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Prevalence and predictors of chronic pain intensity and disability among adults with sickle cell disease

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Abstract

Among 170 adults with sickle cell disease, we evaluated chronic pain impact and disability prevalence, assessed age and gender differences, and identified psychosocial predictors of chronic pain intensity and disability. Most participants had a high level of disability. Chronic pain intensity and disability were significantly associated with pain catastrophizing and chronic pain self-efficacy, and worsened with age. Further research is needed to confirm study findings and develop interventions, including palliative care approaches that address catastrophizing and disability, particularly for young women and middle-aged adults with sickle cell disease. Moreover, consistent clinical assessment of chronic pain and psychosocial health should be implemented.

Keywords

adults, chronic pain, coping, disability, sickle cell disease

Introduction

Sickle cell disease (SCD) is a group of inherited red blood cell disorders that affect approximately 100,000 individuals in the United States (Ballas et al., 2010; Centers for Disease Control and Prevention [CDC], 2019). The disease results in estimated medical costs exceeding US$1.1 billion annually and the majority of these costs are attributed to pain—the hallmark of SCD (Ballas et al., 2010; Dunlop and Bennett, 2006; Kauf et al., 2009; Yusuf et al., 2010). In SCD, the pain has been classified as acute, subacute, chronic, episodic, and even mixed—described as chronic pain spinning off recurrent acute pain or acute pain superimposed on chronic pain (Ballas et al., 2012b; Dampier et al., 2017; Taylor et al., 2010). Acute pain, or a pain crisis, is the main complication of SCD, and it most commonly results in frequent healthcare encounters, especially for 18- to 39-year-olds (Ballas et al., 2012a; Brousseau et al., 2010; Yusuf et al., 2010). However, it is unclear whether the presenting pain may be mixed for some individuals. In recent years, Dampier et al. (2017) have defined chronic SCD pain as ongoing pain that was present, in one or more locations, on most days for more than 6 months. They propose three subtypes of chronic SCD pain based on the presence or absence of either clinical signs or test results: (1) chronic SCD pain without contributory SCD complications, (2) chronic SCD pain with contributory SCD complications, and (3) chronic SCD pain with mixed pain types, if contributory SCD complications and pain are occurring in unrelated sites. Contributory SCD complications may include avascular necrosis of joints, bone infarction, leg ulcers, osteomyelitis, and central and peripheral sensitization (Ballas and Eckman, 2009; Lutz et al., 2015; Smith and Scherer, 2010).

Chronic pain is a major problem among adults who have SCD. In their daily diary study, Smith et al. (2008) reported that 54 percent of adults with SCD have pain 51 percent of the time, and 29 percent have pain almost daily, with the

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pain being moderate on average. Chronic pain contributes to significant disability in SCD (Swanson et al., 2011). It can persist for months or years, and it is associated with functional disability that results in school absenteeism and missed days of work (Ballas et al., 2012b; Gil et al., 2004; Smith et al., 2008; Taylor et al., 2010). It is also accompanied by suffering, anxiety, despair, helplessness, depression, insomnia, and loneliness (Ballas et al., 2012b). Overall, chronic pain limits productivity, goal attainment, and quality of life of adults with SCD who often report the inadequacy or ineffectiveness of pharmacological pain management (Lattimer et al., 2010; Levenson et al., 2008; Panepinto and Bonner, 2012; Taylor et al., 2010; Zempsky, 2010).

Adults with SCD use self-management strategies to cope with pain (Jenerette et al., 2011a; Matthie et al., 2015, 2018; Matthie and Jenerette, 2015, 2017; Tanabe et al., 2010). Among these individuals, those who demonstrate higher self-efficacy have greater social support, a higher educational level, and tend to employ more self-management strategies to cope with acute pain (Matthie et al., 2015). In addition to these factors, researchers have identified psychosocial factors that influence coping with chronic pain in SCD or other chronic pain conditions. These factors include health literacy, perceived cognitive functioning, pain catastrophizing, chronic pain self-efficacy, and chronic pain acceptance. Health literacy, an individual's capacity to obtain and understand health information and services to make appropriate health decisions, is associated with greater use of health-promoting behaviors, preventive services, and overall better health status (CDC, 2016; Nielsen-Bohlman et al., 2004). Cognitive functioning describes the constructs, including working memory, processing speed, and executive functioning, that are important for achieving competence with self-management of chronic conditions (Bucuvalas, 2013; Glisky, 2007). Deficits in global cognitive functioning in adults with SCD may affect their ability to manage chronic pain (Vichinsky et al., 2010). Pain catastrophizing denotes exaggerated and ruminating negative thoughts and emotions that occur during actual or perceived pain stimulation (Trudeau et al., 2015). Avoidance of pain catastrophizing is important for effective self-management; however, adults with SCD have reported rates of catastrophizing that were higher than those of individuals with other chronic pain conditions such as rheumatoid arthritis (Citero Vde et al., 2007; Leung, 2012; Oguhebe et al., 2014). Chronic pain self-efficacy, an individual's perceived ability to cope with the consequences of chronic pain, has been associated with better coping, levels of functioning, and responses to treatment (Anderson et al., 1995). Chronic pain acceptance, the process by which one acknowledges having pain but focuses on living a satisfying life despite that pain, is associated with lower pain intensity, less distress and disability, and higher levels of daily activity (McCracken, 1998).

