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Prevalence of chronic pain after traumatic spinal cord injury: A systematic review

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Abstract—Published studies have reported widely divergent estimates of the prevalence of chronic pain among individuals with (traumatic) spinal cord injury (SCI). To develop an estimate based on a synthesis of the research, we used searches of MEDLINE, CINAHL, PsycINFO, and other bibliographic databases and an ancestor search to identify articles published since 1966 in any language that reported a pain prevalence rate for at least 30 subjects with certain or likely traumatic SCI. Data on sample makeup, study quality indicators, and pain prevalence were abstracted independently by two researchers. A total of 42 studies reported pain prevalence rates that ranged from 26% to 96%, with a fairly even spread between these extremes. The reported rate did not appear to be related to study quality. Pain prevalence in the combined samples did not appreciably differ between males and females, those with complete versus incomplete SCI, and those with paraplegia versus tetraplegia. We conclude that too much heterogeneity was present in the reports to calculate a post-SCI pain prevalence rate using meta-analytic methods. Further research is needed to determine whether rates are related to sample makeup (e.g., average subject age), research methods used (e.g., telephone interview vs self-report instruments), or even the definition of "chronic" pain.

Key words: complete, epidemiology, incomplete, pain, paraplegia, prevalence, rehabilitation, sex, spinal cord injuries, systematic review, tetraplegia.

INTRODUCTION

The fact that pain is a common consequence of spinal cord injury (SCI) hardly deserves mention; almost every author reporting on some aspect of SCI pain mentions it. Neuropathic pains resulting from damage to the spinal cord, nociceptive pains caused by the unusual demands an SCI places on the upper limbs, and "mixed" pains are well-known and have been studied extensively. Less commonly noted is that people with SCI may have chronic pain from many other causes (e.g., chronic headache and pain that accompanies cancer, herpes zoster, and any number of other disorders), much as the general population does. Bar-On and Ohry argue that individuals with SCI experience these "non-SCI" pains with a lower frequency than their peers because they may not be able to feel somatogenic pain below the level of injury [1]. No evidence to support this claim has been identified.

In spite of fairly extensive research in this area, contradictory answers are reported for many queries regarding SCI pain. Even some of the most basic questions are unanswered. For instance, no agreement exists on the percentage of persons with SCI who develop chronic pain—reports offer widely varying estimates, from 11 to

Abbreviations: ASIA = American Spinal Injury Association, CI = confidence interval, CV = coefficient of variation, NIDRR = National Institute on Disability and Rehabilitation Research, NRS = numeric rating scale, SCD = spinal cord disorder, SCI = spinal cord injury, SD = standard deviation, VRS = verbal rating scale.

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94 percent for "pain" [2–3] and 18 to 63 percent for "severe, disabling pain" [3–5]. For a more limited category—shoulder pain—the prevalence estimates range from 30 [6] to 51 percent [7].

Similar discrepancies are found for pain risk factors. Consensus exists with respect to only one finding: the lack of differences in pain reports between the sexes [8–10]. Otherwise, widespread disagreement exists—Are persons with paraplegia more likely to have pain than those with tetraplegia [8–9,11]? Are people with incomplete injury more likely to suffer pain than those with complete injury [8,10,12]? Does etiology of injury make a difference in the development of pain [2,13]?

The discrepancies in post-SCI pain prevalence estimates, which have been noted by a number of authors, may result from various causes, including the following:

- Sample composition. Research has suggested that pain after SCI may vary by level and completeness of injury, time since SCI onset (especially for musculoskeletal and visceral pain), and age at SCI onset. To the degree that large disparities exist between reported pain prevalence for those with paraplegia versus tetraplegia, differences in the percent of subjects with paraplegia between one sample and another will result in large differences in the reported pain prevalence. Other factors that affect prevalence may be the country and/or cultural group studied. Major differences have been noted between cultures in how they deal with and express pain [14], and these differences presumably affect responses to questions on pain used in surveys, even if a careful process of translation and back-translation is used to lexically and functionally equalize the survey instruments [15].
- Data collection year. Changes in acute surgical, medical, and rehabilitative treatments over the last 50 years may have resulted in changes in pain prevalence. For instance, the increased availability in the last decade of lightweight, customizable wheelchairs, which may be less likely to cause upper-limb musculoskeletal pain than the heavier wheelchairs available in the past [16], could make a difference in prevalence rates between more recent and older studies. Similarly, the availability of medications that have been found to be effective for the treatment of neuropathic pain might explain differences between older and more recent studies.
- Pain definition. In most research on chronic pain conducted outside the area of SCI, the continuous or intermittent presence of pain for at least 6 months is used as the cutoff for "chronic" pain. In research on SCI pain, a 3-month cutoff is sometimes used or, more commonly, no criterion for chronicity is used at all. Similarly, studies differ on whether they report on any level of pain or pain of a defined severity—serious enough to interfere with functioning, for example.
- Study design. Study designs also vary sufficiently that reported prevalence rates may be affected. In principle, prevalence refers to the pain present at exactly the point of reporting. For those investigators interested in establishing prevalence rates, the subjects' reports of pain explicitly or implicitly refer to "these days" or "of late," because not everyone has continuous pain. Period prevalence refers to the presence of pain (of a specified severity and duration) at least once during a specific time period, e.g., the last year. Prevalence and period prevalence both have been used in reports that use the simple term prevalence. In addition, some studies have used the incidence of pain at any time since the SCI onset. This method can be equated with a period prevalence, with the additional problem that the period is of unspecified duration.

This research assesses whether consistent estimates of the prevalence of and risk factors for SCI pain can be established based on careful evaluation and differentiation of the methods and sample characteristics of existing studies. This article is part of a larger systematic study of the prevalence of post-SCI pain. This first article concerns all types of pain after SCI taken together. It will describe the range and pattern of prevalence rates reported in the literature, assess differences (if any) in pain reports associated with three risk factors (sex, level of injury, and completeness of injury), and assess the extent to which meta-analytic methods may be applied to published prevalence data. Later articles will focus on specific pains (such as shoulder pain, neuropathic pain, and musculoskeletal pain) and other risk factors (such as age and time since injury) that may affect the prevalence of these pain types.

METHODS

Potential articles were identified in a database created as part of an ongoing project to find and classify all empirical research on pain after SCI [17]. This ongoing project limits the literature screened to publications from

1966 or later, which is the year MEDLINE® started publishing its bibliographies. A second reason for selecting this cutoff point was that older studies were generally of poor quality and were often published with many lacunae in the description of the methods and results. MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, ISI Web of Knowledge, and other bibliographic databases are searched on a regular basis for literature on pain after SCI. For all articles identified, the abstract is inspected to determine whether the article, chapter, or book likely or certainly deals with empirical research on chronic pain in humans with a (traumatic) SCI, and the full document is obtained for such articles. The full article is also obtained for entries in the databases for which no abstract is available. The reference lists of all publications received are examined ("ancestor search") to identify additional articles that for one reason or another had not been entered in any of the bibliographic databases or had not been found because of inadequate indexing. *Spinal Cord* (and its predecessor *Paraplegia*), *Topics in Spinal Cord Injury Rehabilitation*, and *Journal of Spinal Cord Medicine* are hand-searched for additional articles.

The studies identified in this larger project are routinely independently reviewed by 2 trained screeners, from a pool of 5 to 10 rehabilitation researchers and clinicians, who establish whether the published study indeed concerns (chronic) pain in individuals with traumatic SCI. In addition, the screeners determine which topic category(ies) the article fits into: one of these categories is "prevalence, incidence, and risk factors for pain."

For the present systematic review, we identified potential studies for inclusion from the database created for the larger ongoing study. In addition, we performed a new search of the bibliographic databases using the key words (thesaurus terms) spinal cord injury, pain, prevalence/incidence, and their equivalents as available, as well as the identical text words. Articles published from 1966 through the end of calendar year 2007 were included. The majority of the articles identified with this search were not included in this systematic review because they dealt with nontraumatic SCI, concerned the prevalence of something other than pain, or otherwise did not satisfy our inclusion criteria. A large number of articles were identified from the database that reported SCI pain prevalence but that had not been classified as such in the bibliographic databases. Their abstracts also lacked the relevant text words. The following selection criteria were used to identify articles that were relevant to this systematic review:

- Traumatic SCI. Only studies that involved individuals with traumatic SCI were included; if the sample included subjects with traumatic SCI and those with nontraumatic spinal cord disorders (SCDs) and the report did not separate these two groups, at least 75 percent of the cases needed to have traumatic SCI. If this percentage could not be established based on an explicit report of the causes of injury or age of onset (SCI onset at less than 40 years of age for at least 75% was assumed to indicate traumatic SCI), the study was not included. If separate prevalence reports were found for those with traumatic SCI versus other SCD, only data for the former group were abstracted.
- Chronic pain. Studies that used any severity and duration of pain as inclusion criterion were included, but the inclusion criteria (if reported) were noted and are reported in **Table 1**. Nonpain phenomena that often accompany neuropathic pain [18] were not included if the person did not experience pain.
- Pain cause. Only studies that reported on all the pains experienced by subjects were included. If authors limited reports to, e.g., below-level pain [19] or back pain [20], the article was excluded.
- SCI etiology. Only studies that incorporated all etiologies of traumatic SCI were included. For instance, a study by McKinley et al. that reported on pain in patients with SCI due to gunshot wound was excluded because this specific etiology may affect pain prevalence [21]. If the author referred to traumatic SCI only, we assumed that no selection based on trauma mechanism had been applied.
- Prevalence rate. Absence or presence of pain in an unselected series of persons with SCI was the information sought. Because of the lack of distinction between pain prevalence other than pain "right this minute" and period prevalence, reports on period prevalence for a period of up to 1 year prior to the date of data collection were included. Incidence reports and reports that were not clear on what was being reported (prevalence, point prevalence, or incidence) were excluded. All studies that selected persons with pain exclusively or preferentially were excluded, e.g., Barrett et al.'s study [22]. Whether or not persons with SCI pain *might* be overrepresented in a sample was one of the study characteristics coded; for surveys, generic questionnaires or those focused on a nonpain topic were

