskeletal pain patterns, specifically shoulder pain, to activity levels and limitations in individuals with newly acquired SCI, nor to these relationships across the initial year post injury. Thus, we are collecting pain-related psychosocial data during our larger longitudinal study, which will provide a comprehensive clinical and psychosocial factor progression description regarding the development and persistence of shoulder pain in individuals following SCI.

To understand a biopsychosocial model of pain over time, we must first understand the presenting psychological pain-related factors early after SCI, during inpatient rehabilitation. Therefore, our current aim is to characterize musculoskeletal shoulder pain and pain-related psychological constructs in individuals with newly acquired SCI. We hypothesized individuals with newly acquired SCI would demonstrate shoulder pain as well as clinically elevated levels of kinesiophobia and pain catastrophizing, which will associate with subjective QoL.

Methods

Our presented findings are a cross-sectional analysis of baseline measures from a larger longitudinal study. Our larger study was a multisite, repeated-measures design with Institutional Review Board approval acquired from all sites. Three data collection points were utilized: during initial rehabilitation hospitalization, 6 months post rehabilitation, and 12 months post rehabilitation. Individuals with newly acquired SCI were recruited and enrolled from inpatient rehabilitation programs at three rehabilitation hospitals, located in both urban and suburban communities (Magee Rehabilitation Hospital, Philadelphia, PA; Good Shepherd Rehabilitation Network, Allentown, PA; University of Maryland Rehabilitation and Orthopaedic Institute, Baltimore, MD). Analysis of the baseline pain-related psychological survey data is presented here.

Inclusion criteria required individuals be at least 18 years old; engaging in inpatient rehabilitation following a newly acquired SCI (complete or incomplete SCI of American Spinal Injury Association/International Standard for Neurological Classification of SCI grade A, B, C, or D [18, 19]); expected manual wheelchair use for at least 50% mobility; possess active shoulder elevation to 90°, and medically stable. Individuals with self-reported conditions influencing upper extremity function, such as upper extremity radicular symptoms, preexisting neurological conditions, or other health conditions, were excluded. Presence or absence of shoulder pain was not an eligibility consideration and was

not included in screening criteria. Similarly, level of injury was not an inclusion criterion; rather, expected manual wheelchair use was the optimal factor considered to best understand manual wheelchair user pain.

Following procedures review and obtaining signed informed consent, we obtained the following demographic data: age, gender, race (American Indian/Alaska Native, Asian, Native Hawaiian or Pacific Islander, Black or African American, White, or other), ethnicity (Hispanic/Latino, Non-Hispanic), marital status (single/never married, married, divorced, separated, widowed), occupation (pre-injury-employed/working, homemaker, student, retired, unemployed, other), educational level (less than high school, high school diploma, associate's degree, bachelor's degree, graduate degree, other), income level (<$15,000, $15,000–24,999, $25,000–49,000, $50,000–74,999, ≥$75,000), injury level (cervical, thoracic, lumbar, sacral, other), and cause of injury (fall, motor vehicle accident, gunshot, medical/surgical, another accident). Height and weight were obtained from the medical record. Other clinical measures were acquired and reported elsewhere [20].

Study measures

The self-report Musculoskeletal Pain Survey (MPS) assesses musculoskeletal pain [21]. This questionnaire asks the participant to rate pain seriousness (0 = not at all to 5 = very serious) and frequency (0 = never to 3 = more than three times per week). Next, a bilateral shoulder pain score (MPS_Shldr) was calculated as seriousness*frequency (max score = 30). This measure has been used previously in individuals with newly acquired SCI [21–24]; however, no psychometric properties are reported.

The Tampa Kinesiophobia Scale (TSK-11) assesses fear of movement (kinesiophobia). The validated 11-item version (TSK-11) [25] yields a score range of 11–44, with higher scores indicating greater fear of movement and reinjury. The TSK-11 comprises opinion-based items evaluating the participants' general status on a scale of 1–4 (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). TSK-11 offers excellent reliability (ICC = 0.81, SEM = 2.54). Scores >50% total are indicative of high level of kinesiophobia [26], therefore, TSK-11 scores of >22 were identified as clinical risk of activity limitations.

The Fear of Pain Questionnaire (FPQ) is a 9-item measure of fear and anxiety of painful stimuli [27]. For each painful situation described on the FPQ, participants rate how "fearful" they are on a scale from 1 (not at all) to 5 (extreme) with total score range of 9–45. Previous research reported adequate internal consistency (α range, 0.86–0.87) on the FPQ scales [27].