Despite the prevalence of chronic pain in adults with SCD, to date, there is a dearth of evidence in the literature regarding disability due to chronic pain in this population. Therefore, the primary objectives of this descriptive, cross-sectional study of adults with SCD were to (1) evaluate the impact of chronic pain and prevalence of chronic pain disability, (2) assess for age and gender differences, and (3) identify psychosocial predictors of chronic pain intensity and chronic pain disability. These data may help to improve the assessment and management of chronic pain in adults with SCD.

Methods

Participants and procedures

Emory University's institutional review board and Grady Memorial Hospital's research oversight committee approved this study (IRB00094815). Recruitment and data collection occurred at the Georgia Comprehensive Sickle Cell Center at Grady Memorial Hospital, between March 2018 and July 2019, using direct contact and flyers. The eligibility and inclusion criteria for participants were as follows: 18–40 years old; diagnosed with SCD; experiences chronic pain; and can read, write, and understand English. Using electronic medical records, we identified eligible patients with a medical diagnosis of chronic pain and/or a prescription for long-acting narcotics such as morphine sulfate controlled-release or oxycodone controlled-release tablets. We then approached all eligible patients and patients who self-selected through flyers before or after their scheduled clinic appointment and assessed their self-reported eligibility before enrollment. Of the approximately 400 potentially eligible patients who were screened for the study, 170 were confirmed as eligible and were interested in being participants. Among patients who met the eligibility criteria, reasons for declining participation included lack of time, currently experiencing a pain crisis, not feeling well, or lack of interest. Each participant provided informed and written consent, completed all study questionnaires, and received a US$30 gift card after completing the questionnaires.

Measures

Data were collected using the following questionnaires and by reviewing participants' electronic medical records. A demographic questionnaire was used to gather data on age, gender, race, ethnicity, SCD type, annual income, years of education, number of chronic pain days, and daily pain rating. Participants' electronic health records were reviewed to assess their medical history, laboratory values, prescribed pain, and SCD medications, as well as the number of pain crises and hospital utilization in the year prior to study enrollment. Also, the Adult Sickle Cell Quality of Life

Measurement Information System's (ASCQ-Me®) SCD Medical History Checklist was used to assess health complications related to SCD (Keller et al., 2017). Complications on the checklist are leg ulcers, lung damage, kidney damage, retinopathy, hip or shoulder damage, stroke, spleen damage or removal, regular blood transfusions, and daily pain medicine use. The number of complications is summed to create a score, and severity is categorized as *low* (scores less than 2), *medium* (scores equal to 2), and *high* (scores greater than 2). In previous studies, this checklist has been established as a valid indicator of SCD severity among adults (Keller et al., 2014, 2017).

The chronic pain grade questionnaire was used to assess chronic pain grade based on chronic pain intensity and chronic pain disability (Smith et al., 1997). Items are scored on a scale from 0 to 10, with total scores for chronic pain intensity and chronic pain disability ranging from 0 to 100. Based on these scores, individuals were classified into five categories: Grade 0, *no intensity-no disability*; Grade I, *low intensity-low disability*; Grade II, *high intensity-low disability*; Grade III, *high disability-moderately limiting*; and Grade IV, *high disability-severely limiting*. In previous studies, internal instrument consistency was $\alpha = 0.91$, and evidence of validity included significant correlations between the questionnaire and the Short Form (SF)-36 (Smith et al., 1997). Cronbach's alpha in the current study was 0.85.

