

Research Article

Secondary health conditions and disability among people with spinal cord injury: A prospective cohort study

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Objective: To examine how secondary health conditions (SHCs) that develop early after a spinal cord injury (SCI) are related to disability over time.

Design: Prospective cohort study.

Setting: Two spinal units in New Zealand (Burwood Spinal Unit and Auckland Spinal Rehabilitation Unit).

Participants: Between 2007 and 2009, 91 people participated in three telephone interviews approximately 6, 18, and 30 months after the occurrence of a SCI.

Outcome measures: SHCs were measured using 14 items derived from the Secondary Complications Survey. Disability was measured using the 12-item World Health Organization Disability Assessment Schedule 2.0. Linear regression analyses were performed to investigate associations between SHCs at 6 months and disability at each assessment point.

Results: The most prevalent SHCs were leg spasms, constipation, back pain, pain below the level of SCI, and shoulder pain. Constipation, urinary tract infection, and headaches at 6 months post-SCI were associated with significantly higher levels of disability at each subsequent follow-up, independent of age, sex and SCI impairment. Back pain, and pain below the SCI, at 6 months were associated with significantly greater disability at 18 months, and difficulty coughing at 6 months was associated with significantly greater disability at 30 months.

Conclusion: The experience of specific SHCs in the first 6 months after an SCI is related to greater long-term disability. In order to reduce the disability burden of people with SCI, efforts should be directed toward early prevention of these SHCs.

Keywords: Disability, Secondary health conditions, Spinal cord injury

Introduction

People with spinal cord injury (SCI) are at risk of experiencing a diverse range of secondary health conditions (SHCs) that are a direct or indirect result of damage to the spinal cord.¹ Particularly common SHCs among people with SCI include pain, spasticity, urinary tract infections, bowel problems, respiratory difficulties, autonomic dysreflexia, osteoporosis, and pressure ulcers.² Cross-sectional research in the United States has found that people with SCI

typically experience between 8 and 14 SHCs annually; with several SHCs occurring concurrently.³ SHCs have also been found to endure,⁴ with a high prevalence of SHCs evident more than 10 years after a SCI.⁵

Individuals with SCI perceive many SHCs to be preventable.⁶ Nevertheless, SHCs are a leading cause of rehospitalisation,⁷ and have been found to contribute to the higher rates of morbidity and mortality evident among SCI populations.^{8,9} SHCs affect the capacity of individuals with SCI to maintain their autonomy, health, and wellbeing; negatively impacting on quality of life and participation in activities of daily living.^{3,10} Treatment of SCI-related SHCs also contributes an

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economic burden of SCI for society,¹¹ and for individuals and their families.¹²

Although a number of studies have investigated risk factors for the development of SHCs,^{4,13–15} few studies have examined outcomes associated with SHCs. In the Netherlands, among 282 individuals with a SCI that had occurred at least 10 years earlier, musculoskeletal pain, pressure ulcers, spasticity, and constipation were independently associated with lower quality of life.⁵ In a smaller sample of 56 U.S. adults with SCI, 75% identified that their most problematic SHC had a significant negative impact on their social participation and 64% perceived a negative impact on their daily life.³

Only three studies have described the effect of SHCs on physical functioning.^{16–18} In addition to level and completeness of SCI, the total number of SHCs was a significant predictor of functioning in a community sample of 318 people in the Netherlands 3.6 years post-SCI.¹⁶ Among 340 participants from the Canadian Rick Hansen Spinal Cord Injury Registry, health conditions at 9–18 months post-SCI (including pre-SCI comorbidities and post-SCI complications) were cross-sectionally associated with poor motor scores, worse physical and mental health, reduced function, and low levels of life satisfaction.¹⁷ Higher disability and tetraplegia were significantly associated with total number of self-reported SHCs in a cross-sectional survey of people with traumatic and non-traumatic SCI living in Australia.¹⁸ Each of these studies investigated the contribution of the overall number of SHCs or comorbidities reported by participants, rather than the contribution of specific conditions.

Studies are yet to explore relationships between SHCs and outcomes prospectively. This is necessary to determine whether early prevention of SHCs would contribute to improving the long-term health and wellbeing of people with SCI. Prospective research would also help to identify temporal relationships between SHCs and the development of poor outcomes; current cross-sectional findings cannot provide information on whether SHCs precede poor outcomes or vice versa.

