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ORIGINAL ARTICLE

Pain intensity, pain interference and characteristics of spinal cord injury

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Study Design: Postal survey.
Objectives: To examine if the intensity of pain in persons with spinal cord injury (SCI) varied as a function of pain site, and to identify the patient and SCI characteristics associated with pain location, pain intensity and pain interference in a sample of persons with SCI.
Setting: Community sample, United States.
Methods: A postal survey including measures of pain intensity, pain interference, other pain, demographic and medical characteristics was completed by 238 adults with SCI.
Results: Average pain intensity was moderate and pain was common across the body. Demographic and medical variables, including SCI level, were generally not associated with pain prevalence, intensity and interference. However, persons with higher level injuries were more likely to report upper extremity pain than persons with paraplegic injuries. The lower body was the location of the highest pain ratings.
Conclusion: Persons with SCI tend to experience high pain intensity over multiple body locations. Lower body pain was as common as upper extremity pain, but tended to be more intense.
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Keywords: pain site; spinal cord injury; pain; pain interference; functioning

Introduction

Pain is experienced, to some degree, by the majority of persons after spinal cord injury (SCI).[1] For many of these individuals, the pain is severe and accompanied by reduced physical functioning and lower quality of life.[2] Pain conditions among persons with SCI tend to be stable, or become worse, over time across studies with follow-up periods up to 10 years.[3]

Previous research has found a high degree of variability in the extent to which pain interferes with functional activities in persons with SCI.[4] Explaining the variable impact of pain is an important goal for research, with direct bearing on the design of more effective interventions. Other investigators have examined which SCI characteristics might predict variability in the presence, intensity and impact of pain. Unfortunately, few consistencies have emerged from these efforts.[1] For example, level of injury has been found to be associated with pain prevalence in some studies[5,6] but not in others.[7] Older age has been associated with higher pain prevalence in a few studies,[6,7] but other research has suggested that pain interference is greater among both the youngest and oldest age groups.[8]

It has been suggested that inconsistencies in the literature are, in part, attributable to variations in how pain is defined and measured.[1] In addition, associations between physical factors and pain may depend on the location and type of SCI-related pain. Siddall *et al.*,[9] for example, found that presence of pain overall was not associated with completeness or level of injury, but when pain was categorized as neuropathic versus musculoskeletal, neuropathic pain was found to be more common among persons with tetraplegia versus paraplegia. Similarly, the prevalence and intensity of shoulder pain has been found to be higher among persons with tetraplegia.[10]

The primary purpose of the present study was to expand on past research concerning the predictors of pain in persons with SCI by determining whether (and which) patient characteristics are associated with pain location, pain intensity and pain interference. In addition, this study examined whether pain after SCI was more common or more intense at certain body sites. Based on previous

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research, we hypothesized that upper extremity pain would be more common among persons with cervical injuries. We did not expect to find strong associations between other injuries or demographic factors and pain location, intensity or interference.

Methods

Participants
Study participants were persons with SCI who were involved in a survey on pain in persons with SCI described in a prior report.[11] The previous report focused on the frequency and impact of pain but not on the predictors of pain, which is the focus of the current study. For this survey, questionnaires and consent forms were mailed to 760 individuals. Participants were paid $25 for completing and returning the forms. Individuals who did not reply within 2 weeks were contacted and reminded to return the questionnaires. All study procedures were approved by the University of Washington Human Subjects review committee.

Responses were received from 392 (51.6%) of the 760 invited to participate. Among the non-responders, 49 did not participate because the address was invalid, 4 because the participant was deceased, 6 were ineligible to participate and 5 declined participation. Thus, surveys and consent forms were received from 328 (43.2%) of the original 760 potential participants. Sixty-eight respondents reported no current pain problems and so did not have data to contribute to analyses. Included in the present analyses were 238 participants (31.3% of the original sample), who reported current pain and who had returned complete data.

Measures
The survey included questions assessing demographic (age, education, employment status, ethnicity and marital status) and medical variables (SCI level, completeness of injury and date of injury).

Pain location. Participants were also asked to identify whether or not they currently experience pain, and if so, where they experience pain. Pain location was assessed using a pain location checklist developed by the researchers that asked respondents to rate the presence or absence of pain in 17 different locations including the head, neck, shoulder, upper back, lower back, arms, elbows, wrists, hands, buttocks, hips, chest, abdomen/pelvis, legs, knees, ankles and feet.