The BRIEF health literacy screening tool was used to assess the amount of help that participants need in healthcare situations (Boston University, 2018). Items are scored on a scale from 1 to 5 (*always* to *never* and *not at all* to *extremely*), and higher total scores indicate greater health literacy. Health literacy levels are categorized as *inadequate* (4–12), *marginal* (13–16), and *adequate* (17–20; Haun et al., 2012). This tool shows evidence of convergent validity with the Short-Test of Functional Health Literacy in Adults questionnaire ($r = 0.42$) and the Rapid Estimate of Adult Literacy in Medicine test ($r = 0.40$; Boston University, 2018). Cronbach's alpha in the current study was 0.80.

The Patient-Reported Outcomes Measurement Information System's (PROMIS®) Cognitive Function v2.0 tool was used to assess perceived changes in cognitive functional abilities within the past 7 days (HealthMeasures, 2017). Items are scored on a scale from 1 to 5 (*very often/several times a day* to *never*), and total raw scores are rescaled into a standardized score, or a *T* score, which has a mean of 50 and a standard deviation (*SD*) of 10. This tool showed good internal consistency reliability in previous studies (Cella et al., 2010). Cronbach's alpha in the current study was 0.95.

The pain catastrophizing scale was used to assess thoughts and feelings when participants experienced pain (Chappe, 2017; Sullivan et al., 1995). Items are scored on a scale from 0 to 4 (*not at all* to *all the time*), and higher scores indicate a higher degree of catastrophizing. Among adults with SCD, internal instrument reliability was $\alpha = 0.93$ in previous studies (Mathur et al., 2016). Cronbach's alpha in the current study was 0.93.

The chronic pain self-efficacy scale was used to assess efficacy expectations for coping with the consequences of chronic pain (Anderson et al., 1995). Items are scored on a 10-point Likert-type scale from 10 to 100 (*very uncertain* to *very certain*), and higher scores indicate higher chronic pain self-efficacy. In previous studies, the internal reliability of the three subscales were $\alpha = 0.88$ (self-efficacy for pain management), $\alpha = 0.87$ (self-efficacy for coping with symptoms), and $\alpha = 0.90$ (self-efficacy for physical functioning; Anderson et al., 1995). Cronbach's alpha in the current study was 0.96.

The chronic pain acceptance questionnaire was used to assess participants' acceptance of pain (Fish et al., 2010). Items are scored on a scale from 0 to 6 (*never true* to *always true*), and higher scores indicate higher levels of acceptance. In previous studies, instrument reliability was $\alpha = 0.77$ and $\alpha = 0.89$ (Fish et al., 2010). Cronbach's alpha in the current study was 0.75.

The social support questionnaire was used to assess participants' perceptions of the desirability, availability, use, and usefulness of social support (Zich and Temoshok, 1987). Items are scored on a scale from 1 to 5 (*not at all* to *very much, constantly*), and higher scores indicate higher levels of social support. In previous studies, evidence of validity included significant correlations between this questionnaire and the Commitment subscale of Kobasa's Hardiness Scale (Zich and Temoshok, 1987). Cronbach's alpha in the current study was 0.96.

Statistical analysis

Study data were collected and managed using the Research Electronic Data Capture (REDCap) software and were analyzed using IBM SPSS 26 (Harris et al., 2009). All study variables had complete data. Descriptive statistics were reported as frequencies. Analysis of variance (ANOVA) and Mann–Whitney *U* tests were used to evaluate significant participant differences. We also evaluated the effect of the psychosocial factors on chronic pain intensity and chronic pain disability (chronic pain outcomes). First, bivariate associations between the factors and chronic pain outcomes were assessed using Pearson's correlation or Spearman's rank correlation as appropriate. Next, multiple linear regression was used to assess the combined effects of the factors on the chronic pain outcomes after adjusting for demographics. Given the study objectives, we determined that at 80 percent power and $\alpha = 0.05$, a sample size of 170 would enable the detection of small to moderate effect sizes ($r^2 = 0.067$–0.075) for a regression model with six factors. We evaluated the global *F* test and adjusted R^2 as measures of model adequacy. Akaike information criterion (AIC) was used to select the most parsimonious model, where a

Table 1. Demographic characteristics of study participants ($N = 170$).