Table 1.
Studies reporting prevalence of pain after spinal cord injury (SCI): Reported prevalence rate and methodological issues likely to affect estimated rates.*

Study	Prevalence Rate (%)	Oversampling Pain Cases	Adequate Pain Description	Pain Chronicity Criterion	Pain Severity Criterion	Time Since Onset SCI Criterion (yr)	Relevant Inclusion/ Exclusion Criteria
Lundqvist et al., 1991 [1]	25.5	Possibly	Partial	—	ADL limiting	—	—
Johnson et al., 1998 [2]	27.0	—	No	—	—	—	—
Pagliacci et al., 2007 [3]	31.9	—	No	—	—	—	—
Craig et al., 1994 [4]	32.2	—	—	—	—	—	—
Saikkonen et al., 2004 [5]	36.6	—	—	—	Problem	1	—
Meade et al., 2006 [6]	38.3	—	—	—	—	—	—
McColl et al., 2002 [7]	43.5	—	Partial	—	—	20	—
Putzke et al., 2001 [8]	43.7	—	Partial	—	Limiting work ability	—	—
Anson & Shepherd, 1996 [9]	45.1	Possibly	No	—	"Problem"	—	—
Anke et al., 1995 [10]	45.6	—	—	—	Moderate or more severe	—	—
Meyers et al., 1999 [11]	48.2	—	No	—	—	—	Poor health
Elliott & Harkins, 1991 [12]	49.5	Possibly	—	2 weeks	—	—	—
Bloemen-Vrencken et al., 2005 [13]	55.3	—	Partial	—	—	—	—
Brooks et al., 1992 [14]	59.5	Possibly	No	—	—	2	—
Post et al., 1998 [15]	60.9	—	—	—	—	—	—
Störmer et al., 1997 [16]	61.0	Possibly	Partial	3 months	Distressing	2	—
Demirel et al., 1998 [17]	61.7	—	Partial	—	Moderate or more severe	—	—
McKinley et al., 2002 [18]	62.0	—	No	—	—	—	—
Kennedy et al., 1997 [19]	19.7	—	Partial	—	—	—	—
Norrbrink Budh et al., 2003 [20]	63.8	Possibly	—	2 weeks	—	—	—
Sved et al., 1997; Siddall et al., 2003; Siddall et al., 1999 [21–23]	63.8	—	No	—	—	—	—
Krause & Crewe, 1990 [24]	64.0	—	Partial	—	"Problem"	2	—
Levi et al., 1995 [25–26]	64.3	—	Partial	"Not of short duration"	Significant problem	—	—
Knútsdóttir, 1993 [27]	64.4	—	No	—	—	—	—
Jan & Wilson, 2004 [28]	65.0	Possibly	Partial	—	—	—	—
Fenollosa et al., 1993 [29]	65.5	Possibly	No	6 months	—	—	—
Yap et al., 2003 [30]	70.0	—	No	—	Significant	—	—
Frisbie & Aguilera, 1990 [31]	72.7	—	No	3 weeks	—	—	—
Klotz et al., 2002 [32]	74.8	—	—	—	—	2	—
Cardenas et al., 2002 [33]	75.8	Possibly	—	—	—	—	—
Rintala et al., 2005 [34]	76.1	—	Partial	6 months	Frequent	—	—
Cairns et al., 1996 [35]	76.5	—	—	—	—	—	—
Widerström-Noga et al., 1999 [36]	76.7	—	—	—	—	—	—
Finnerup et al., 2001 [37]	77.3	Possibly	No	3 months	—	—	—
Summers et al., 1991 [38]	77.8	Possibly	—	—	—	1	—
Ravenscroft et al., 2000 [39]	78.8	Possibly	Partial	4 months	—	—	—
Turner et al., 2001 & 1999 [40–41]	79.2	—	—	—	Persistent and bothersome	—	—
Jensen et al., 2005 [42]	79.6	Possibly	—	—	—	—	—
Nepomuceno et al., 1979 [43]	80.0	—	Partial	—	—	1	—
Cardenas et al., 2004 [44]	80.3	—	—	—	—	1	—
Donnelly & Eng, 2005 [45]	86.4	—	—	—	—	—	—
Raissi et al., 2007 [46]	96.2	—	Partial	—	—	—	—

Table 1. (Continued)

Studies reporting prevalence of pain after spinal cord injury (SCI): Reported prevalence rate and methodological issues likely to affect estimated rates.*

Note: Many studies reported inclusion criteria, but only those presumably affecting pain prevalence reports are entered into table.

*To make scanning table easier, the following entries were omitted: Oversampling of cases with pain: Not likely; Adequate pain description: Yes (Adequate); Pain chronicity criterion: None provided; Pain severity criterion: None provided; Time since onset SCI criterion: None used; Relevant inclusion and exclusion criteria: None.

1. Lundqvist C, Siosteen A, Blomstrand C, Lind B, Sullivan M. Spinal cord injuries. Clinical, functional, and emotional status. Spine. 1991;16(1):78–83. [PMID: 2003241]
2. Johnson RL, Gerhart KA, McCray J, Menconi JC, Whiteneck GG. Secondary conditions following spinal cord injury in a population-based sample. Spinal Cord. 1998; 36(1):45–50. [PMID: 9471138]
3. Pagliacci MC, Franceschini M, Di Clemente B, Agosti M, Spizzichino L; GISEM. A multicentre follow-up of clinical aspects of traumatic spinal cord injury. Spinal Cord. 2007;45(6):404–10. [PMID: 17102809]
4. Craig AR, Hancock KM, Dickson HG. Spinal cord injury: A search for determinants of depression two years after the event. Br J Clin Psychol. 1994;33(Pt 2):221–30. [PMID: 8038741]
5. Saikkonen J, Karppi P, Huusko TM, Dahlberg A, Mäkinen J, Uutela T. Life situation of spinal cord-injured persons in central Finland. Spinal Cord. 2004;42(8):459–65. [PMID: 15111996]
6. Meade MA, Barrett K, Ellenbogen PS, Jackson MN. Work intensity and variations in health and personal characteristics of individuals with spinal cord injury (SCI). J Vocat Rehabil. 2006;25(1):13–19.
7. McColl MA, Charlifue S, Glass C, Savic G, Meehan M. International differences in ageing and spinal cord injury. Spinal Cord. 2002;40(3):128–36. [PMID: 11859439]
8. Putzke JD, Richards JS, DeVivo MJ. Quality of life after spinal cord injury caused by gunshot. Arch Phys Med Rehabil. 2001;82(7):949–54. [PMID: 11441384]
9. Anson CA, Shepherd C. Incidence of secondary complications in spinal cord injury. Int J Rehabil Res. 1996;19(1):55–66. [PMID: 8730544]
10. Anke AG, Stenehjem AE, Stanghelle JK. Pain and life quality within 2 years of spinal cord injury. Paraplegia. 1995;33(10):555–59. [PMID: 8848308]
11. Meyers AR, Bisbee A, Winter M. The “Boston model” of managed care and spinal cord injury: A cross-sectional study of the outcomes of risk-based, prepaid, managed care. Arch Phys Med Rehabil. 1999;80(11):1450–56. [PMID: 10569440]
12. Elliott T, Harkins S. Psychosocial concomitants of persistent pain among persons with spinal cord injuries. NeuroRehabilitation. 1991;1:7–16.
13. Bloemen-Vrencken JH, Post MW, Hendriks JM, De Reus EC, De Witte LP. Health problems of persons with spinal cord injury living in the Netherlands. Disabil Rehabil. 2005;27(22):1381–89. [PMID: 16321920]
14. Brooks ME, Brouner R, Ohry A. Long term follow up of spinal cord injury caused by penetrating missiles. Paraplegia. 1992;30(2):131–34. [PMID: 1589289]
15. Post MW, De Witte LP, Van Asbeck FW, Van Dijk AJ, Schrijvers AJ. Predictors of health status and life satisfaction in spinal cord injury. Arch Phys Med Rehabil. 1998;79(4):395–401. [PMID: 9552104]
16. Störmer S, Gerner HJ, Grüninger W, Metzmacher K, Föllinger S, Wienke C, Aldinger W, Walker N, Zimmermann M, Paeslack V. Chronic pain/dysaesthesiae in spinal cord injury patients: Results of a multicentre study. Spinal Cord. 1997;35(7):446–55. [PMID: 9232750]
17. Demirel G, Yllmaz H, Gencosmanolu B, Kesikta N. Pain following spinal cord injury. Spinal Cord. 1998;36(1):25–28. [PMID: 9471134]
18. McKinley WO, Tewksbury MA, Godbout CJ. Comparison of medical complications following nontraumatic and traumatic spinal cord injury. J Spinal Cord Med. 2002;25(2):88–93. [PMID: 12137222]
19. Kennedy P, Frankel H, Gardner B, Nuseibeh I. Factors associated with acute and chronic pain following traumatic spinal cord injuries. Spinal Cord. 1997; 35(12):814–17. [PMID: 9429260]
20. Norrbrink Budh C, Lund I, Ertzgaard P, Holtz A, Hultling C, Levi R, Werhagen L, Lundeberg T. Pain in a Swedish spinal cord injury population. Clin Rehabil. 2003;17(6):685–90. [PMID: 12971714]
21. Sved P, Siddall PJ, McClelland J, Cousins MJ. Relationship between surgery and pain following spinal cord injury. Spinal Cord. 1997;35(8):526–30. [PMID: 9267918]
22. 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(3):249–57. [PMID: 12791431]
23. Siddall PJ, Taylor DA, McClelland JM, Rutkowski SB, Cousins MJ. Pain report and the relationship of pain to physical factors in the first 6 months following spinal cord injury. Pain. 1999;81(1–2):187–97. [PMID: 10353507]
24. Krause J, Crewe N. Long term prediction of self-reported problems following spinal cord injury. Paraplegia. 1990;28:186–202.
25. Levi R, Hultling C, Nash MS, Seiger A. The Stockholm spinal cord injury study: 1. Medical problems in a regional SCI population. Paraplegia. 1995;33(6):308–15. [PMID: 7644255]
26. Levi R, Hultling C, Seiger A. The Stockholm Spinal Cord Injury Study: 2. Associations between clinical patient characteristics and post-acute medical problems. Paraplegia. 1995;33(10):585–94. [PMID: 8848313]
27. Knútsdóttir S. Spinal cord injuries in Iceland 1973–1989. A follow up study. Paraplegia. 1993;31(1):68–72. [PMID: 8446450]
28. Jan FK, Wilson PE. A survey of chronic pain in the pediatric spinal cord injury population. J Spinal Cord Med. 2004;27 Suppl 1:S50–53. [PMID: 15503703]
29. Fenollosa P, Pallares J, Cervera J, Pelegrin F, Inigo V, Giner M, Forner V. Chronic pain in the spinal cord injured: Statistical approach and pharmacological treatment. Paraplegia. 1993;31(11):722–29. [PMID: 7507585]
30. Yap EC, Tow A, Menon EB, Chan KF, Kong KH. Pain during in-patient rehabilitation after traumatic spinal cord injury. Int J Rehabil Res. 2003;26(2):137–40. [PMID: 12799608]
31. Frisbie JH, Aguilera EJ. Chronic pain after spinal cord injury: An expedient diagnostic approach. Paraplegia. 1990;28(7):460–65. [PMID: 2250989]
32. Klotz R, Joseph PA, Ravaud JF, Wiart L, Barat M; Tetrafigap Group. The Tetrafigap Survey on the long-term outcome of tetraplegic spinal cord injured persons: Part III. Medical complications and associated factors. Spinal Cord. 2002;40(9):457–67. [PMID: 12185607]
33. Cardenas DD, Turner JA, Warms CA, Marshall HM. Classification of chronic pain associated with spinal cord injuries. Arch Phys Med Rehabil. 2002;83(12): 1708–14. [PMID: 12474174]