The Pain Catastrophizing Scale (PCS) consists of 13 items rated on a 5-point scale (0 = not at all to 4 = all the time) with a score range of 0–52 [7]. Participants rated the degree to which specified thoughts and feelings occur when experiencing pain across three dimensions of pain catastrophizing: rumination, ("I cannot stop thinking about how much it hurts," score 0–16), magnification ("I worry that something serious may happen," score 0–12), and helplessness ("There is nothing I can do to reduce the intensity of the pain," score = 0–24). The PCS has a strong test–retest reliability ($r = 0.70$) indicating that individuals may possess enduring beliefs about the threat value of painful stimuli [7]. A PCS total score of ≥30 represents a clinically relevant level of catastrophizing with individuals who score between 20 and 30 considered at moderate risk for chronic pain development [28]. A rumination subscale score of ≥11, magnification subscale score of ≥5, and/or helplessness subscale score of ≥13 also represent a clinically relevant level of catastrophizing. Clinically relevant moderate-risk level for the rumination subscale is 8–10, magnification is 3–4, and helplessness is 8–12 [28]. PCS validation exists for clinical and nonclinical populations [29].

The Subjective Quality of Life Questionnaire (SQoL) is a global measure of subjective QoL [30]. Using a Likert-type scale, participants are asked to consider everything in their life and rate the overall quality on an ordinal scale from 1 (life is very distressing; it is hard to imagine how it could get much worse) to 7 (life is great; it is hard to imagine how it could get much better). Test–retest reliability is high (91% agreement), and the tool is validated for individuals with SCI [30].

Coping strategies used during inpatient rehabilitation were determined with The Chronic Pain Coping Inventory-42 (CPCI-42). The CPCI-42, a 42-item abbreviated version of the original 65-item CPCI, assesses eight specific coping responses to pain (resting, task persistence, guarding, asking for assistance, relaxation, coping self-statements, exercise, and seeking social support) [31]. The coping strategies frequency is measured by the total number of days the strategy was used in the past week (0–7) with all subscale item means calculated. Strategies are further classified as passive, proactive, and self-coping strategies. The CPCI-42 scales demonstrate good psychometric properties and adequate to excellent test–retest stability (0.65–0.90) [32].

Data analysis

Descriptive statistics including means, standard deviations, medians, and interquartile ranges, or frequencies were determined for the demographic variables, as well as pain (MPS_shldr), and psychosocial measures (TSK-11, FPQ, PCS, SQoL, CPCI-42). For the MPS_Shldr, the percentage of individuals with nonzero pain was calculated. Parametric

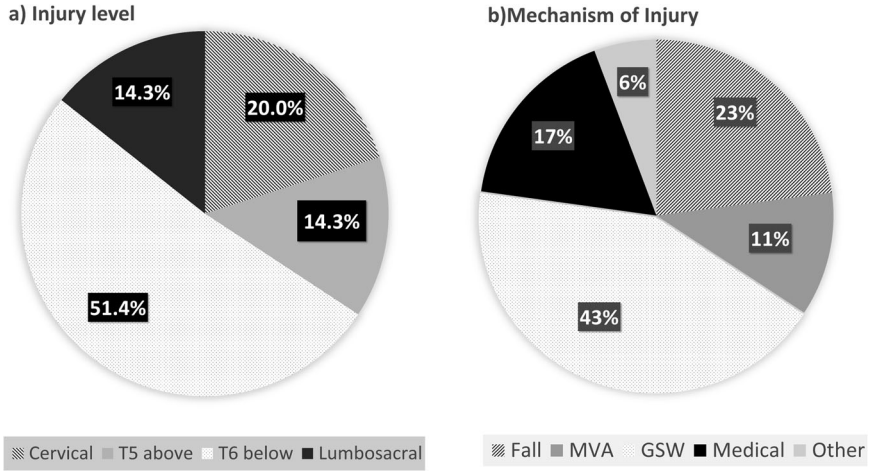

Fig. 1 Injury characteristics of those with spinal cord injury. **a** Level of injury. **b** Mechanism of injury. MVA motor vehicle accident, GSW gunshot wound.

assumptions for continuous data were examined. The MPS_Shldr (seriousness, frequency, total) and CPCI_42 measures were not normally distributed, with all other measures meeting parametric assumptions. Spearman rho (ρ) correlations examined associations of pain with age and psychosocial measures (TSK-11, PCS, FPQ, SQoL, CPCI-42). As this work was a preliminary analysis to determine these related factors for individuals with newly acquired SCI, we set the significance at $p \le 0.05$. Strength of association (correlation) was defined as weak if $\rho < 0.30$, moderate for $\rho = 0.30$–0.50, and strong when $\rho > 0.50$ [33]. All analyses were performed in IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA).