Demographics	Number	Percentages
Age group (years)		
18–25	61	35.9
26–30	54	31.8
31–40	55	32.4
Gender		
Female	91	53.5
Male	78	45.9
Transgender male	1	0.6
Sickle cell type		
HbSS	116	68.2
HbSC	44	25.9
Hb S Beta Thal (+ or 0)	8	4.7
Unsure	2	1.2
Education		
⩽High-school degree	77	45.3
Some college, no degree	54	31.8
2- or 4-year college degree	39	22.9
Employment		
Employed	64	37.6
Unemployed	41	24.1
Disabled	49	28.8
Student	16	9.4
Relationship status		
Single/never married	136	80
Married or domestic partnership	29	17.1
Separated or divorced	5	2.9
Annual household income		
Under US$15,000	51	30
US$15,000–US$34,999	34	20
⩾US$35,000	25	14.7
Unknown	60	35.3
Health insurance		
Medicaid	93	54.7
Medicare	39	22.9
Private insurance	22	12.9
Other	8	4.7
Uninsured	8	4.7

lower AIC indicated better model fit. We also evaluated a measure of effect size (partial η^2) and a two-sided p value was used for all testing.

Results

Participants

The demographic characteristics of the 170 participants are summarized in Table 1. Study participants self-identified as Black adults and they were 18–40 years old ($M = 28.05$, $SD = 5.826$). They were primarily women (53.5%, $n = 91$) who were single/never married (80%, $n = 136$), had at least some college experience (54.7%, $n = 93$), were unemployed or disabled (52.9%, $n = 90$), had sickle cell anemia (68.2%, $n = 116$), experienced fatigue/low energy (81.2%, $n = 138$), and were of non-Hispanic/non-Latino ethnicity (98.2%, $n = 167$). Participants reported 0–7 SCD complications ($M = 2.40$, $SD = 1.412$) and disease severity was *medium* or *high* for 72.9 percent ($n = 124$) of the sample.

Table 2. Summary of chronic pain outcomes and psychosocial factors ($N = 170$).

Variable	Minimum–maximum	Mean	Standard deviation
Chronic pain			
Intensity	0–100	62.94	20.650
Disability	0–100	54.33	25.318
Psychosocial factors			
Health literacy	4–20	16.75	3.743
Perceived cognitive functioning	8–40	17.66	8.589
T score	22.41–63.48	34.43	8.758
Pain catastrophizing	0–52	24.41	13.032
Chronic pain acceptance	6–48	31.62	7.353
Chronic pain self-efficacy	220–2200	1403.53	446.686
Social support	30–150	107.44	26.446

Upon reviewing participants' electronic medical records, the most frequently diagnosed SCD complications were documented as lung damage (72.3%, $n = 123$), avascular necrosis of the hip or shoulder (24.1%, $n = 41$), stroke (18.8%, $n = 32$), and spleen damage or removal (18.8%, $n = 32$). Hemoglobin ranged from 3.9 to 14.3 g/dL ($M = 9.67$, $SD = 1.964$), hematocrit ranged from 12.1 to 42 percent ($M = 28.20$, $SD = 5.944$), and red blood cells ranged from 1.5 to 5.72 million/mm^3 ($M = 3.21$, $SD = 0.974$). The most frequently prescribed medications for SCD were Hydroxyurea (55.3%, $n = 94$) and Endari (2.9%, $n = 5$). Various formulations of oxycodone (69.4%, $n = 118$), ibuprofen (34.1%, $n = 58$), and morphine sulfate (27.6%, $n = 47$) were most frequently prescribed for pain. In the year prior to study enrollment, the number of pain crises experienced by participants ranged from 0 to 35 ($M = 5.66$, $SD = 7.867$), the number of emergency department (ED) visits with pain as the presenting problem ranged from 0 to 34 ($M = 4.91$, $SD = 7.201$), hospital admissions for pain ranged from 0 to 8 ($M = 0.82$, $SD = 1.432$), and the number of sickle cell center clinic visits ranged from 1 to 32 ($M = 4.48$, $SD = 3.899$). Average pain level during ED visits ranged from 3 to 10 ($M = 8.32$, $SD = 1.348$), and the average length of stay of the ED visit ranged from 0 to 26 hours ($M = 7.98$, $SD = 2.847$). For the purpose of diagnosis and treatment, it was unclear whether the pain was categorized as acute, chronic, or mixed pain.