Table 1. (Continued)

Studies reporting prevalence of pain after spinal cord injury (SCI): Reported prevalence rate and methodological issues likely to affect estimated rates.

34. Rintala DH, Holmes SA, Fiess RN, Courtade D, Loubser PG. Prevalence and characteristics of chronic pain in veterans with spinal cord injury. J Rehabil Res Dev. 2005;42(5):573–84. [PMID: 16586183]
35. Cairns DM, Adkins RH, Scott MD. Pain and depression in acute traumatic spinal cord injury: Origins of chronic problematic pain? Arch Phys Med Rehabil. 1996;77(4):329–35. [PMID: 8607754]
36. Widerström-Noga EG, Felipe-Cuervo E, Broton JG, Duncan RC, Yezierski RP. Perceived difficulty in dealing with consequences of spinal cord injury. Arch Phys Med Rehabil. 1999;80(5):580–86. [PMID: 10326925]
37. Finnerup NB, Johannesen IL, Sindrup SH, Bach FW, Jensen TS. Pain and dysesthesia in patients with spinal cord injury: A postal survey. Spinal Cord. 2001; 39(5):256–62. [PMID: 11438841]
38. Summers JD, Rapoff MA, Varghese G, Porter K, Palmer RE. Psychosocial factors in chronic spinal cord injury pain. Pain. 1991;47(2):183–89. [PMID: 1762813]
39. Ravenscroft A, Ahmed YS, Burnside IG. Chronic pain after SCI. A patient survey. Spinal Cord. 2000;38(10):611–14. [PMID: 11093322]
40. Turner JA, Cardenas DD, Warms CA, McClellan CB. Chronic pain associated with spinal cord injuries: A community survey. Arch Phys Med Rehabil. 2001; 82(4):501–9. [PMID: 11295011]
41. Turner JA, Cardenas DD. Chronic pain problems in individuals with spinal cord injuries. Semin Clin Neuropsychiatry. 1999;4(3):186–94. [PMID: 10498786]
42. Jensen MP, Hoffman AJ, Cardenas DD. Chronic pain in individuals with spinal cord injury: A survey and longitudinal study. Spinal Cord. 2005;43(12):704–12. [PMID: 15968299]
43. Nepomuceno C, Fine PR, Richards JS, Gowens H, Stover SL, Rantanuabol U, Houston R. Pain in patients with spinal cord injury. Arch Phys Med Rehabil. 1979; 60(12):605–9. [PMID: 518270]
44. Cardenas DD, Bryce TN, Shem K, Richards JS, Elhefni H. Gender and minority differences in the pain experience of people with spinal cord injury. Arch Phys Med Rehabil. 2004;85(11):1774–81. [PMID: 15520972]
45. Donnelly C, Eng JJ. Pain following spinal cord injury: The impact on community reintegration. Spinal Cord. 2005;43(5):278–82. [PMID: 15570317]
46. Raissi GR, Mokhtari A, Mansouri K. Reports from spinal cord injury patients: Eight months after the 2003 earthquake in Bam, Iran. Am J Phys Med Rehabil. 2007; 86(11):912–17. [PMID: 18049137]

ADL = activities of daily living.

assumed to have no selective attrition in favor of persons with SCI pain. However, questionnaires focused on pain only were assumed to be of greater interest to those with pain and were coded as such.

- Abstractable data. Another criterion was that at least two of the following three data elements were reported: total number of cases studied, total number of cases with pain, and percent with pain. If two of these elements are known, the third can be calculated. In studies for which all three were reported, the consistency between the figures was assessed and the study excluded if any discrepancy was found beyond rounding errors.
- Sample size. The minimum number of subjects reported on (for the total sample, rather than subgroups defined by sex, completeness of injury, or level of injury) was set to 30. This choice reflects both avoidance of the risk of very high or very low prevalence rates in small samples due to chance fluctuations and the processing costs (man-hours dedicated to abstracting, checking, keying) per subject.

A list of articles screened for inclusion in the present systematic review that were excluded, with the reason for exclusion, is available from the corresponding author. (Many studies had multiple reasons for exclusion, but only one is provided).

To the degree that the information was available in the article, the following data were abstracted with a custom form:

- Information on the study: country, year of data collection, subject identification methods, and investigation methods.
- Information on sample inclusion and exclusion criteria.
- Information on the sample composition, if available: sex, completeness of injury (simplified, if necessary and possible, to complete [generally American Spinal Injury Association (ASIA) A] vs all other [ASIA B, C, D, and, in some studies, E]), level of injury (simplified, if necessary and possible, to paraplegia vs tetraplegia), mean or median age, mean or median age at injury, and mean or median years since injury.
- Information on the total number of subjects, the number of subjects reporting pain, and the percent of subjects with pain, as available, for the total sample and for subgroups defined by sex, level of injury, and completeness of injury. In most instances, pain prevalence for the total sample was available, but the availability of the prevalence rates for the three subgroups varied.
- Information on study quality. A list of more than 30 criteria for a well-designed, -executed, and -reported SCI pain prevalence study was developed, which

included items such as attrition percentage (percent of subjects targeted for study but not actually studied for reasons other than death), adequate statistical analysis, and a minimum report on the characteristics of the sample studied. Items were derived from existing standards for the reporting of research, such as the Consolidated Standards of Reporting Trials (CONSORT) [23–24], Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [25], Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) [26–27], and Standards for the Reporting of Diagnostic Accuracy studies (STARD) [28–29], as well as from previous systematic reviews of pain prevalence reports [30–33]. The items were scored on a 0 to 2 scale (mostly "no," "partly," and "yes"; some had a variant scoring system because they were considered more or less significant than average) and results totaled to obtain an overall quality score. The theoretical maximum score was 92, with higher scores indicating better quality. Because the maximum was lower for studies to which certain criteria were not applicable, the percent of applicable maximum was calculated to reflect quality.

Copies of the data abstraction instrument and the syllabus with instructions are available from the corresponding author.