Secondary analysis further explored the impact of injury level pain and pain-related psychosocial factors. Individuals were classified by injury level as T5 and above ($n = 12$) or T6 and below ($n = 23$). The levels of injury groups were compared by the Mann–Whitney ($p \le 0.05$) test on total MPS_Shldr seriousness and by independent t tests on psychosocial variables. Chi Square assessed the association of the presence of shoulder pain and risk of catastrophizing (PCS_total ≥ 20) and kinesiophobia (TSK-11 > 22).

Results

Thirty-five adult volunteers (males = 32, females = 3, age = 37.1 ± 14.9 years) attending initial inpatient rehabilitation for a newly acquired SCI at one of the three freestanding rehabilitation hospitals participated. Nearly 83% of participants demonstrated thoracic level injury with the most common injury mechanism being gunshot wound (43%), followed by falls (23%, Fig. 1). The majority of individuals identified their race as white (60%) followed by African American (34%). Over 65% of individuals reported an education level of high school or below, with nearly 29% reporting postsecondary education. Annual household income was reported at <$15,000 in almost 30% of the sample. Table 1 shows the demographic characteristics.

Over 43% of participants reported musculoskeletal shoulder pain, with 53% of those reporting bilateral pain (Table 2). Injury level did not differentially impact shoulder pain (MPS_Shldr, $Z = -0.67$, $p = 0.56$) or psychosocial outcome scores [TSK-11 ($t = -0.43$, $df = 33$, $p = 0.07$), FPQ ($t = -1.23$, $df = 33$, $p = 0.23$), PCS_Total ($t = -1.63$, $df = 33$, $p = 0.11$), or SQoL ($t = -0.60$, $df = 33$, $p = 0.55$)]. For the TSK-11, 68.7% of individuals reported a clinically relevant risk (TSK-11 > 22). Clinically relevant risk for development of persistent, chronic pain was identified by the PCS_total score in 15/35 individuals (Table 3). Shoulder pain presence was not a significant predictor of an "at risk" scoring level on the TSK-11 ($X^2 = 0.26$, $df = 1$, $p = 0.72$) or the PCS ($X^2 = 3.15$, $df = 1$, $p = 0.10$).

Age was not associated with shoulder pain or any of the psychosocial measures (TSK-11, PCS, FPQ-9, SQoL, CPCI-42 strategies, Table 4). Shoulder pain (MPS_shoulder) was significantly associated with PCS_total ($\rho = 0.41$, $p = 0.01$), and PCS_magnification subscale ($\rho = 0.46$, $p = 0.01$) and PCS_rumination subscale ($\rho = 0.39$, $p = 0.02$). TSK-11 correlated positively with the FPQ ($\rho = 0.42$, $p = 0.01$) and was inversely related to SQoL ($\rho = -0.49$, $p < 0.001$). FPQ correlated with the PCS total ($\rho = 0.42$, $p = 0.01$) Table 5.

Discussion

To our knowledge, this is the first study to assess musculoskeletal shoulder pain and pain-related psychological factors in individuals with newly acquired SCI. The few previous studies investigating pain and psychological variables after SCI focused on depression and anxiety [34, 35]. SCI is a sudden, unexpected event and we obtained our measures during the initial rehabilitation phase. Our

Table 1 Demographic information of participants with newly acquired spinal cord injury.