Descriptive statistics for the psychosocial factors are provided in Table 2. Health literacy scores were high, 17–20, for 62.4 percent ($n = 106$) of the participants. Of the participants, 78.2 percent ($n = 133$) had cognitive functioning

T scores that were 1–3 *SDs* below the mean for the general population. Levels of pain catastrophizing were in the 50th–75th percentiles (score of 20–30) for 32.35 percent ($n=55$) of the participants and above the 75th percentile (scores > 30) for 33.53 percent ($n=57$) of participants. The majority of the participants reported that they were *moderately certain* to *very certain* that they could regularly perform tasks for managing pain (56.5%, $n=96$), functioning physically (81.8%, $n=139$), and coping with symptoms (61.2%, $n=104$). Chronic pain acceptance scores were high (30–48) for 66.5 percent ($n=113$) of participants, and 64.7 percent ($n=110$) reported moderate to high social support.

Impact of chronic pain and prevalence of chronic pain disability

During data collection, participants were asked to quantify the average number of days during which they experience chronic pain. The majority of the participants reported experiencing chronic pain for 3–6 days each week (84.1%, $n=143$). On pain days, 88.8 percent ($n=151$) of participants reported moderate (4–6; 27.6%) to severe pain (7–10; 61.2%) with an average pain score of 6.75 on a scale of 1–10. Given the reported scores for chronic pain intensity and chronic pain disability (Table 2), chronic pain grade was Grade III (*high disability–moderately limiting*) or Grade IV (*high disability–severely limiting*) for more than half of the participants (57.1%, $n=97$).

In the past 6 months, the intensity of the worst pain ranged from 7 to 10 for 82.9 percent ($n=141$) of the participants. The level of pain interference in daily activities in the past 6 months was rated as 4–6 (45.3%, $n=77$) or 7–10 (31.8%, $n=54$) on a scale from 0 to 10 (*no interference* to *unable to carry on activities*). The level at which pain changed their ability to take part in recreational, social, and family activities in the past 6 months was rated as 4–6 (43.5%, $n=74$) or 7–10 (34.7%, $n=59$) on a scale from 0 to 10 (*no change* to *extreme change*). The level at which pain changed their ability to work, including housework, in the past 6 months was rated as 4–6 (37.1%, $n=63$) or 7–10 (37.6%, $n=64$) on a scale from 0 to 10 (*no change* to *extreme change*). Among the participants, the number of days they were kept from usual activities, such as work, school, or housework, in the past 6 months was 0–6 days (40.6%, $n=69$) and 7–14 days (26.5%, $n=45$).

Age and gender differences

There was an association between chronic pain grade and age, χ^2 (8) = 20.13, $p=0.010$, with a statistically significant difference in chronic pain grade between age groups on one-way ANOVA. Tukey post hoc tests revealed that chronic pain intensity was significantly higher for the 31–40 years age group (67.88 ± 17.48 points) than for the 18–25 years age group (56.61 ± 24.51 points), $p=0.008$. Similarly, disability was significantly higher for the 31–40 years age group (61.33 ± 23.71 points) than for the 18–25 years age group (49.78 ± 28.29 points), $p=0.038$.

Female participants had a statistically significantly higher level of education ($U=2520$, $p=0.001$) and greater levels of fatigue/low energy ($U=2733.5$, $p=0.000$), pain catastrophizing ($U=2840.5$, $p=0.018$), health literacy ($U=2793.5$, $p=0.011$), and perceived cognitive functioning ($U=2943.5$, $p=0.041$) than male participants. Male participants had a statistically significantly higher level of annual income ($U=2651.5$, $p=0.002$) and SCD complications ($U=2958.5$, $p=0.042$) than female participants.

Psychosocial predictors of chronic pain intensity and chronic pain disability

Correlation analysis showed primarily small to medium associations among demographics, psychosocial factors, chronic pain intensity, and chronic pain disability (Table 3). We observed a positive relationship between pain catastrophizing and chronic pain intensity ($p=0.000$) and disability ($p=0.000$). We also observed a negative relationship between chronic pain self-efficacy and chronic pain intensity ($p=0.026$) and chronic pain disability ($p=0.000$). There were no significant associations between health literacy, perceived cognitive functioning, chronic pain acceptance, social support, chronic pain intensity, and chronic pain disability. However, there was a positive relationship between health literacy and chronic pain grade ($p=0.040$) and between perceived cognitive functioning and chronic pain intensity ($p=0.021$).