All articles were independently screened for applicability by two of the three investigators. For eligible articles, data of interest were abstracted independently by randomly selected pairs of two of the three investigators. Discrepancies between reviewers were resolved by discussion, with consultation from the third author when necessary. Most discrepancies between data abstractors were fairly easily resolved because they resulted from overlooking information or misunderstanding the meaning of information. Some difficulties were due to ambiguities in the syllabus that the abstractors followed; these too were resolved easily once the intent of the study and of the various items was clarified. More difficult were discrepancies in items referring to study quality. Allowing discrepancies between "yes" and "partly" or "partly" and "no" to stand was necessary in order to avoid writing extensive and prescriptive instructions for most items. Many of these "minor" discrepancies were due to the fact that most of these studies were not designed solely or even primarily to produce information on the prevalence of SCI pain, and as a consequence, much of the information that is crucial for evaluating an epidemiological study was described not at all or incompletely. The number of discrepancies in which one reviewer rated an item as "yes" (done completely and/or adequately) and the second reviewer selected "no" (not done at all or done or reported very inadequately) was small, and these were resolved without too much discussion.

The mean and standard deviation (SD) data for the study quality score were very similar for the three reviewers (mean ± SD between 10.2 ± 5.1 and 10.8 ± 6.5), suggesting that they applied the rules similarly. Just the same, even after the reviewers resolved the major discrepancies, the correlation between them was only 0.61 (average over three pairs of reviewers), suggesting that their interpretation of the information provided in the articles and/or the application of the scoring rules was variable. To eliminate random error as much as possible, we calculated an average quality score as the mean of the two reviewers who had scored a study. This mean score was used when the relationship of prevalence rate to research quality was investigated.

As indicated previously, both for total samples and subsamples, the consistency between the total number of cases reported, the number with pain, and the percentage with pain was assessed. For studies and (sub)samples in which one of these three data elements was absent, the missing element was calculated from the numbers reported. All reported/calculated data were evaluated for internal consistency; for instance, if prevalence for males was reported as 60 percent and for females as 65 percent, the prevalence for the total sample must have been between those two numbers (inclusive), whatever the percentage of females in the sample.

In several instances, an author or group of authors reported on the same study sample in two or more publications—most commonly, but not always, with the same sample size. We used a careful analysis to identify these "twins" and "triplets" and to identify the report that was most complete. In a few instances, information from multiple reports was combined into the results presented here (**Table 1** references).

We intended to use meta-analytic techniques to combine the findings of all studies and determine new estimates of the pain prevalence rates in traumatic SCI, overall and in subgroups defined by sex, completeness of injury, and level of injury. Combining these data only makes sense if we can presume that the samples are drawn from the same population. If the results are homogeneous, they can be statistically combined into a "supersample."

We used a chi-square test to assess homogeneity. If the test is significant, the samples are heterogeneous, and we can assume that the studies used different methods of defining chronic pain, sampled different populations, or for some other reason cannot be combined legitimately.

The coefficient of variation (CV), also called the relative SD, represents the SD divided by the mean: it was used to quantify variation between studies, as was the ratio of the highest to the lowest prevalence rate reported.

We used analysis of variance to evaluate the relationship between prevalence rate reported and characteristics of the studies; we used correlation analysis (Pearson *r*) to evaluate the relationship between prevalence rate and continuous characteristics of the samples, such as percentage of cases with paraplegia.

RESULTS

Study Characteristics

More than 200 articles were screened, and 42 studies (described in 46 articles) satisfying the inclusion criteria were identified. Most were not designed to be SCI pain prevalence studies; in many instances, the studies focused on reporting characteristics of patients discharged from rehabilitation programs or describing the severity and consequences of health problems in a population. Almost all of the studies were done in Western countries and published (coincidentally, all in English) between the years 1987 and 2007.

Most studies did not use (or did not report) a duration criterion to define chronic pain; only nine stipulated a minimum duration, which ranged from "at least two weeks" to "at least six months" (**Table 1**). Similarly, most studies did not specify a minimum level for severity of the pain reported. The 13 that did so used a variety of criteria, ranging from "limiting ADLs [activities of daily living]" to "designated as at least moderate in severity" on a verbal rating scale (VRS) that ranged from none to unbearable, for instance.

The typical study provided information on the characteristics of the sample in terms of sex, level of injury, and completeness of injury, as well as two out of three of the following: mean or median age at injury, years since injury, and current age. However, only a minority of the studies reported data for all six characteristics. Quite a bit of sample-to-sample variation was found in these subject descriptors when they were reported. Many authors did not use (or did not report using) any selection criteria beyond the presence of a traumatic SCI.

The average study scored poorly in terms of the criteria for a good epidemiological pain study. The range was between 5 and 26 percent of the possible maximum, with a mean ± SD score of 10.4 ± 5.7 percent.

Pain Prevalence

The prevalence rates culled from the 42 studies are presented in **Table 1**. They ranged from 26 to 96 percent, and the graphical presentation in the **Figure** indicates that between these two extremes every value was more or less equally likely. The **Figure** also displays the 95 percent confidence interval (CI) for the prevalence rates reported by (or computed from) the studies. The 95 percent CI depends mostly on sample size; therefore, studies like that of Cardenas et al. [34], with a sample size of over 2,900, produce a much narrower range for the estimated pain prevalence rate than a small study like that of Craig et al. [35], which, with 31 cases, barely had enough subjects for inclusion in the review. The mean ± SD of the prevalence rates was 62 ± 18 percent. This range would seem too wide for the mean to be accepted as the true post-SCI pain prevalence rate—significant heterogeneity exists in the sample of studies, which was confirmed by the chi-square test of homogeneity: $\chi^2 = 1{,}484$, $p < 0.001$, $df = 41$.

The calculation of this mean of 62 percent gives equal weight to all samples, however small or large. Another average pain prevalence rate can be calculated by combining all samples into a "supersample" and calculating the prevalence for this large group. This approach gives each study weight in proportion to its number of cases. The prevalence rate calculated this way was 63 percent, with a narrow 95 percent CI of 62 to 64 percent. The CV for these 42 reports was 0.30, while the ratio of the highest reported rate to the lowest was 4.88. That is, the study with the highest prevalence rate (Raissi et al. = 96.2% [36]) had a rate almost four times as high as the study with the lowest pain prevalence rate (Lundqvist et al. = 25.5% [37]).

The Pearson correlation between study quality scores and prevalence was –0.22, which indicates that the better studies had a slight tendency to produce lower pain prevalence rates. However, the percent of the variance in prevalence rates explained is less than 5 percent, and with a sample of 42 studies, the correlation is not statistically significant. One step commonly taken when heterogeneity is evident is to distinguish subsamples of studies different from one another in one or more relevant characteristics. A

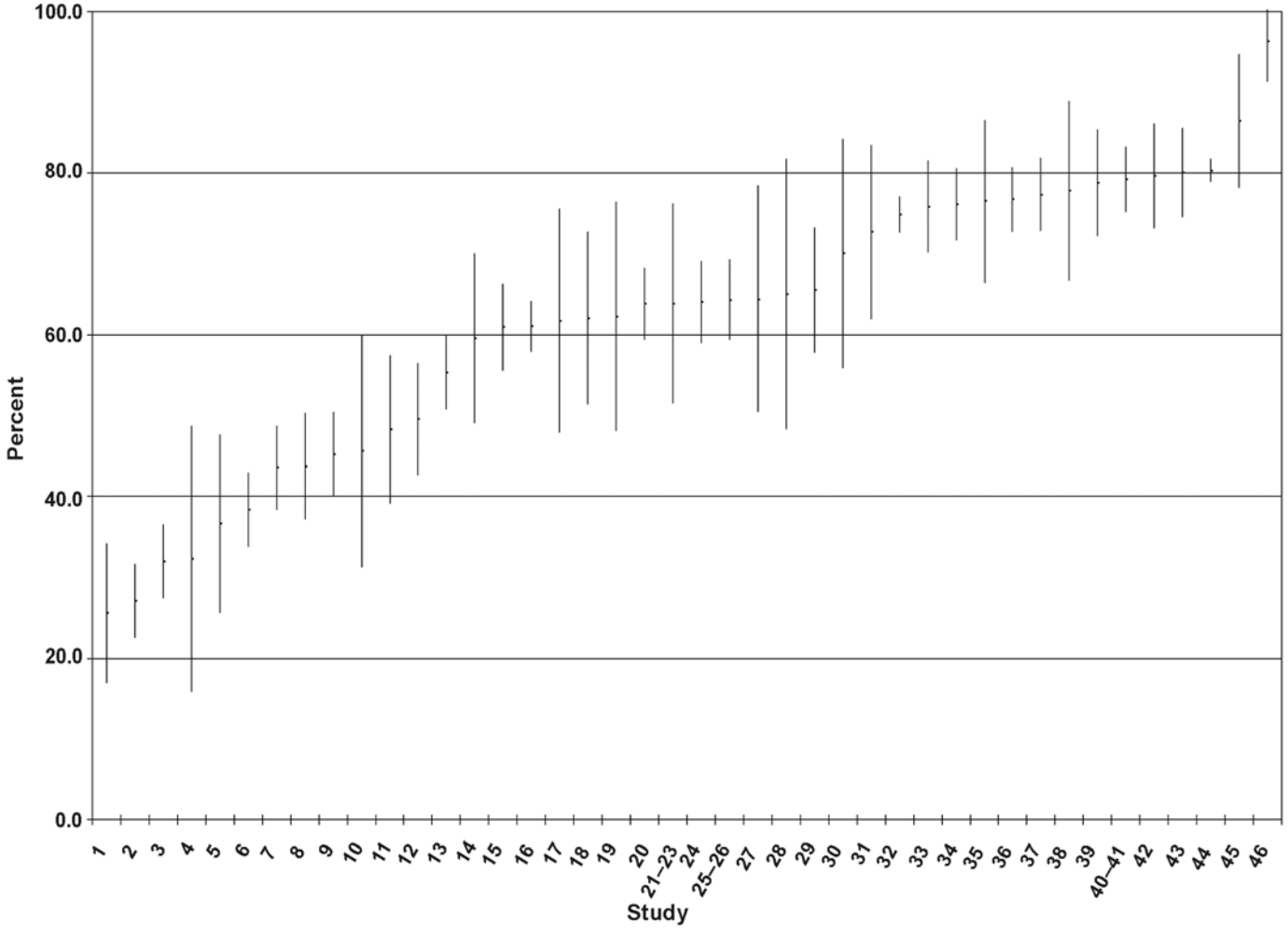

Figure.
Prevalence of chronic pain after spinal cord injury in various studies: Point estimate and 95% confidence interval. Numbers along *x*-axis correspond to reference numbers in **Table 1**.