Age (years, mean ± SD)	37.1 ± 14.9
Height (cm, mean ± SD)	177.3 ± 9.1
Weight (kg, mean ± SD)	80.7 ± 17.8
Ethnicity	
Hispanic/Latino	$n = 1$ (2.9%)
Non-Hispanic	$n = 32$ (91.4%)
Other	$n = 2$ (5.7%)
Race	
African American	$n = 12$ (34.4%)
White	$n = 21$ (60%)
Asian	$n = 0$ (0%)
Other	$n = 2$ (5.7%)
Education	
Less than or equal to high school	$n = 5$ (14.3%)
High school diploma	$n = 18$ (51.4%)
Associate's degree	$n = 2$ (5.6%)
Bachelor's degree	$n = 5$ (14.3%)
Master's degree	$n = 3$ (8.6%)
Doctorate degree	$n = 0$ (0%)
Other	$n = 2$ (5.7%)
Occupation	
Employed	$n = 25$ (71.4%)
Student	$n = 4$ (11.4%)
Retired	$n = 1$ (2.9%)
Other	$n = 5$ (14.3%)
Annual Income	
<$15,000	$n = 10$ (28.6%)
$15,000–24,999	$n = 5$ (14.3%)
$25,000–49,000	$n = 5$ (14.3%)
$50,000–74,000	$n = 7$ (20.0%)
>$75,000	$n = 8$ (22.9%)
Marital status	
Single/never married	$n = 21$ (60.0%)
Married	$n = 13$ (37.1%)
Divorced	$n = 1$ (2.9%)

hypotheses that individuals with newly acquired SCI would experience shoulder pain with elevated levels of kinesiophobia and pain catastrophizing early after injury were confirmed.

Shoulder pain development following SCI demonstrates a negative association with physical activity and QoL [36]. Eriks-Hoogland et al. state 43% of individuals with SCI participating in inpatient rehabilitation report musculoskeletal shoulder pain [24]. Similarly, 43% of our sample reported shoulder pain. Of clinical consequence was bilateral, moderate to severe intensity shoulder pain was reported in 53% of those experiencing pain with frequency >3 times per week. In concert with a large, stated pain percentage, the frequency and severity of pain were elevated regardless of injury level. The possible clinical implication of rehabilitation physical demands such as transfer training, weight relief maneuver, and wheelchair propulsion potentially contribute to early-onset shoulder pain.

Early-onset pain following SCI has been described as the most important predictor of future pain [21]. However, psychological factors including pain catastrophizing were identified as significant pain persistence and rehabilitation outcomes predictors [4, 5]. Identification of the factors impacting shoulder pain development and its persistence is critical for breaking the clinical shoulder pain cycle and limiting reduced function and resultant independence loss, significant participation limitations, and decreased QoL.

In addition, emotions, particularly fear and anxiety, played an important role in the experience of both acute and chronic musculoskeletal pain [37]. Our findings indicate individuals with newly acquired SCI experienced musculoskeletal shoulder pain, clinically relevant levels of fear of pain, pain catastrophizing, and kinesiophobia. Kinesiophobia levels were directly associated with catastrophizing and fear of pain with an inverse relationship to global SQoL. High pain catastrophizing levels and fear-avoidance pain beliefs were associated with sustained and increased functional disability after pain onset [38]. Previous research demonstrated associations between these pain-related psychological variables and outcomes. For example, Linton reported psychosocial variables contributed to chronic pain development [39]. Furthermore, pain catastrophizing and fear of pain potentially increase the risk of developing multisite pain following musculoskeletal injury. Across varied populations, kinesiophobia predicted a negative influence on functional outcomes of rehabilitation [5, 40]. TSK-11 mean score of 25.5 in the current study is similar to scores reported for other musculoskeletal conditions, including osteoarthritis (24.5), upper extremity disorders (25.6 points), and chronic low back pain (27.7) [41]. Pain catastrophizing and other constructs of pain-related fear appear to be independent risk factors for predicting the persistence of pain and poorer clinical outcomes [16]. Our participants were in initial rehabilitation; thus, their data indicated the vital need to address these pain-related factors early after SCI to optimize rehabilitation and decrease future pain development.

Pain catastrophizing is a multidimensional construct with three components that encompass potential for different associations with pain-related outcomes; rumination, magnification, and helplessness [7]. Rumination and magnification are proposed as cognitive processes for an ongoing focus on pain and pain perception as threatening, while helplessness is a perceived inability to cope with pain. In our current study, pain catastrophizing and its magnification

Table 2 Pain and pain-related psychosocial factors.