Regression analysis indicated that the full model, including all psychosocial factors and adjusted for all demographics, significantly predicted chronic pain intensity; $F(35, 134)=2.08$, $p=0.002$. The full model explained 18 percent of the variance in chronic pain intensity after adjusting for the number of factors. The final model of chronic pain intensity, which included the psychosocial factors after being adjusted for age, employment, and annual income (AIC of 1487 vs 1511 in the full model), explained 22 percent of the total variance (Table 4). Among the factors, pain catastrophizing had a significant positive relationship with chronic pain intensity. A unit change in pain catastrophizing increased chronic pain intensity by 0.28 units, 95 percent confidence interval (CI: 0.07–0.50). The full model also significantly predicted chronic pain disability; $F(35, 134)=2.39$, $p<0.001$. The final model (AIC of 1555 vs 1572 for the full model), which included all the factors after being adjusted for education, relationship status, employment, annual income, and health insurance, explained 25 percent of the total variance in chronic pain disability. Pain catastrophizing was also positively associated with chronic pain disability. A unit change in pain catastrophizing increased chronic pain disability by

Table 3. Correlations among demographics, psychosocial factors, and chronic pain outcomes ($N = 170$).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Demographics														
1. Age	1	0.093	−0.277[b]	0.128	0.126	0.004	0.068	0.122	−0.029	−0.101	−0.100	0.232[b]	0.218[b]	0.204[b]
2. Education level		1	−0.069	−0.165[a]	0.281[b]	0.306[b]	0.006	0.005	0.161[a]	0.197[b]	0.084	−0.114	−0.056	0.003
3. Annual income			1	−0.074	−0.199[b]	−0.053	0.079	−0.123	0.052	0.010	0.102	−0.304[b]	−0.237[b]	−0.143
4. SCD complications				1	0.041	−0.223[b]	0.008	0.142	−0.112	−0.148	−0.106	0.094	0.098	0.188[a]
5. Fatigue/low energy					1	0.141	0.120	0.228[b]	0.039	−0.122	−0.062	0.334	0.271	0.271[b]
Psychosocial factors														
6. Health literacy						1	−0.167a	.067	0.171[a]	0.154[a]	.035	−0.032	0.065	0.158[a]
7. Perceived cognitive functioning							1	0.146	0.004	−0.186[a]	−0.126	0.176[a]	0.139	0.088
8. Pain catastrophizing								1	−0.078	−0.270[b]	−0.122	0.279[b]	0.359[b]	0.328[b]
9. Chronic pain acceptance									1	0.429[b]	0.209[b]	0.040	−0.059	−0.140
10. Chronic pain self-efficacy										1	0.386[b]	−0.171[a]	−0.272[b]	−0.198[b]
11. Social support											1	−0.087	−0.118	−0.064
Chronic pain														
12. Intensity												1	0.657[b]	0.549[b]
13. Disability													1	0.746[b]
14. Grade														1

SCD: sickle cell disease.
[a]$p < 0.05$.
[b]$p < 0.01$.

Table 4. Multiple linear regression analysis of psychosocial factors and chronic pain outcomes ($N = 170$).

Psychosocial factors	Regression model for chronic pain intensity				Regression model for chronic pain disability			
	B	95% CI of *B*	*t*	Partial η^2	*B*	95% CI of *B*	*t*	Partial η^2
Health literacy								
Inadequate	−1.47	−9.75 to 6.80	−0.35	0.001	−11.07	−21.34 to −0.80	−2.13	0.03
Marginal	1.13	−5.50 to 7.76	0.34	0.001	−2.25	−10.31 to 5.82	−0.55	0.002
Adequate (reference)	0	–	–	–	0	–	–	
Perceived cognitive functioning	0.31[a]	−0.01 to 0.64	1.90	0.02	0.23	−0.17 to 0.62	1.14	0.01
Pain catastrophizing	0.28[b]	0.07 to 0.50	2.57	0.01	0.48[c]	0.22 to 0.74	3.61	0.07
Chronic pain self-efficacy	−0.002	−0.01 to 0.01	−0.49	0.001	−0.01	−0.02 to 0.00	−1.69	0.02
Chronic pain acceptance	0.27	−0.14 to 0.68	1.26	0.01	0.18	−0.32 to 0.67	0.71	0.003
Social support	0.02	−0.10 to 0.13	0.27	0.00	0.04	−0.09 to 0.18	0.65	0.002
Global *F*	$F(15, 154) = 4.20$				$F(21, 148) = 3.69$			
R^2 (adjusted R^2)	0.29 (0.22)				0.34 (0.25)			

CI: confidence interval.
Regression models were adjusted for all participants' characteristics that were significant at $\alpha = 0.10$.
[a]$p < 0.1$.
[b]$p < 0.05$.
[c]$p < 0.01$.