scan of **Table 1** suggests that the study characteristics tabulated, such as minimum pain chronicity required or pain severity cutoff used, do not explain the prevalence rate variation. The same is true for whether subject recruitment was likely to have resulted in oversampling of those with pain, whether an adequate description of what constitutes pain and how it is measured was included, and whether time since SCI onset was a criterion in subject selection. Formal statistical tests (analysis of variance) of these and other potentially relevant characteristics of the study designs and the characteristics of subjects included produced no statistically significant results, which confirms the impression conveyed by **Table 1**. Neither was any statistically significant result found when the percentage of cases with pain was correlated with the percentage of males, the percentage with paraplegia, or the percentage with a complete injury in the respective samples.

Pain Prevalence by Sex, Level of Injury, and Completeness of Injury

Even if between-study differences in methods and sample makeup are so great that no average pain prevalence rate can be calculated, the within-study subgroup differences are possibly, and even likely, consistent from one study to the next, such that conclusions can be drawn about those subject characteristics that affect pain. For instance, if in the population of individuals with SCI those with incomplete injury are more likely to have pain

than those with complete injury, one would expect that differential to appear whatever the method of the study or the overall sample pain prevalence rate. (The exception would be a case of interaction between these subject characteristics and some other aspect of the study design in affecting the pain prevalence rate found.) For three subject characteristics: sex, level of injury, and completeness of injury, a large enough number of studies reported these data that this approach to assessing subgroup differences was feasible.

Table 2 provides prevalence information with respect to sex. Eight studies offered separate prevalence rates for males and females. The chi-square test indicated that for both males and females, the samples were not homogeneous with respect to the rate of pain prevalence (both $p < 0.001$, $df = 7$), which suggests that calculating a mean rate across studies is not justifiable. The ratio of the male to female rates was calculated as a simple way of indicating whether females were more or less likely to have pain. We assumed that this ratio was fairly independent of the investigative methods used in the eight studies and of the overall prevalence estimate they produced. The ratio varied from 0.66 (in the Rintala et al. study [38]), suggesting that females are more likely to report pain, to 1.18 (in the Anke et al. study [9]), indicating a slight tendency for males to report pain more often. These two studies that produced the extreme ratio values have small numbers of cases, and therefore, the male:female ratio calculated for them may be spuriously high or low. When all the samples were combined (to create a supersample with more than 4,000 male and more than 1,000 female subjects), the ratio of the male to the female prevalence rate was 0.94, suggesting that females on average are slightly more likely to report pain after SCI than males are. This calculation gives proportionally greater weight to the larger studies; if the methodology of these larger studies, for some reason, favored pain reporting by women, this bias

Table 2.
Studies reporting prevalence of pain for males (M) and females (F): Percent with pain by sex and corresponding ratio.

Study	M		F		Ratio M:F
	n	% with Pain	*n*	% with Pain	
Anke et al., 1995 [1]	36	47	10	40	1.18
Demirel et al., 1998 [2]	29	62	18	61	1.02
Cardenas et al., 2004 [3]	2,325	80	590	82	0.98
Fenollosa et al., 1993 [4]	117	65	28	68	0.96
Klotz et al., 2002 [5]	1,135	73	288	78	0.93
Levi et al., 1995 [6–7]	286	63	67	70	0.90
Norrbrink Budh et al., 2003 [8]	336	60	120	74	0.81
Rintala et al., 2004* [9]	69	64	27	96	0.66
Total *N*	4,333	—	1,148	—	—
Weighted Mean and Ratio	—	74	—	79	0.94
Unweighted Mean and Ratio	—	64	—	71	0.93

*Rintala et al.'s study was not included in **Table 1** and the **Figure** because oversampling of females was used in creating the study sample.

1. Anke AG, Stenehjem AE, Stanghelle JK. Pain and life quality within 2 years of spinal cord injury. Paraplegia. 1995;33(10):555–59. [PMID: 8848308]
2. Demirel G, Yllmaz H, Gencosmanolu B, Kesikta N. Pain following spinal cord injury. Spinal Cord. 1998;36(1):25–28. [PMID: 9471134]
3. Cardenas DD, Bryce TN, Shem K, Richards JS, Elhefni H. Gender and minority differences in the pain experience of people with spinal cord injury. Arch Phys Med Rehabil. 2004;85(11):1774–81. [PMID: 15520972]
4. Fenollosa P, Pallares J, Cervera J, Pelegrin F, Inigo V, Giner M, Forner V. Chronic pain in the spinal cord injured: Statistical approach and pharmacological treatment. Paraplegia. 1993;31(11):722–29. [PMID: 7507585]
5. Klotz R, Joseph PA, Ravaud JF, Wiart L, Barat M; Tetrafigap Group. The Tetrafigap Survey on the long-term outcome of tetraplegic spinal cord injured persons: Part III. Medical complications and associated factors. Spinal Cord. 2002;40(9):457–67. [PMID: 12185607]
6. Levi R, Hultling C, Nash MS, Seiger A. The Stockholm spinal cord injury study: 1. Medical problems in a regional SCI population. Paraplegia. 1995;33(6):308–15. [PMID: 7644255]
7. Levi R, Hultling C, Seiger A. The Stockholm Spinal Cord Injury Study: 2. Associations between clinical patient characteristics and post-acute medical problems. Paraplegia. 1995;33(10):585–94. [PMID: 8848313]
8. Norrbrink Budh C, Lund I, Ertzgaard P, Holtz A, Hultling C, Levi R, Werhagen L, Lundeberg T. Pain in a Swedish spinal cord injury population. Clin Rehabil. 2003;17(6):685–90. [PMID: 12971714]
9. Rintala DH, Hart KA, Priebe MM. Predicting consistency of pain over a 10-year period in persons with spinal cord injury. J Rehabil Res Dev. 2004;41(1):75–88. [PMID: 15273900]

might "overpower" the true tendency, which may have been reflected in the other studies. Giving each study, whether large or small, the same weight eliminates this problem. The last row in **Table 2** suggests that if all studies are given equal weight, the pain prevalence rates for males and females are somewhat reduced but their ratio remains almost the same. The ratio of the highest to the lowest male:female ratio was 1.79 (1.18 divided by 0.66), and the CV was 0.16 for the eight studies in **Table 2**. Both of these values are appreciably lower than the corresponding figures for the pain prevalence rates for all 42 studies.

The results in **Table 3** suggest that completeness of injury (at least as simplified to complete versus incomplete) was also not strongly associated with differences in pain prevalence. The chi-square test indicated that for both those with incomplete and those with complete injuries the samples were not homogeneous with respect to pain prevalence rate (both $p < 0.001$, $df = 8$), suggesting that calculating a mean rate across studies is not defensible. The incomplete:complete ratios ranged from 0.71 (those with complete injury are somewhat more likely to report pain) to 1.38 (those with incomplete injury more often have pain), but these extremes were found for small samples. Both the weighted and unweighted average ratio over the nine samples summarized in **Table 3** were close to 1.00, suggesting that completeness of injury is not relevant to pain. The ratio of the highest to the lowest calculated complete-incomplete rate was 1.94, and the CV was 0.19, suggesting that limited heterogeneity exists in these parameters.

The results in **Table 4** indicate that level of injury also has restricted relevance to variation in pain prevalence rates. The chi-square test indicated that for individuals

Table 3.
Studies reporting prevalence of pain for individuals with complete (C) and incomplete (I) injury: Percent with pain by completeness of injury and corresponding ratio.