One outcome that has received limited attention in the SCI literature is disability. No published study appears to have examined the relationship between SHCs and disability using a validated disability-specific measure. The extent to which SHCs relate to disability is important as greater disability is likely to necessitate more contact with healthcare providers and increased costs for the health sector, and places a higher level of burden on individuals and their families over time.¹⁹ Furthermore, there are opportunities to prevent SHCs

post-SCI, such as through improved access to maintenance rehabilitation for at-risk individuals,¹² unlike other factors (e.g. level of SCI impairment) that are strongly associated with disability outcomes.²⁰

The aims of this study were to: (1) describe disability over time among New Zealanders with a recently diagnosed SCI; (2) examine the prevalence of 14 commonly-reported SHCs over time; and (3) investigate the contributions of specific SHCs experienced at 6 months post-SCI to longer-term disability.

Methods

Design

This investigation uses data from the ‘Longitudinal Study of the Life Histories of People with Spinal Cord Injury’ study (HRC 07/302), which has been detailed elsewhere,²¹ but is briefly described below. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Participants

Between 2007 and 2009, individuals aged 16–64 years admitted to either of New Zealand’s two spinal units with a new (first) SCI were invited to participate in the study. People were ineligible to participate if: their multi-disciplinary clinical team identified cognitive or communication problems or other diagnoses (e.g. psychosis) precluding participation; they had a prognosis of likely death within 6 months; they were not New Zealand (NZ) residents; or they had no neurological damage to their spinal cord.

Procedure

Nurses at each spinal unit collected the demographic and clinical information of all individuals admitted with SCI across the study period, including dates of birth, SCI and admission, sex, ethnicity, and ASIA Impairment Scale (AIS) grade.²⁰ Nurses gave a letter of invitation to eligible individuals, explaining that participation would involve three follow-up telephone interviews. Contact details of potentially interested people were then provided to the study team, and trained interviewers contacted participants to collect their consent and to schedule each interview. The interviewers were people with lived experience of SCI.²²

During the first interview participants were asked about their pre-SCI socio-demographic characteristics using questions from the 2006 Census,²³ as well as their pre-SCI health status, income, and material standard of living. At each interview participants completed a number of standardized questionnaires designed to

measure health and behavioral characteristics, post-SCI symptoms, and disability.²¹ The focus of this paper is on the relationship between specific SHCs and disability.

Measures

SHCs were measured using an adapted version of the Secondary Complications Survey²⁴; to reduce participant burden and following feedback from a group of New Zealanders with lived experience of SCI, 14 of the 17 SHCs listed in the survey were evaluated. Participants rated each item according to incidence and severity (response options: ‘I don’t have this problem’, ‘Problem is not at all/slightly/moderately/greatly bothersome’). The 14 SHCs were: leg swelling, leg spasms, shortness of breath, difficulty coughing, bowel constipation, diarrhea, indigestion, urinary tract infection (UTI), urinary incontinence, bladder program problems, headaches, back pain, shoulder pain, and pain below injury level.

Disability was assessed using the 12-item World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0).²⁵ This measure consists of 12 items that assess function in six key domains – cognition, mobility, self-care, interpersonal relationships, daily activities (household and work), and participation. Each item is self-rated on a 5-point scale, ranging from ‘none’ (0) to ‘extreme’ (4). Ratings are summed to calculate a total score ranging from 0 (no disability) to 48 (maximum disability), with higher scores indicating greater functional limitations.²⁶ The WHODAS 2.0 has been identified as a valid and reliable instrument for assessing disability across a variety of settings and populations.^{27,28}

Data analysis

Statistical analyses were completed using Stata[®] 15.1.²⁹ Associations between baseline characteristics and participation in all three interviews were assessed using chi-square tests. Descriptive statistics were used to examine disability scores at each time-point across a range of sociodemographic and SCI impairment characteristics. Descriptive statistics also examined SHCs and disability scores over time. For this, responses for each SHC were dichotomized into two groups: ‘no problem’ and ‘any problem, regardless of associated ‘bother’’. Finally, multiple linear regression analyses were undertaken to examine the contributions of each SHC to disability at every interview time point (cross-sectional relationships), and the contributions of each SHC at 6 months to disability at each subsequent interview time point (longitudinal relationships), after controlling for potential confounders, including sex,

age, and AIS grade. These potential confounders were included as independent variables in each regression model. Complete case analyses were conducted in all instances.

Results

Clinical data was collected on 238 people with SCI. Of these people, 76 were ineligible to participate (aged under 16 years, $n = 10$; aged over 64 years, $n = 42$; unable to communicate, $n = 7$; advised not to approach, $n = 3$; died, $n = 1$; non-resident, $n = 8$; no neurological damage, $n = 3$; prognosis less than 6 months survival, $n = 2$). Of the 162 people eligible, 118 participated in the initial study interview (73% response rate); 15 people declined to take part and 29 were non-contactable despite multiple contact attempts.