Pain intensity. Participants were asked to rate their average pain intensity during the past week on a 0–10 Numerical Rating Scale (NRS), with 0 = 'no pain,' and 10 = 'pain as bad as could be.' Numerical pain ratings scales have been shown to have good test-retest reliability and adequate validity in terms of associations with other pain measures and treatments.[12] Participants used the NRS to rate overall pain intensity and pain intensity at each body location.

Pain interference. A 12-item form of the BPI (Brief Pain Inventory Interference scale),[13] modified for persons with SCI,[14] was used to measure the degree to which pain had interfered with daily activities during the past week. Scores on the BPI range from 0 to 10, with higher scores indicating greater pain interference with activities of daily life. This form of the BPI has strong reliability and validity, as shown through associations with related constructs.[14]

Statistical analyses
Distributions and residual plots of all variables were examined to assess for assumptions of models, skewness and influential data points. These examinations showed no gross violations of assumptions. Pearson correlations, *t*-tests, χ^2-analyses and analyses of variance were used to examine associations among key study variables. Patient self-report of neurological level was classified as follows for analyses: C1–C4 were classified as high tetraplegia, injuries at levels C5–T1 were classified as low tetraplegia and lesions below T2 were classified as paraplegia.

Results

Although the response rate for this study did not differ substantially from other similar survey studies in persons with SCI,[15] we sought to compare participants excluded for incomplete data to respondents with complete data on demographic, pain and SCI characteristics available for analysis to help evaluate the representativeness of our sample. The *t*-tests were used for continuous data (age, level of injury, time since SCI, pain intensity and pain interference) and χ^2-tests for categorical variables (gender, marital status, education, employment status and completeness of SCI). Only gender was significantly related to completeness of data, with women being more likely to return complete data than men ($\chi^2 = 5.3$, $P < 0.05$). Respondents and non-respondents did not differ on demographic or SCI characteristics.

Demographic and SCI characteristics
Demographic and SCI characteristics of the sample are shown in Table 1. Demographic variables including age, gender, marital status, ethnicity and education were not significantly related to pain ratings or location (all *P*-values > 0.25). Not surprisingly, persons working or attending school part-time or full-time were younger ($F = 34.68$, $P < 0.001$) and reported less pain interference ($F = 7.72$, $P < 0.001$) than persons not attending school or work. Vocational status was not significantly related to pain intensity. Age at SCI, time since SCI and completeness of injury were also not significantly related to pain intensity or interference (all *P*-values > 0.15).

Presence of pain, pain location and SCI level
Table 2 shows the number of patients, grouped according to level of injury, who reported pain in areas of the body above injury level, below injury level, at injury level or in upper extremities. Persons with paraplegia were more likely to report presence of at level pain, and less likely to report upper extremity pain, than were persons with higher level injuries ($\chi^2 = 7.11$, $P < 0.05$). Otherwise, persons with high

Table 1 Demographic and SCI characteristics

Variable		
Current age (M, SD)	47.3	13.1
Age at SCI (M, SD)	36.1	14.3
Time since SCI (M, SD)	11.0	9.5
C1–C4 level injuries (%)	7	
C5–T1 level injuries (%)	40	
T2–S4/S5 injuries (%)	53	
Complete injury (%)	32	
Female (%)	28	
Ethnic group (%)		
White	86	
Hispanic/Chicano	3	
Black	2	
Native American	5	
Asian	2	
Pacific Islander/mixed	2	
Marital status (%)		
Married	40	
Living with partner	9	
Never married	28	
Separated/divorced	20	
Education level (%)		
Grade 11 or lower	6	
High school/GED	18	
Vocational/technical/business school	10	
Some college	30	
College graduate	23	
Graduate/professional school	13	
Employment (%)		
Full-time	22	
Part-time	10	
School/vocational training	5	
Retired	12	
Homemaker	3	
Unemployed	48	

Abbreviation: GED, general equivalence diploma; M, mean; SCI, spinal cord injuries; SD, standard deviation.

Table 2 Presence of pain by general location and level of injury

Variable	*Above level pain* (n, %)	*At level pain* (n, %)	*Below level* (n, %)	*Upper extremity* (n, %)
C1–C4 ($n=16$)	5 (31)	3 (19)	13 (81)	15 (94)
C5–T1 ($n=95$)	33 (35)	36 (38)	71 (75)	78 (82)
Paraplegia ($n=127$)	53 (42)	63 (50)	90 (71)	78 (61)

Persons with paraplegia were proportionally more likely to report presence of at level pain, and less likely to report upper extremity pain than persons with higher level injuries, $\chi^2=7.11$, $P<0.05$. Row percentages do not total to 100% because participants can fit in more than one cell.