Study	I		C		Ratio I:C
	n	% with Pain	*n*	% with Pain	
Brooks et al., 1992 [1]	32	72	52	52	1.38
Post et al., 1998 [2]	156	65	162	57	1.14
Klotz et al., 2002 [3]	640	77	723	70	1.11
Nepomuceno et al., 1979 [4]	22	82	53	75	1.08
Levi et al., 1995 [5–6]	188	65	139	65	1.00
Fenollosa et al., 1993 [7]	62	65	83	66	0.97
Norrbrink Budh et al., 2003 [8]	318	62	144	64	0.97
Yap et al., 2003 [9]	25	64	15	80	0.80
Anke et al., 1995 [10]	28	39	18	56	0.71
Total *N*	1,471	—	1,389	—	—
Weighted Mean and Ratio	—	70	—	66	1.05
Unweighted Mean and Ratio	—	66	—	65	1.02

1. Brooks ME, Brouner R, Ohry A. Long term follow up of spinal cord injury caused by penetrating missiles. Paraplegia. 1992;30(2):131–34. [PMID: 1589289]
2. Post MW, De Witte LP, Van Asbeck FW, Van Dijk AJ, Schrijvers AJ. Predictors of health status and life satisfaction in spinal cord injury. Arch Phys Med Rehabil. 1998;79(4):395–401. [PMID: 9552104]
3. Klotz R, Joseph PA, Ravaud JF, Wiart L, Barat M; Tetrafigap Group. The Tetrafigap Survey on the long-term outcome of tetraplegic spinal cord injured persons: Part III. Medical complications and associated factors. Spinal Cord. 2002;40(9):457–67. [PMID: 12185607]
4. Nepomuceno C, Fine PR, Richards JS, Gowens H, Stover SL, Rantanuabol U, Houston R. Pain in patients with spinal cord injury. Arch Phys Med Rehabil. 1979; 60(12):605–9. [PMID: 518270]
5. Levi R, Hultling C, Nash MS, Seiger A. The Stockholm spinal cord injury study: 1. Medical problems in a regional SCI population. Paraplegia. 1995;33(6):308–15. [PMID: 7644255]
6. Levi R, Hultling C, Seiger A. The Stockholm Spinal Cord Injury Study: 2. Associations between clinical patient characteristics and post-acute medical problems. Paraplegia. 1995;33(10):585–94. [PMID: 8848313]
7. Fenollosa P, Pallares J, Cervera J, Pelegrin F, Inigo V, Giner M, Forner V. Chronic pain in the spinal cord injured: Statistical approach and pharmacological treatment. Paraplegia. 1993;31(11):722–29. [PMID: 7507585]
8. Norrbrink Budh C, Lund I, Ertzgaard P, Holtz A, Hultling C, Levi R, Werhagen L, Lundeberg T. Pain in a Swedish spinal cord injury population. Clin Rehabil. 2003; 17(6):685–90. [PMID: 12971714]
9. Yap EC, Tow A, Menon EB, Chan KF, Kong KH. Pain during in-patient rehabilitation after traumatic spinal cord injury. Int J Rehabil Res. 2003;26(2):137–40. [PMID: 12799608]
10. Anke AG, Stenehjem AE, Stanghelle JK. Pain and life quality within 2 years of spinal cord injury. Paraplegia. 1995;33(10):555–59. [PMID: 8848308]

Table 4.
Studies reporting prevalence of pain for individuals with paraplegia (P) and tetraplegia (T): Percent with pain by type of injury and corresponding ratio.

Study	P		T		Ratio P:T
	n	% with Pain	*n*	% with Pain	
Brooks et al., 1992 [1]	68	63	16	38	1.69
Yap et al., 2003 [2]	24	82	16	50	1.67
Elliott & Harkins, 1991 [3]	118	54	80	43	1.28
Levi et al., 1995 [4–5]	181	70	146	60	1.18
Nepomuceno et al., 1979 [6]	110	84	90	76	1.11
Post et al., 1998 [7]	184	63	138	57	1.11
Anson & Shepherd, 1996 [8]	149	48	190	43	1.10
Cardenas et al., 2004 [9]	1,416	83	1,499	78	1.07
Norrbrink Budh et al., 2003 [10]	238	66	200	64	1.04
Anke et al., 1995 [11]	23	43	23	48	0.91
Fenollosa et al., 1993 [12]	107	64	38	76	0.83
Knútsdóttir, 1993 [13]	20	40	25	76	0.53
Total *N*	2,638	—	2,461	—	—
Weighted Mean and Ratio	—	74	—	70	1.06
Unweighted Mean and Ratio	—	63	—	59	1.12

1. Brooks ME, Brouner R, Ohry A. Long term follow up of spinal cord injury caused by penetrating missiles. Paraplegia. 1992;30(2):131–34. [PMID: 1589289]
2. Yap EC, Tow A, Menon EB, Chan KF, Kong KH. Pain during in-patient rehabilitation after traumatic spinal cord injury. Int J Rehabil Res. 2003;26(2):137–40. [PMID: 12799608]
3. Elliott T, Harkins S. Psychosocial concomitants of persistent pain among persons with spinal cord injuries. NeuroRehabilitation. 1991;1:7–16.
4. Levi R, Hultling C, Nash MS, Seiger A. The Stockholm spinal cord injury study: 1. Medical problems in a regional SCI population. Paraplegia. 1995;33(6): 308–15. [PMID: 7644255]
5. Levi R, Hultling C, Seiger A. The Stockholm Spinal Cord Injury Study: 2. Associations between clinical patient characteristics and post-acute medical problems. Paraplegia. 1995;33(10):585–94. [PMID: 8848313]
6. Nepomuceno C, Fine PR, Richards JS, Gowens H, Stover SL, Rantanuabol U, Houston R. Pain in patients with spinal cord injury. Arch Phys Med Rehabil. 1979;60(12):605–9. [PMID: 518270]
7. Post MW, De Witte LP, Van Asbeck FW, Van Dijk AJ, Schrijvers AJ. Predictors of health status and life satisfaction in spinal cord injury. Arch Phys Med Rehabil. 1998;79(4):395–401. [PMID: 9552104]
8. Anson CA, Shepherd C. Incidence of secondary complications in spinal cord injury. Int J Rehabil Res. 1996;19(1):55–66. [PMID: 8730544]
9. Cardenas DD, Bryce TN, Shem K, Richards JS, Elhefni H. Gender and minority differences in the pain experience of people with spinal cord injury. Arch Phys Med Rehabil. 2004;85(11):1774–81. [PMID: 15520972]
10. Norrbrink Budh C, Lund I, Ertzgaard P, Holtz A, Hultling C, Levi R, Werhagen L, Lundeberg T. Pain in a Swedish spinal cord injury population. Clin Rehabil. 2003;17(6):685–90. [PMID: 12971714]
11. Anke AG, Stenehjem AE, Stanghelle JK. Pain and life quality within 2 years of spinal cord injury. Paraplegia. 1995;33(10):555–59. [PMID: 8848308]
12. Fenollosa P, Pallares J, Cervera J, Pelegrin F, Inigo V, Giner M, Forner V. Chronic pain in the spinal cord injured: Statistical approach and pharmacological treatment. Paraplegia. 1993;31(11):722–29. [PMID: 7507585]
13. Knútsdóttir S. Spinal cord injuries in Iceland 1973–1989. A follow up study. Paraplegia. 1993;31(1):68–72. [PMID: 8446450]

with tetraplegia and those with paraplegia the samples were not homogeneous with respect to pain prevalence rate (both $p < 0.001$, $df = 11$), suggesting that calculating a mean rate across studies is not justifiable. The range of ratios was wider for these studies (from a low of 0.53 to a high of 1.69; the latter would mean that people with paraplegia are much more likely to report pain than those with tetraplegia), but the average ratio over these 12 studies, whether weighted or unweighted, was close to 1.00, suggesting that at best a minor tendency for individuals with paraplegia to have pain more often was present. The ratio of the highest to the lowest calculated paraplegia-to-tetraplegia ratio was 3.19, however, and the CV was 0.29, suggesting that a fair amount of heterogeneity is present in these data.

DISCUSSION

Pain after SCI is a common phenomenon, with an often significant impact on functioning and quality of life, well beyond the effect of the SCI itself. Knowledge of pain prevalence rates is important for a number of reasons. The overall prevalence of pain, combined with information on the severity and impact of the pain, suggests the significance of the problem and the priority pain should

have for researchers, research funders, policy makers, and possibly clinicians. Information on differential pain prevalence rates, by time since injury, level of injury, and other clinical and demographic characteristics may suggest factors that cause, aggravate, or alleviate SCI pain, as well as potential treatment approaches or potential ways to develop new treatments or prevention programs. Unfortunately, the studies most researchers and clinicians are familiar with vary so much in reported prevalence, overall and for subgroups, that consistent patterns do not offer themselves. In such situations, a systematic review, if possible capped with a meta-analysis, may offer an opportunity to synthesize and summarize the results. The purpose of our work was to carefully and systematically review the published research on pain after SCI and assess the potential for a statistical summary, both for all individuals with traumatic SCI and for subgroups, if possible.

Unfortunately, the SCI pain prevalence estimates reported in the 42 studies included varied so widely that a meta-analysis was not feasible. Almost any value between 26 and 96 percent has been reported; no clustering of prevalence rates around a single value was noted, suggesting that the study samples are heterogeneous, which was confirmed by a statistically significant chi-square test. Sample fluctuations may explain part of the discrepancy; however, the lack of overlap of the 95 percent CIs displayed in the **Figure** suggests that discrepancies between the studies resulted from factors other than chance. The reasons presumably are methodological: major differences exist in the data collection methods employed, the inclusion and exclusion criteria used by the various authors, and the definitions of minimum pain duration and minimum pain severity applied. Differences in sample makeup in terms of current mean age and time since onset may also be of relevance. In addition, geographic area and year of data collection may have played a role.