0.48 units, 95 percent CI (0.20–0.76; Table 4). The effect size estimates were small for most correlates except for a medium effect size for pain catastrophizing (partial $\eta^2 = 0.07$), which explained 7 percent of the variation in chronic pain disability.

Discussion

In this descriptive, cross-sectional study of adults with SCD we aimed to (1) evaluate the impact of chronic pain and prevalence of chronic pain disability, (2) assess for age and gender differences, and (3) identify psychosocial predictors of chronic pain intensity and chronic pain disability. Our study contributes to the growing literature on chronic pain in SCD. More than half of our participants reported moderate to severe chronic pain that was *highly disabling-moderately limiting* or *severely limiting*. We found worse chronic pain and chronic pain disability in older participants, and females had greater pain catastrophizing. These findings are consistent with previous reports of a high incidence of chronic pain in individuals with SCD and the association with various patient-reported outcomes (Badawy et al., 2018; Karafin et al., 2019; Matthie et al., 2018; Smith et al., 2008; Taylor et al., 2010; Thompson and Eriator, 2014). Our findings also support the pain prone phenotype for developing chronic pain that has been described in non-SCD conditions (Phillips and Clauw, 2013). However, chronic pain has been typically defined by pain duration. These definitions do not capture all facets of chronic pain and may result in high prevalence estimates that could limit effective policy development and treatment (Merskey and Bogduk, 1994; Pitcher et al., 2019; Von Korff et al., 2016). Our study provides critical new details regarding the prevalence of disability from chronic pain and the impact of chronic pain on the lives of adults with SCD, and it supports a call to action to ameliorate suffering in this vulnerable population. Disability may be helpful in further stratifying, characterizing, and describing chronic SCD pain and how it influences outcomes. Moreover, these additional characteristics may be evaluated as outcomes in future research that is aimed at mitigating symptoms.

In a sample of mainly young adults, we observed that older age was significantly associated with chronic pain intensity and chronic pain disability, which supports previous reports of the relationship between chronic pain and age (Brandow et al., 2017; Pope et al., 2016). In older individuals, it is possible that the source of chronic pain may be non-SCD conditions such as arthritis (Darbari et al., 2014). This would support the proposal from Dampier et al. (2017) to identify a subtype of chronic pain as chronic SCD pain without contributory SCD complications. In our sample, male participants had more SCD complications than female participants, so they could be considered to be at a greater risk for higher chronic pain intensity and chronic pain disability. Yet, female participants had higher levels of factors associated with poor chronic pain outcomes, including fatigue/low energy, pain catastrophizing, and concerns with perceived cognitive functioning. The significant differences in age and gender profiles provide the rationale for considering these factors when designing interventions for managing chronic SCD pain and evaluating response to treatment. Interventions may need to be developed specifically for young women with SCD to help with early adoption of positive coping strategies to better facilitate the transition to middle age while living with chronic pain. Additional interventions, that incorporate palliative care principles, can then be developed for middle-aged adults

with SCD to improve overall functioning and decrease disability.

The highest grades of chronic pain were noted among the unemployed or disabled. Employment has been described as an important aspect of "successful" aging with SCD. Successful aging is defined as one's perception of a favorable adaptation to the cumulative physiologic and functional changes associated with the passing of time (Flood, 2005). It is associated with life satisfaction, mastery and growth, active engagement with life, and independence (Moody, 2005). Among adults with SCD, those who experience more severe chronic pain may be unable to work or to work consistently (Jenerette et al., 2011a, 2011b; Jenerette and Lauderdale, 2008). Employment may be limited by a lack of education, which could also be influenced by chronic pain. In other chronic pain populations, chronic pain grade has been associated with high unemployment rates, pain-related functional limitations, depression, fair to poor self-rated health, frequent use of opioids, and frequent pain–related doctor visits (Von Korff et al., 1992). In conjunction with these studies, our finding suggests that individuals with the highest chronic pain grades are the ones who suffer the greatest physical and psychological burden. As a result, they require more healthcare services but are often unable to afford these services due to financial limitations arising from disability, resulting in a higher cost to society. Assistance programs can help to mitigate this burden while providing necessary care and support for adults with SCD who experience chronic pain.