Table 3 Presence of pain by body site and level of injury

	High cervical	*Low cervical*	*Paraplegia*
Head	19	14	15
Neck*	38	52	34
Shoulder**	75	70	50
Upper back	44	41	40
Lower back	69	51	64
Arms*	50	41	20
Elbows	12	21	18
Wrists	19	31	26
Hands*	44	44	23
Buttocks	31	43	49
Hips	44	35	44
Chest	25	11	10
Abdomen	31	35	40
Legs	38	44	56
Knees	25	28	34
Ankles	19	25	27
Feet	38	44	40
other	7	5	12

Numbers represent % with pain in each location by column.
$P<0.05$, **$P<0.01$, ***$P<0.001$.

cervical injuries, low cervical injuries and paraplegia were similar with regards to pain sites.

Table 3 lists the number of patients with pain at specific body sites according to level of injury. Every body site had some pain for at least 10% of the sample. Among participants with high cervical injuries, the three most common sites were the shoulder, lower back and arms. Among those with low cervical injuries, pain was most common in the shoulder, neck and lower back. Among those with paraplegia, the three most common sites were the lower back, legs and shoulder. Persons with low cervical injuries were more likely to report the neck as a pain site than were those with high cervical injuries or paraplegia ($P<0.05$). Persons with paraplegia were less likely than those with higher level injuries to report pain in the shoulder ($P<0.01$), arms ($P<0.05$) or hands ($P<0.05$).

Pain intensity and pain interference by location and SCI level

Table 4 shows overall pain intensity (NRS) and pain interference (BPI) as a function of level of injury. There were no statistically significant differences on the overall pain intensity or pain interference between persons with high cervical injuries, low cervical injuries and paraplegia. Table 5 shows pain intensity by level of injury and specific body sites. Average pain ratings ranged from 3 to 7 across sites, with the large majority (88%) of sites falling between 4 and 6 on the NRS. The three sites with the highest pain intensity were identified from those sites listed as pain sites by at least 30% of the sample. Among persons with high cervical injuries, the highest pain ratings were for the buttocks, hips and knees. Among those with low cervical injuries, the highest pain ratings were the buttocks, abdomen and legs. Persons with paraplegia rated buttocks, hips and legs as the most painful sites. In summary, sites on the lower body were associated with the highest pain ratings, regardless of level of injury. There were no statistically significant differences on pain intensity, at any site, between persons with high cervical injuries, low cervical injuries and paraplegia.

Discussion

It has been well-documented that pain after SCI is common, tends to be severe in about one-third of those with pain, and

Table 4 Pain intensity and interference by level of injury

	High cervical (C1–C4)	*Low cervical (C5–T1)*	*Paraplegia*
NRS (M, SD)	3.67 (2.50)	5.04 (2.15)	5.62 (2.29)
BPI (M, SD)	4.57 (3.58)	3.16 (2.26)	3.54 (2.76)

Abbreviations: BPI, brief pain inventory; NRS, numerical rating scale.

Table 5 Pain intensity by body site and level of injury

	Average pain for that location		
	High cervical	*Low cervical*	*Paraplegia*
Head	5.3 (2.3)	4.8 (2.9)	5.4 (3.0)
Neck	4.2 (1.2)	4.9 (2.4)	4.5 (2.2)
Shoulder	4.7 (2.4)	5.2 (2.4)	5.0 (2.6)
Upper back	4.3 (1.1)	4.9 (2.6)	5.6 (2.4)
Lower back	4.7 (2.7)	5.1 (2.4)	5.9 (2.3)
Arms	4.6 (2.4)	5.0 (2.5)	5.0 (3.0)
Elbows	7.0 (1.4)	5.0 (2.9)	4.4 (3.0)
Wrists	5.7 (1.6)	4.5 (2.4)	4.6 (2.0)
Hands	4.3 (2.4)	4.8 (2.5)	4.7 (2.7)
Buttocks	6.4 (2.9)	5.7 (2.5)	6.3 (2.3)
Hips	6.4 (2.6)	5.1 (2.3)	6.2 (2.4)
Chest	3.0 (1.8)	5.4 (3.3)	5.1 (2.1)
Abdomen	4.8 (3.2)	5.7 (2.7)	5.5 (2.5)
Legs	5.3 (2.2)	5.4 (2.5)	6.0 (2.1)
Knees	6.0 (2.4)	5.4 (2.4)	5.7 (2.8)
Ankles	5.3 (1.5)	5.2 (2.9)	5.4 (2.6)
Feet	5.2 (3.1)	5.2 (2.7)	6.0 (2.7)
Other	—	7.3 (2.4)	6.7 (2.5)