Our attempt to reduce variability by subsampling studies was not successful. None of the methodological characteristics of the studies, such as likelihood of oversampling of those with pain, pain definition, or chronicity of pain (**Table 1**), explained the variance in reported pain rates. The fact that the ratios of pain prevalence rates for males versus females, those with complete versus incomplete injury, and those with paraplegia versus tetraplegia were close to 1.00 (**Tables 2–4**) suggests that these characteristics also offer minimal help in explaining between-sample differences.

Use of the study-quality rating scores to select studies also did not help reduce the heterogeneity of studies: the Pearson correlation between study quality and reported pain prevalence was –0.22, which explained less than 5 percent of the variance in prevalence. Using quality scores to select articles for inclusion in systematic reviews or to weight the results of studies when included in meta-analysis is a contentious subject [39–40]; in the current application, the weak relationship (possibly due to an inadequate instrument or poor use of the instrument) suggested that further selection would not be fruitful. However, the quality scores were reported to indicate that most of the studies in the area of SCI pain are weak in terms of design and reporting; researchers need to improve their studies and reports.

In addition to calculation of mean prevalence rates for subgroups of articles or subsamples in studies, another potential approach to explaining key outcome differences between studies exists that might be useful in future investigations: meta-regression [41]. In meta-regression, the outcome of interest (here, reported post-SCI pain prevalence rate) is regressed on variables that reflect research methods and sample characteristics, with the study as the unit of analysis. Meta-regression does not need reports of prevalence rates by, e.g., sex but can work with the percentage of females in the sample for which an overall prevalence rate is known, which would be an advantage in the present situation. While only eight studies provided pain prevalence rates separately for males and females, the percentage of females in the sample was reported for all but one study. However, many characteristics, of both the study methodology and of the people studied, can potentially affect the prevalence rates found, and for authors to report on all of them is uncommon. Many articles did not address such basic information as inclusion and exclusion criteria, which presumably have a major impact on the pain prevalence rates reported. If one uses the traditional rule of thumb for regression analysis that 10 cases are needed for each variable, a sample of 42 studies would allow for 4 explanatory variables, if complete information was available for each one. If one is willing to relax the criterion to five cases per variable, eight predictors could be used. The information reported here makes clear that the potential number of predictor variables is much larger than that.

While the individual studies may have differed in prevalence rate differences between males and females, people with paraplegia versus tetraplegia, and those with

complete versus incomplete injury, the differences are fairly minor if the totality of the published literature is taken into account. Disregarding in each instance the two most extreme studies, the ratio of pain prevalence among males to that among females is in the 0.80 to 1.00 range. For those with paraplegia versus tetraplegia, the ratio is in the range of 0.80 to 1.60, and for those with complete versus incomplete injury, the ratio is in the range of 0.80 to 1.15. Thus, in none of these instances is a large difference found between the subgroups, and the differences are even smaller if one relies on the weighted or unweighted average of the various studies that contributed the relevant ratios. We should note, however, that quite a bit of variation exists in the ratio of prevalence rates for paraplegia versus tetraplegia, suggesting that an interaction may be present between level of injury and some methodological characteristic of studies—for instance, on postal questionnaires, people with paraplegia could be more likely than those with tetraplegia to report pain, but they are less likely to endorse pain in a routine annual checkup.

The failure of our attempts to narrow the range in which the overall pain prevalence lies suggests that the issue of post-SCI pain is still unsettled: the prevalence is anywhere between 26 and 96 percent, and no rational basis exists for narrowing that range. More research is needed, but that additional research must satisfy a number of requirements to make a clear contribution, especially a contribution to a future systematic review:

- A clear description of the research methodology must be present, including the source of the sample; a definition of traumatic SCI; the methods for identifying cases; and an accounting of cases lost to death, unknown address, refusal, and other reasons.
- Authors should offer an explicit definition of pain in terms of chronicity and severity. Anything less than moderate pain may only minimally affect functioning and lifestyle, even if untreated. Thus, for research and other purposes, knowing how many people (overall and in subgroups) have moderate or more severe pain may be more important. A VRS may do to assess pain severity, or one could use the finding that a numeric rating scale (NRS) score of 4 or higher (or the equivalent on a visual analog scale) represents moderately severe pain for most people [42–43]. Ideally, a 0- to 10-point NRS should be used to quantify pain intensity as recommended by the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) [44–46]; the International SCI Pain Basic Data Set [47]; and the National Institute on Disability and Rehabilitation Research (NIDDR)-sponsored SCI Pain Outcomes Committee [48].
- In any future publications, a clear description of the sample studied must also be included, in terms of etiology of SCI (at a minimum, traumatic versus other), sex, level of injury (ideally using more categories than just tetraplegia and paraplegia), completeness of injury (ideally reporting in terms of the ASIA impairment scale), age at injury, current age, and years since onset of SCI.

CONCLUSIONS

The published research on pain prevalence rates unfortunately does not allow meta-analysis to settle the question of the prevalence of chronic pain after SCI. Apparently the published information does allow one to conclude that sex and completeness of injury have a very small impact on the experience of pain. The same may be true for level of injury. The conduct and reporting of future studies of the prevalence of post-SCI pain need to be improved in order to make systematic reviewing and meta-analytic synthesis techniques more feasible.

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REFERENCES

1. Bar-On Z, Ohry A. The acute abdomen in spinal cord injury individuals. Paraplegia. 1995;33(12):704–6. [PMID: 8927409]
2. Davidoff G, Roth E, Guarracini M, Sliwa J, Yarkony G. Function-limiting dysesthetic pain syndrome among traumatic spinal cord injury patients: A cross-sectional study. Pain. 1987;29(1):39–48. [PMID: 3588000] DOI:10.1016/0304-3959(87)90176-X
3. Loubser PG, Donovan WH. Chronic pain associated with spinal cord injury. In: Narayan RK, Wilberger JE, Povlischock JT, editors. Neurotrauma. New York (NY): McGraw-Hill; 1996. p. 1311–22.
4. Mariano AJ. Chronic pain and spinal cord injury. Clin J Pain. 1992;8(2):87–92. [PMID: 1633387] DOI:10.1097/00002508-199206000-00005
5. Cairns DM, Adkins RH, Scott MD. Pain and depression in acute traumatic spinal cord injury: Origins of chronic problematic pain? Arch Phys Med Rehabil. 1996;77(4):329–35. [PMID: 8607754] DOI:10.1016/S0003-9993(96)90079-9
6. Bayley JC, Cochran TP, Sledge CB. The weight-bearing shoulder. The impingement syndrome in paraplegics. J Bone Joint Surg Am. 1987;69(5):676–78. [PMID: 3597466]
7. Nichols PJ, Norman PA, Ennis JR. Wheelchair user's shoulder? Shoulder pain in patients with spinal cord lesions. Scand J Rehabil Med. 1979;11(1):29–32. [PMID: 419395]
8. Demirel G, Yllmaz H, Gencosmanolu B, Kesikta N. Pain following spinal cord injury. Spinal Cord. 1998;36(1):25–28. [PMID: 9471134] DOI:10.1038/sj.sc.3100523
9. Anke AG, Stenehjem AE, Stanghelle JK. Pain and life quality within 2 years of spinal cord injury. Paraplegia. 1995; 33(10):555–59. [PMID: 8848308]
10. Fenollosa P, Pallares J, Cervera J, Pelegrin F, Inigo V, Giner M, Forner V. Chronic pain in the spinal cord injured: Statistical approach and pharmacological treatment. Paraplegia. 1993;31(11):722–29. [PMID: 7507585]
11. Cohen MJ, McArthur DL, Vulpe M, Schandler SL, Gerber KE. Comparing chronic pain from spinal cord injury to chronic pain of other origins. Pain. 1988;35(1):57–63. [PMID: 3200598] DOI:10.1016/0304-3959(88)90276-X
12. Summers JD, Rapoff MA, Varghese G, Porter K, Palmer RE. Psychosocial factors in chronic spinal cord injury pain. Pain. 1991;47(2):183–89. [PMID: 1762813] DOI:10.1016/0304-3959(91)90203-A
13. Richards JS, Stover SL, Jaworski T. Effect of bullet removal on subsequent pain in persons with spinal cord injury secondary to gunshot wound. J Neurosurg. 1990;73(3):401–4. [PMID: 2384778]
14. Zborowski M. People in pain. San Francisco (CA): Jossey-Bass; 1969.
15. Ware JE Jr, Keller SD, Gandek B, Brazier JE, Sullivan M. Evaluating translations of health status questionnaires. Methods from the IQOLA project. International Quality of Life Assessment. Int J Technol Assess Health Care. 1995; 11(3):525–51. [PMID: 7591551]
16. Paralyzed Veterans of America Consortium for Spinal Cord Medicine. Preservation of upper limb function following spinal cord injury: A clinical practice guideline for health-care professionals. J Spinal Cord Med. 2005;28(5):434–70. [PMID: 16869091]
17. Dijkers MP. Searching the literature for information on traumatic spinal cord injury: The usefulness of abstracts. Spinal Cord. 2003;41(2):76–84. [PMID: 12595869] DOI:10.1038/sj.sc.3101414
18. Siddall PJ, McClelland J. Non-painful sensory phenomena after spinal cord injury. J Neurol Neurosurg Psychiatry. 1999; 66(5):617–22. [PMID: 10209173] DOI:10.1136/jnnp.66.5.617
19. Kumar V, Kirubakaran V, Powell B. Spinal cord injured veterans—A rehabilitation profile. VA Pract. 1987.
20. Singh R, Sharma S. Sexuality and women with spinal cord injury. Sex Disabil. 2005;23(1):21–33. DOI:10.1007/s11195-004-2077-5
21. McKinley WO, Johns JS, Musgrove JJ. Clinical presentations, medical complications, and functional outcomes of individuals with gunshot wound-induced spinal cord injury. Am J Phys Med Rehabil. 1999;78(2):102–7. [PMID: 10088582] DOI:10.1097/00002060-199903000-00002
22. Barrett H, McClelland JM, Rutkowski SB, Siddall PJ. Pain characteristics in patients admitted to hospital with complications after spinal cord injury. Arch Phys Med Rehabil. 2003;84(6):789–95. [PMID: 12808528] DOI:10.1016/S0003-9993(02)04944-4
23. Moher D, Schulz KF, Altman D; CONSORT Group (Consolidated Standards of Reporting Trials). The CONSORT statement: Revised recommendations for improving the quality of reports of parallel-group randomized trials. J Am Podiatr Med Assoc. 2001;91(8):437–42. [PMID: 11574648]
24. Altman DG, Schulz KF, Moher D, Egger M, Davidoff F, Elbourne D, Gotzsche PC, Lang T; CONSORT Group (Consolidated Standards of Reporting Trials). The revised CONSORT statement for reporting randomized trials: Explanation and elaboration. Ann Intern Med. 2001;134(8): 663–94. [PMID: 11304107]