Presence of shoulder pain (nonzero rating, $n = 35$)	15/35; 42.9%		43%[a]
Bilateral shoulder pain ($n = 15$)	8/15; 53.3%		–
Musculoskeletal Pain Score (MPS)			
	Mean (SD)	**Median (Interquartile range)**	**Comparison Mean (SD)**
MPS_shoulder ($n = 15$; score = 0–30)	9.0 (6.4)	6.0 (4–18)	11.2 (0.9)[b] 8.5 (8.8)[c]
MPS_seriousness (score 0–5) *n*: left = 10/15; right 13/15	Left = 1.7 (1.3) Right = 2.1 (1.2)	2 (0–3) 2 (1–4)	2.7 (1.1)[b] 2.7 (1.4)[b]
MPS frequency (score 0–3) *n*: left = 10/15; right 13/15	Left = 1.5 (1.4) Right = 2.0 (1.1)	1 (0–3) 2 (1–3)	2.6 (0.7)[b] 2.6 (0.7)[b]
Chronic Pain Coping Inventrory-42 ($n = 35$, score 0–7)			
Passive strategies	5.0 (1.3)	5.4 (4.6–6.0)	2.6 (1.9)[d]
Proactive strategies	4.5 (1.3)	4.7 (3.3–5.5)	3.7 (1.9)[d]
Self-coping strategies	5.7 (1.6)	6.4 (4.8–7.0)	2.5 (2.0)[d]
Psychosocial Outcome Measures ($n = 35$)			
	Mean (SD)		**Comparison Mean (SD)**
TSK (score = 11–44)	25.5 (6.8)		20.5 (5.3)[c]
FPQ-9 (score = 9–45)	23.4 (8.5)		17.4 (6.3)[c]
PCS_total (score 0–52)	17.7(11.2)		9.6 (9.9)[c]
PCS_rumination subscale (score = 0–16)	8.0 (4.8)		–
PCS_magnification subscale (score = 0–12)	3.1 (3.1)		–
PCS_helplessness subscale (score = 0–24)	6.8 (5.1)		–
SQoL (score = 1–7)	4.4 (1.6)		5.7 (0.9)[c] 5.2 (1.1)[e]

TSK Tampa Kinesiophobia Scale, *FPQ-9* Fear of Pain Questionnaire, *PCS* Pain Catastrophizing Scale, *SQoL* Subjective Quality of Life.

[a]Individuals ($n = 225$) with newly acquired SCI [24].

[b]Individuals ($n = 116$) with newly acquired SCI [21].

[c]Individuals ($n = 26$) with chronic SCI [15].

[d]Individuals ($n = 127$) with chronic SCI [44].

[e]Individuals ($n = 134$) with chronic SCI [45].

and rumination subscales correlated with shoulder pain intensity. The PCS total and subscale scores were similar to those reported by Osman et al. for a pain outpatient sample and community sample, respectively [42]. Based on risk criteria, 43% of our sample were at moderate risk for developing persistent pain with 14% demonstrating a clinically relevant, high level of pain catastrophizing [28]. In addition, based on subscale scores, 35% of participants demonstrated rumination scores in a clinically relevant level, 43% and 37% demonstrated moderate risk based on magnification and helplessness subscales, respectively. Fear of movement, TSK-11 scores, were in the upper half (>22) for 27/35 participants with more than 50% (14/27) in absence of shoulder pain. Findings of such high-risk presence of catastrophizing and kinesiophobia in this early stage following SCI, with or without pain, indicates the critical need for early assessment and intervention to mitigate the potential for pain development and persistence.

Greater scores in catastrophizing and passive coping predicted greater pain interference in individuals with SCI [43]. Negative and/or maladaptive coping strategies and beliefs appear as critical targets in decreasing pain persistence and interference following SCI. Our study indicated pain catastrophizing, not coping strategy selection, was associated with shoulder pain in those with newly acquired SCI. However, our participants used passive strategies more than proactive coping strategies. A cascade impact may occur with pain catastrophizing contributing to elevated pain levels and emotional distress, increasing the probability of a persistent pain condition [39]. Our findings support the need to identify individuals

Table 3 Pain Catastrophizing Scale (PCS) and subscales (*n*, % of sample)—clinically relevant risk score ($n = 35$).

PCS_High risk			
PCS total (risk score ≥30)	Rumination subscale (risk score ≥11)	Magnification subscale (risk score ≥5)	Helplessness subscale (risk score ≥13)
5 (14.3%)	12 (34.3%)	10 (28.6%)	5 (14.3%)
PCS_Moderate risk			
PCS total (risk score = 20–29)	Rumination subscale (risk score = 8–10)	Magnification subscale (risk score = 3–4)	Helplessness subscale (risk score = 8–12)
10 (28.6%)	6 (17.2)	5 (14.3%)	8 (22.6%)
PCS_"any risk"			
PCS total	Rumination subscale	Magnification subscale	Helplessness subscale
15 (42.9%)	18(51.4%)	15(42.9%)	13 (37.1%)

who score highly on the PCS as well as the TSK-11 and to implement targeted intervention programs to include education on active, positive coping strategies to reduce this persistent pain condition risk.