Differences in average pain scores between injury levels are not statistically significant.

has the potential to impact heavily on well-being and functioning. The results of this study underscore the seriousness of pain problems following SCI. Pain intensity ratings in this sample were within the 'moderate' range;[16] between 4 and 6 on the 0–10 NRS across body locations. Moreover, every body location was identified as a pain site by at least 10% of the sample. The high prevalence and intensity of pain observed in this sample is consistent with past results from our research group[11] and others.[17] Pain interference levels in this sample were comparable to levels found in our prior work with persons with SCI.[14,16]

An important finding from this study was that SCI level was associated with the presence of pain, but not with pain intensity or interference. Although the shoulder was one of the most common pain sites identified by participants, regardless of level of injury, persons with higher level injuries were more likely to report upper extremity pain than were persons with paraplegic injuries. Other studies have produced similar findings.[11,18] Curtis *et al.*,[10] found that persons with tetraplegia were more likely to experience shoulder pain than their counterparts with paraplegia, but they also found that shoulder pain intensity was highest in this group of patients. These findings may be attributable to neuropathic pain at the level of the lesion or from deficits in upper extremity strength and function that result in muscle contractures, problems with posture and soft tissue strains from activities of daily living. This suggests that persons with higher level spinal cord injuries may benefit most from upper extremity pain prevention and management programs. However, it is also important to note that lower back pain was identified by between 50 and 70% of the participants, making lower back pain as common as shoulder pain in this sample. The implication of these findings is that pain is common throughout the body after SCI; therefore, the most critical task for researchers and clinicians may be the identification and treatment of the most severe and interfering pains.

The lower body appeared to be the location of the highest pain ratings in this sample, regardless of level of injury or other medical or demographic variables. Similarly, Siddall *et al.*,[9] found that neuropathic pain at or below the level of the spinal cord lesion was identified as severe in persons with SCI. This comparison between studies must be considered carefully, because the present study lacked data to systematically categorize pain as neuropathic versus musculoskeletal. Major SCI pain classification systems[19,20] agree that neuropathic pain is typically perceived at or below the level of injury in areas without normal sensation, and that musculoskeletal pain most often occurs in areas of normal sensation and high activity such as the shoulder. The implication is that lower body pains were perceived as more severe by patients in the present sample possibly because pains in the lower body are more likely to be neuropathic in origin. However, this interpretation remains speculative in the absence of data classifying pain as neuropathic versus musculoskeletal in this study.

As predicted, and consistent with previous research, demographic and medical variables tended not to be associated with pain locations or ratings of pain intensity and interference. Persons with upper cervical injuries, lower cervical injuries and paraplegia did not differ in the intensity of overall pain, pain interference or pain intensity at specific sites. Similarly, SCI characteristics such as age at SCI, time since SCI and completeness of injury were unrelated to pain ratings. These results are not surprising given past findings, as noted in reviews spanning decades of research.[1] One explanation for the lack of clear associations between medical and demographic factors and SCI pain may be methodological problems across studies, such as small sample sizes, cross-sectional designs and variability in pain definitions and measures. Alternatively, consistent findings may be elusive if variability in pain ratings is better accounted for by psychological factors. For example, a well-replicated finding in both cross-sectional and longitudinal studies is that psychological factors, such as mood or cognitions, are better predictors of pain and pain interference than factors such as level, completeness or etiology of injury.[8]

Design limitations should be considered when interpreting these results. The restricted ethnic diversity of the sample, while being typical of the region in which the study was conducted, limits generalizability of results. This study was also limited by the low number of persons with higher level cervical injuries. In addition, the use of a self-report mailed survey presents problems. The response rate for the study was typical for mailed survey studies but this may limit the generalizability of results. Also, the conditions under

which the questionnaires were completed are unknown and possibly could have influenced responses. Alternative methods for administering self-report questionnaires, such as administration in controlled settings, could be used in future studies. Finally, as noted earlier, data and methods allowing for systematic classification of SCI pain were not available, limiting the degree to which results can be compared to past research.