The majority of the study participants, based on self-reports and medical record review, were not found to have a documented, fixed injury such as avascular necrosis of a joint as a source of chronic pain (Ballas et al., 2012a). If the source of chronic pain is not accurately identified and treated, then the likelihood of increased chronic pain intensity and chronic pain disability is a logical but avoidable outcome. It could be that some of our study participants experience chronic pain that has been described as intractable pain occurring between pain crises (Darbari et al., 2014). Also, the pain may be what Dampier et al. (2017) describe as chronic SCD pain without contributory SCD complications or chronic SCD pain with mixed pain types. In the clinical setting, additional inquiries regarding chronic pain symptomology and the threshold for interventions are needed to achieve a consensus regarding the evaluation, diagnosis, and treatment of chronic SCD pain. Clinical assessment of chronic pain in SCD should be consistently repeated over time to better understand and characterize both the pain and its contributing factors.

Of the psychosocial factors, pain catastrophizing and chronic pain self-efficacy were most significantly related to chronic pain outcomes. This finding is consistent with previous reports of the relationships among high pain catastrophizing, more intense pain, and higher levels of disability, as well as the relationship between self-efficacy and functional impairment (Jackson et al., 2014; Sullivan et al., 1995, 1998). In our sample, chronic pain intensity and chronic pain disability were associated with higher pain catastrophizing and lower chronic pain self-efficacy. These factors are key mechanisms of action in psychosocial treatments for chronic pain (Turner et al., 2007). Given the significance of these factors in this study, it may be helpful to target them in future chronic pain intervention programs. In the clinical setting, assessment and treatment of the psychosocial aspects of SCD are often lacking. This study provides information regarding factors that clinicians should consider while developing their routine comprehensive care plans.

Unexpectedly, higher chronic pain grade was associated with higher health literacy, and higher perceived cognitive functioning was associated with chronic pain intensity. In this sample, perhaps the confluence of high rates of fatigue/low energy, disability, and lower income negatively influenced participants' ability to promote and maintain lower chronic pain intensity and disability despite having high health literacy. Also, greater concerns with perceived cognitive functioning may be related to the negative emotional influence of pain catastrophizing and the perceived effect of SCD on the mind, thus contributing to higher chronic pain intensity.

This study had a few limitations. This was a descriptive study that was conducted in a single, large, comprehensive SCD center, so we are unable to report on the generalizability of the findings to the overall SCD population. We are cognizant of the fact that data obtained through participants' self-reporting may be subject to social desirability bias, so we evaluated questionnaire data in conjunction with reviewing each participant's electronic medical records. In our evaluation of the study relationships, there may exist other factors not accounted for in the analyses that could explain the variations in chronic pain outcomes, and the higher proportion of female participants may have also influenced the findings. The small to medium correlations and effect sizes suggest that larger studies are needed to further evaluate and expand the study results. Besides, we did not collect data regarding adherence to SCD and pain medications, or data regarding other quality-of-life domains. Therefore, our interpretation of chronic pain outcomes is limited. Finally, because this was a descriptive study, we did not apply a Bonferroni correction for multiple testing to control the family-wise error rate. Instead, we conducted a global F test and used AIC for model selection.

In conclusion, our study supports the growing evidence needed to influence the management of chronic pain among adults with SCD. In this sample of young adults, older age, female gender, pain catastrophizing, and chronic pain self-efficacy play an important role in chronic pain. More than half the individuals in our study experienced *highly disabling–moderately limiting* or *severely limiting*

chronic pain that was significantly associated with higher pain catastrophizing and lower chronic pain self-efficacy. However, the significance of our findings should be confirmed in larger studies with repeated measures. We suggest a few recommendations for future research and practice. Our observation that chronic pain increases with age provides the rationale for conducting longitudinal studies of the trajectories of transition to, maintenance of, and the possible progression of chronic SCD pain over time. The contribution of SCD complications to chronic pain provides the impetus for vigilance in prevention, screening, and early management of these complications. In addition, the important contributions of psychosocial factors should not be overlooked. Thus, we recommend not only using palliative care interventions for individuals with SCD, but incorporating assessment and management of psychosocial factors into comprehensive clinical SCD care. Our observation that chronic pain may manifest differently by gender reiterates the need for studying mechanisms that contribute to different self-management resources and supports the need for developing interventions that specifically target young women and middle-aged adults with SCD. Finally, the presence of severe and disabling chronic pain in our sample despite prescriptions for pain medications supports the need for developing non-pharmacological interventions for chronic pain among adults with SCD. Given promising data from the recent literature regarding the use of mobile technology among adults with SCD, there may be an opportunity to utilize this technology in delivering non-pharmacological interventions to address chronic pain in this population (Badawy et al., 2016; Badawy et al., 2018; Shah et al., 2014).

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