Interviews occurred approximately 6, 18, and 30 months post-SCI. Specifically, the first interview occurred 6.5 months (mean) from the date of SCI (median = 6.4; interquartile range (IQR) = 4.8–7.6 months). Of the 118 participants who completed the first interview, 103 (87%) participated in the second interview approximately 18 months post-SCI (mean = 16.5; median = 16.5; IQR = 15.0–17.6 months). Ninety-one participants (77%) completed the final interview approximately 30 months post-SCI (mean = 31.5; median = 30.2; IQR = 29.2–32.8 months).

Among the 27 people who did not complete all three interviews, 2 died, 4 declined, 1 left the country, and 20 could not be contacted. A greater proportion of people of Māori or Pacific ethnicity ($P = 0.03$), or with a more severe AIS grade ($P = 0.03$) did not complete all three interviews (Table 1). No significant differences in the proportions of participants with specific SHCs at 6 months were detected between those who completed every interview and those who did not.

Participant characteristics

The majority of participants completing all three interviews were male, of NZ European ethnicity, married or living with a partner, and in paid employment prior to their SCI (Table 1). Twenty-four (26%) of the 91 participants completing all three interviews had a complete SCI (as indicated by AIS grade A), while 67 (74%) had an incomplete SCI. The mean age at time of SCI was 41 years.

Disability

Average disability scores increased over time, with lower disability reported at 6 months post-SCI (Mean = 19.7, Standard Deviation (SD) = 10.0), compared to 18

Table 1 Associations between pre-SCI and SCI characteristics and participation in all three interviews – *n* (%).

	Total (<i>n</i> = 118)	Completed all interviews (<i>n</i> = 91)	Did not complete all interviews (<i>n</i> = 27)	<i>P</i>
<i>Pre-SCI characteristics</i>				
Sex				
Male	90 (76)	69 (76)	21 (78)	0.83
Female	28 (24)	22 (24)	6 (22)	
Age (years)				
16–24	21 (18)	16 (18)	5 (18)	0.91
25–34	21 (18)	16 (18)	5 (18)	
35–44	24 (20)	17 (19)	7 (26)	
45–54	28 (24)	23 (25)	5 (19)	
55–64	24 (20)	19 (20)	5 (19)	
Ethnicity				
Non-Māori/non-Pacific	85 (72)	71 (78)	14 (52)	0.03
Māori	23 (20)	14 (15)	9 (33)	
Pacific	10 (8)	6 (7)	4 (15)	
Marital Status				
Married/living with partner	64 (54)	53 (58)	11 (41)	0.43
Single	35 (30)	26 (29)	9 (33)	
Divorced/widowed	17 (14)	12 (13)	5 (19)	
Missing	2 (2)	0 (0)	2 (7)	
Education				
None	34 (29)	23 (25)	11 (41)	0.11
School	21 (18)	19 (21)	2 (7)	
Post-secondary	59 (50)	48 (53)	11 (41)	
Missing	4 (3)	1 (1)	3 (11)	
Employment				
Full time paid employment	92 (78)	71 (78)	21 (78)	0.75
Part time paid employment	6 (5)	4 (4)	2 (7)	
Benefit	9 (8)	8 (9)	1 (4)	
Other	11 (9)	8 (9)	3 (11)	
Adequacy of Income				
More than enough/enough	82 (70)	69 (76)	13 (48)	0.07
Just enough/not enough	32 (27)	22 (24)	10 (37)	
Missing	4 (3)	0 (0)	4 (15)	
<i>SCI-related characteristics</i>				
ACC support				
Yes	93 (79)	74 (81)	19 (70)	0.22
No	25 (21)	17 (19)	8 (30)	
AIS at discharge				
A	36 (31)	24 (26)	12 (44)	0.04
B	9 (8)	5 (6)	4 (15)	
C	10 (8)	10 (11)	0 (0)	
D	63 (53)	52 (57)	11 (41)	

Note. AIS, American Spinal Injury Association (AISA) Impairment Scale; ACC, Accident Compensation Corporation (NZ's universal no-fault accidental injury compensation scheme); SCI, spinal cord injury.

(Mean = 27.7, SD = 10.1) and 30 months (Mean = 26.2, SD = 9.8).