Limitations

The inclusion criteria possessing the "neurological capacity to use a manual wheelchair" excluded individuals with higher level injuries who used power wheelchair. Therefore, limited generalizability to all individuals with SCI may exist. Information regarding length of stay in acute care prior to inpatient rehabilitation was not obtained and may provide further insights into potential characteristics. Our focus was pain-related psychological variables, so other concurrent psychological variables, such as depression and anxiety were not obtained. We recognize that the global subjective QoL measure did not allow us to depict individual QoL constructs, such as physical health, psychological health, social relationships, and environment, which may be related to pain or other psychological constructs. In addition, the potential medication influence upon pain-related psychosocial constructs while in inpatient rehabilitation was outside this preliminary study scope.

Conclusion

Based upon our findings, elevated shoulder pain and pain-related psychological characteristics, such as catastrophizing and kinesiophobia are all present during the early stages following SCI. Given these factors association to pain persistence and rehabilitation outcomes [16], individuals

Table 4 Spearman's rho (ρ) correlation matrix of association of age with pain and psychological variables.

		MPS	PCS	TSK	FPQ	SQoL	CPCI passive	CPCI proactive	CPCI coping	CPCI relax
Age	ρ	0.05	0.08	0.13	0.19	−0.23	0.28	0.00	0.24	−0.07
	p value	0.77	0.66	0.47	0.27	0.19	0.10	0.99	0.16	0.70

MPS Musculoskeletal Shoulder Pain Score, *PCS* Pain Catastrophizing Scale, *TSK* Tampa Kinesiophobia Scale, *FPQ* Fear of Pain Questionnaire, *SQoL* Subjective Quality of Life, *CPCI* Chronic Pain Coping Inventory.

Table 5 Spearman's rho (ρ) correlation matrix of association of pain and psychological variables.

	PCS	TSK	FPQ	SQoL	CPCI passive	CPCI proactive	CPCI coping	CPCI relax
MPS	0.42**	0.14	−0.01	−0.03	0.19	0.07	−0.03	−0.13
PCS		0.30	0.42**	−0.27	0.21	−0.06	0.09	0.12
TSK			0.34*	−0.49***	−0.06	0.02	−0.22	−0.17
FPQ				−0.06	0.20	−0.03	0.18	0.22
SQoL					0.02	−0.09	0.28	0.19

MPS Musculoskeletal Shoulder Pain Score, *PCS* Pain Catastrophizing Scale, *TSK* Tampa Kinesiophobia Scale, *FPQ* Fear of Pain Questionnaire, *SQoL* Subjective Quality of Life, *CPCI* Chronic Pain Coping Inventory.

≤0.05; **≤0.01; *≤0.005.

with newly acquired SCI should be specifically assessed and monitored for these critical factors throughout initial rehabilitation. Specific to these findings, interventions addressing both catastrophizing and kinesiophobia, along with providing adaptive coping strategies during early rehabilitation and further research are warranted. Early identification and mediation of these issues may lead to improved long-term outcomes, improving overall health and well-being and QoL for individuals with SCI.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Author contributions MF as overall study PI was responsible for all aspects of the project from design, data collection, analysis, and manuscript preparation. EE was responsible for data collection at the Drexel site, data entry analysis, and manuscript preparation. LB was responsible for data analysis and interpretation of psychosocial measures, analysis, and manuscript preparation. EG was the primary biostatistician responsible for data analysis, interpretation, and manuscript preparation. MB was responsible for recruitment, screening, and data collection at GSRH, interpretation of outcomes and manuscript review. MS-R was responsible for recruitment and screening of participants from Magee (Drexel site), ongoing consultation on outcomes and manuscript review. SKF, MK, and AS were responsible for recruitment, data collection at University of Maryland site, and manuscript review. HY was site PI at University of Maryland and was responsible for study design, guided recruitment, and data collection, analysis, and manuscript review. PRG was responsible for study design, data collection at University of Maryland, data interpretation, and manuscript review.

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Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

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