25. Fernández E. [Observational studies in epidemiology (STROBE)]. Med Clin (Barc). 2005;125(Suppl 1):43–48. Spanish. [PMID: 16464427] DOI:10.1157/13079173
26. Des Jarlais DC, Lyles C, Crepaz N, TREND Group. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: The TREND statement. Am J Public Health. 2004;94(3):361–66. [PMID: 14998794] DOI:10.2105/AJPH.94.3.361
27. Dzewaltowski DA, Estabrooks PA, Klesges LM, Glasgow RE. Trend: An important step, but not enough. Am J Public Health. 2004;94(9):1474–75. [PMID: 15333294] DOI:10.2105/AJPH.94.9.1474
28. Bossuyt PM, Reitsma JB, Bruns DE, Gatsonis CA, Glasziou PP, Irwig LM, Lijmer JG, Moher D, Rennie D, De Vet HC; STARD Group. Towards complete and accurate reporting of studies of diagnostic accuracy: The STARD initiative. Fam Pract. 2004;21(1):4–10. [PMID: 14760036] DOI:10.1093/fampra/cmh103
29. Bossuyt PM, Reitsma JB, Bruns DE, Gatsonis CA, Glasziou PP, Irwig LM, Moher D, Rennie D, De Vet HC, Lijmer JG; Standards for Reporting of Diagnostic Accuracy. The STARD statement for reporting studies of diagnostic accuracy: Explanation and elaboration. Clin Chem. 2003;49(1): 7–18. [PMID: 12507954]
30. Genaidy AM, Lemasters GK, Lockey J, Succop P, Deddens J, Sobeih T, Dunning K. An epidemiological appraisal instrument—A tool for evaluation of epidemiological studies. Ergonomics. 2007;50(6):920–60. [PMID: 17457750] DOI:10.1080/00140130701237667
31. Côté P, Van der Velde G, Cassidy JD, Carroll LJ, Hogg-Johnson S, Holm LW, Carragee EJ, Haldeman S, Nordin M, Hurwitz EL, Guzman J, Peloso PM; Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. The burden and determinants of neck pain in workers: Results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. Spine. 2008;33(4 Suppl):S60–74. [PMID: 18204402]
32. Van den Beuken-Van Everdingen MH, De Rijke JM, Kessels AG, Schouten HC, Van Kleef M, Patijn J. Prevalence of pain in patients with cancer: A systematic review of the past 40 years. Ann Oncol. 2007;18(9):1437–49. [PMID: 17355955] DOI:10.1093/annonc/mdm056
33. Meeus M, Nijs J, Meirleir KD. Chronic musculoskeletal pain in patients with the chronic fatigue syndrome: A systematic review. Eur J Pain. 2007;11(4):377–86. [PMID: 16843021] DOI:10.1016/j.ejpain.2006.06.005
34. Cardenas DD, Bryce TN, Shem K, Richards JS, Elhefni H. Gender and minority differences in the pain experience of people with spinal cord injury. Arch Phys Med Rehabil. 2004;85(11):1774–81. [PMID: 15520972] DOI:10.1016/j.apmr.2004.04.027
35. Craig AR, Hancock KM, Dickson HG. Spinal cord injury: A search for determinants of depression two years after the event. Br J Clin Psychol. 1994;33(Pt 2):221–30. [PMID: 8038741]
36. Raissi GR, Mokhtari A, Mansouri K. Reports from spinal cord injury patients: Eight months after the 2003 earthquake in Bam, Iran. Am J Phys Med Rehabil. 2007;86(11): 912–17. [PMID: 18049137]
37. Lundqvist C, Siosteen A, Blomstrand C, Lind B, Sullivan M. Spinal cord injuries. Clinical, functional, and emotional status. Spine. 1991;16(1):78–83. [PMID: 2003241]
38. Rintala DH, Hart KA, Priebe MM. Predicting consistency of pain over a 10-year period in persons with spinal cord injury. J Rehabil Res Dev. 2004;41(1):75–88. [PMID: 15273900]
39. Herbison P, Hay-Smith J, Gillespie WJ. Adjustment of meta-analyses on the basis of quality scores should be abandoned. J Clin Epidemiol. 2006;59(12):1249–56. [PMID: 17098567] DOI:10.1016/j.jclinepi.2006.03.008
40. Whiting P, Harbord R, Kleijnen J. No role for quality scores in systematic reviews of diagnostic accuracy studies. BMC Med Res Methodol. 2005;5:19. [PMID: 15918898] DOI:10.1186/1471-2288-5-19
41. Jones DR. Meta-analysis of observational epidemiological studies: A review. J R Soc Med. 1992;85(3):165–68. [PMID: 1556722]
42. Collins SL, Moore RA, McQuay HJ. The visual analogue pain intensity scale: What is moderate pain in millimetres? Pain. 1997;72(1–2):95–97. [PMID: 9272792] DOI:10.1016/S0304-3959(97)00005-5
43. Jensen MP, Chen C, Brugger AM. Postsurgical pain outcome assessment. Pain. 2002;99(1–2):101–9. [PMID: 12237188] DOI:10.1016/S0304-3959(02)00063-5
44. Turk DC, Dworkin RH, Allen RR, Bellamy N, Brandenburg N, Carr DB, Cleeland C, Dionne R, Farrar JT, Galer BS, Hewitt DJ, Jadad AR, Katz NP, Kramer LD, Manning DC, McCormick CG, McDermott MP, McGrath P, Quessy S, Rappaport BA, Robinson JP, Royal MA, Simon L, Stauffer JW, Stein W, Tollett J, Witter J. Core outcome domains for chronic pain clinical trials: IMMPACT recommendations. Pain. 2003;106(3):337–45. [PMID: 14659516] DOI:10.1016/j.pain.2003.08.001
45. Dworkin RH, Turk DC, Farrar JT, Haythornthwaite JA, Jensen MP, Katz NP, Kerns RD, Stucki G, Allen RR, Bellamy N, Carr DB, Chandler J, Cowan P, Dionne R, Galer BS, Hertz S, Jadad AR, Kramer LD, Manning DC, Martin S, McCormick CG, McDermott MP, McGrath P, Quessy S, Rappaport BA, Robbins W, Robinson JP, Rothman M, Royal MA, Simon L, Stauffer JW, Stein W, Tollett J, Wernicke J, Witter J; IMMPACT. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. Pain. 2005;113(1–2):9–19. [PMID: 15621359] DOI:10.1016/j.pain.2004.09.012
46. Dworkin RH, Turk DC, Wyrwich KW, Beaton D, Cleeland CS, Farrar JT, Haythornthwaite JA, Jensen MP, Kerns RD,

Ader DN, Brandenburg N, Burke LB, Cella D, Chandler J, Cowan P, Dimitrova R, Dionne R, Hertz S, Jadad AR, Katz NP, Kehlet H, Kramer LD, Manning DC, McCormick C, McDermott MP, McQuay HJ, Patel S, Porter L, Quessy S, Rappaport BA, Rauschkolb C, Revicki DA, Rothman M, Schmader KE, Stacey BR, Stauffer JW, Von Stein T, White RE, Witter J, Zavisic S. Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. J Pain. 2008;9(2):105–21. [PMID: 18055266] DOI:10.1016/j.jpain.2007.09.005

47. Widerström-Noga E, Biering-Sorensen F, Bryce T, Cardenas DD, Finnerup NB, Jensen MP, Richards JS, Siddall PJ. The International Spinal Cord Injury Pain Basic Data Set. Spinal Cord. 2008;46(12):818–23. [PMID: 18521092] DOI:10.1038/sc.2008.64

48. Bryce TN, Budh CN, Cardenas DD, Dijkers M, Felix ER, Finnerup NB, Kennedy P, Lundeberg T, Richards JS, Rintala DH, Siddall P, Widerström-Noga E. Pain after spinal cord injury: An evidence-based review for clinical practice and research. Report of the National Institute on Disability and Rehabilitation Research Spinal Cord Injury Measures meeting. J Spinal Cord Med. 2007;30(5):421–40. [PMID: 18092558]

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