Variation in disability scores across participants' sociodemographic characteristics is presented in Table 2. Female participants had a tendency towards higher average disability scores at 30 months than male participants. Participants in the 35–44 year age group tended to report greater disability than participants in other age groups. Participants of Pacific ethnicity reported higher average disability than participants of non-Māori/non-Pacific, or Māori, ethnicity at each assessment point. Participants with no formal education reported higher disability at every interview, while participants receiving a benefit (income-tested financial assistance from the NZ government available to individuals unable to work)

had higher average disability at 18 and 30 months than those who were in paid employment pre-SCI. Participants who did not receive support from the Accident Compensation Corporation (ACC; New Zealand's universal no-fault accidental injury compensation scheme) for their SCI tended to have higher disability scores at 30 months than those who did receive ACC support. Individuals with a more severe injury (as indicated by AIS grade) also reported higher average disability at every interview.

Secondary health conditions

The prevalence of SHCs over time is presented in Table 3. The most commonly reported SHC was leg spasm, with 76% of participants experiencing this

Table 2 Participant characteristics and disability scores at each interview.

	6 Months (n = 118) Mean WHODAS (CI)	18 Months (n = 103) Mean WHODAS (CI)	30 Months (n = 91) Mean WHODAS (CI)
Sex			
Male	19.21, 17.10–21.32	27.58, 25.31–29.86	25.42, 23.05–27.79
Female	21.11, 17.26–24.96	27.88, 23.62–32.13	28.50, 24.32–32.68
Age (years)			
16–24	18.43, 13.68–23.17	24.53, 20.57–28.48	22.44, 17.15–27.72
25–34	18.43, 13.66–23.20	24.71, 18.96–30.46	24.25, 19.19–29.38
35–44	23.29, 19.37–27.21	34.15, 30.18–38.12	31.59, 27.40–35.78
45–54	18.43, 15.18–21.68	26.38, 22.38–30.37	25.83, 21.70–29.95
55–64	19.63, 14.72–24.53	28.09, 23.46–32.71	26.47, 21.51–31.44
Ethnicity			
Non-Māori/non-Pacific	19.71, 17.46–21.95	27.46, 25.14–29.78	25.80, 23.50–28.10
Māori	16.91, 13.13–20.69	26.19, 21.54–30.84	25.29, 19.58–30.99
Pacific	25.60, 20.32–30.88	33.14, 25.64–40.65	32.50, 22.22–42.78
Marital status			
Married	20.00, 17.61–22.39	28.83, 26.33–31.33	27.40, 24.73–30.06
Single	17.91, 14.11–21.72	25.21, 21.39–29.03	23.38, 19.37–27.40
Divorced/widowed	20.76, 16.75–24.78	27.64, 20.93–34.36	26.75, 20.67–32.83
Education			
None	21.91, 18.51–25.31	29.19, 25.49–32.88	28.26, 24.25–32.27
School	19.00, 14.42–23.58	26.60, 21.73–31.47	24.95, 20.29–29.61
Post-secondary	18.41, 15.90–20.91	27.39, 24.58–30.20	25.94, 23.02–28.85
Employment			
Full time	19.15, 17.14–21.17	27.76, 25.51–30.02	26.08, 23.75–28.42
Part time	19.67, 3.73–35.61	23.20, 6.98–39.42	18.50, 11.44–25.56
Benefit	21.56, 14.50–28.61	31.50, 23.06–39.94	33.13, 26.64–39.61
Other	22.36, 15.00–29.73	25.90, 19.98–31.82	23.75, 15.68–31.82
Adequacy of income			
Enough	18.70, 16.46–20.93	26.75, 24.37–29.13	25.41, 23.06–27.75
Not enough	21.34, 18.11–24.57	29.88, 26.14–33.62	28.55, 24.24–32.85
ACC support			
Yes	19.63, 17.60–21.67	27.16, 24.97–29.35	25.26, 23.01–27.50
No	19.76, 15.33–24.19	29.57, 24.75–34.40	30.12, 25.21–35.03
AIS at discharge			
A	25.22, 22.33–28.12	33.97, 31.07–36.87	33.00, 29.61–36.39
B	24.78, 20.75–28.80	35.33, 27.21–43.45	34.60, 24.08–45.12
C	21.10, 16.22–25.98	28.20, 24.00–32.40	30.90, 23.99–37.81
D	15.52, 13.02–18.03	23.04, 20.45–25.63	21.29, 19.12–23.45

Note. AIS, American Spinal Injury Association (AISA) Impairment Scale; ACC, Accident Compensation Corporation (NZ's universal no-fault accidental injury compensation scheme); CI, 95% confidence interval; WHODAS, World Health Organization Disability Assessment Schedule.