Conclusions

This study underscores previous research that has found demographic and medical variables to be poor predictors of pain prevalence, intensity and interference among persons with SCI. Only SCI level was associated with the site(s) of pain; persons with higher level injuries were more likely to report upper extremity pain than were persons with paraplegic injuries. However, SCI level was not associated with pain intensity or pain interference. Pain was common at many body locations, suggesting that the most critical task for researchers and clinicians is the identification of the most severe and interfering pains. In this sample, the lower body was the location of the highest pain ratings.

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References

1 Siddall P, Loeser J. Pain following spinal cord injury. *Spinal Cord* 2001; **39**: 63–73.
2 Ehde DM, Jensen MP, Engel JM, Turner JA, Hoffman AJ, Cardenas DD. Chronic pain secondary to disability: a review. *Clin J Pain* 2003; **19**: 3–17.
3 Rintala D, Hart K, Priebe M. Predicting consistency of pain over a 10-year period in persons with spinal cord injury. *J Rehabil Res Dev* 2004; **41**: 75–88.
4 Jensen M, Hoffman A, Cardenas D. Chronic pain in individuals with spinal cord injury: a survey and longitudinal study. *Spinal Cord* 2005; **43**: 704–712.
5 Jensen M, Cardenas DD, Warms C, McClellan C. Chronic pain associated with spinal cord injuries: a community survey. *Arch Phys Med Rehabil* 2001; **82**: 501–508.
6 Demirel G, Yllmaz H, Gencosmanoglue B, Kesiktas N. Pain following spinal cord injury. *Spinal Cord* 1998; **36**: 25–28.
7 Summers JD, Rapoff MA, Varghese G, Porter K, Palmer RE. Psychosocial factors in spinal cord injury pain. *Pain* 1991; **47**: 183–189.
8 Putzke JD, Richards S, Dowler RN. The impact of pain in spinal cord injury: a case control study. *Rehabil Psychol* 2000; **45**: 386–401.
9 Siddall PJ, McClelland JM, Rutkowski SB, Cousins MJ. A longitudinal study of the prevalence and characteristics of pain in the first 5 years following spinal cord injury. *Pain* 2003; **103**: 249–257.
10 Curtis KA, Drysdale GA, Lanza RD, Kolber M, Vitolo RS, West R. Shoulder pain in wheelchair users with tetraplegia and paraplegia. *Arch Phys Med Rehabil* 1999; **80**: 453–457.
11 Turner JA, Cardenas DD, Warms CA, McClellan CB. Chronic pain associated with spinal cord injuries: a community survey. *Arch Phys Med Rehabil* 2001; **82**: 501–509.
12 Jensen MP, Turner JA, Romano JM, Fisher LD. Comparative reliability and validity of chronic pain intensity measures. *Pain* 1999; **83**: 157–162.
13 Cleeland CS, Ryan KM. Pain assessment: global use of the Brief Pain Inventory. *Ann Acad Med* 1994; **23**: 129–138.
14 Raichle KA, Osborne TL, Jensen MP, Cardenas DD. The reliability and validity of pain interference measures in persons with spinal cord injury. *J Pain* 2006; **3**: 179–186.
15 Haythornthwaite JA, Wegener S, Benrud-Larson L, Fisher B, Clark M, Dillingham T *et al*. Factors associated with willingness to try different pain treatments for pain after a spinal cord injury. *Clin J Pain* 2003; **19**: 31–38.
16 Hanley MA, Masedo A, Jensen MP, Cardenas D, Turner JA. Pain interference in persons with spinal cord injury: classification of mild, moderate, and severe pain. *J Pain* 2006; **7**: 129–133.
17 Widerstrom-Noga EG, Felipe-Cuervo E, Yezierski RP. Relationships among clinical characteristics of chronic pain after spinal cord injury. *Arch Phys Med Rehabil* 2001; **82**: 1191–1197.
18 Sie IH, Waters RL, Adkins RH, Gellman H. Upper extremity pain in the postrehabilitation spinal cord injured patient. *Arch Phys Med Rehabil* 1992; **73**: 44–48.
19 Cardenas DD, Turner JA, Warms CA, Marshall HM. Classification of chronic pain associated with spinal cord injuries. *Arch Phys Med Rehabil* 2002; **83**: 1708–1714.
20 Siddall PJ, Yezierski RP, Loeser JD. Taxonomy and epidemiology of spinal cord injury pain. In: Yezierski RP, Burchiel KJ (eds). *Spinal Cord Injury Pain: Assessment, Mechanisms, Management*. IASP Press: Seattle, WA, 2002, pp 9–24.