SHC at 6 months, 75% at 18 months, and 78% at 30 months. Back pain, constipation, pain below the level of SCI, and shoulder pain were also frequently reported at every assessment point. In fact, the proportion of participants experiencing each SHC increased over time in most instances.

Cross-sectional associations between secondary health conditions and disability

Results of regression models investigating the relationship between each SHC and disability scores at each interview time point are presented in Table 4. Shortness of breath was significantly associated with higher disability at 6 months, as was difficulty coughing, constipation, UTI, urinary incontinence, headaches, back pain, shoulder pain, and pain below the SCI

level. At 18 months, leg swelling, shortness of breath, UTI, bladder problems, headaches, back pain, and pain below the level of SCI were each associated with higher disability scores. SHCs significantly associated with disability at 30 months post-SCI included leg spasms, shortness of breath, difficulty coughing, UTI, headaches, shoulder pain, and pain below the SCI level.

Longitudinal associations between secondary health conditions and disability

Results of regression models investigating the relationship between each SHC at 6 months and disability scores at each subsequent assessment point are presented in Table 5. Back pain and pain below the SCI level were significantly associated with increased disability at 18 months. Difficulty coughing at 6 months was

Table 3 Prevalence of secondary health conditions at each interview – *n* (%).

Secondary health condition	6 Months (<i>n</i> = 118)	18 Months (<i>n</i> = 103)	30 Months (<i>n</i> = 91)
Leg swelling			
No problem	60 (51)	61 (60)	48 (53)
Any problem	57 (49)	41 (40)	43 (47)
Leg spasms			
No problem	27 (23)	25 (25)	20 (22)
Any problem	90 (77)	77 (75)	71 (78)
Shortness of breath			
No problem	73 (63)	59 (58)	52 (57)
Any problem	43 (37)	43 (42)	39 (43)
Difficulty coughing			
No problem	68 (58)	70 (69)	61 (67)
Any problem	49 (42)	32 (31)	30 (33)
Bowel constipation			
No problem	43 (37)	43 (42)	34 (37)
Any problem	73 (63)	59 (58)	57 (63)
Diarrhea			
No problem	82 (71)	71 (70)	70 (77)
Any problem	34 (29)	31 (30)	21 (23)
Indigestion			
No problem	87 (75)	80 (78)	64 (70)
Any problem	29 (25)	22 (22)	27 (30)
Urinary tract infection			
No problem	79 (68)	74 (73)	67 (74)
Any problem	38 (32)	28 (27)	24 (26)
Urinary incontinence			
No problem	77 (66)	76 (75)	60 (66)
Any problem	40 (34)	26 (25)	31 (34)
Bladder problems			
No problem	81 (70)	73 (72)	68 (75)
Any problem	35 (30)	29 (28)	23 (25)
Headaches			
No problem	79 (68)	70 (69)	57 (63)
Any problem	37 (32)	32 (31)	34 (37)
Back pain			
No problem	36 (31)	38 (38)	33 (36)
Any problem	81 (69)	63 (62)	58 (64)
Shoulder pain			
No problem	52 (44)	55 (54)	34 (38)
Any problem	65 (56)	46 (46)	56 (62)
Pain below SCI			
No problem	40 (35)	43 (42)	37 (41)
Any problem	73 (65)	59 (58)	53 (59)

significantly associated with increased disability at 30 months. Constipation, UTI, and headaches at 6 months were significantly associated with increased disability at 18 and 30-month interviews.

Discussion

This prospective cohort study completed by 91 individuals who had experienced a ‘first’ SCI suggests that SHCs are prevalent early after injury, and remain elevated over time. Leg spasms, constipation, back pain, pain below the level of SCI, and shoulder pain were the most frequently reported SHCs at 6, 18, and 30 months post-SCI. Self-reported disability scores were found to increase at each assessment point. Several SHCs at 6 months were found to contribute to disability,

even after adjusting for sex, age, and SCI severity. Shortness of breath, urinary incontinence, and shoulder pain were significant predictors of disability at 6 months, while difficulty coughing, constipation, UTI, and headaches predicted disability up to 30 months following initial SCI. Back pain and pain below the SCI level at 6 months predicted disability scores at 18 months post-SCI. Constipation, UTI, and headaches at 6 months were consistently related to disability at every time point. These findings are the first to demonstrate a relationship between SHCs experienced early after SCI and subsequent disability, highlighting key targets for preventive interventions.

A number of studies have also documented a high prevalence of SHCs over time among people with SCI. Consistent with our findings, a study examining SHCs at 1, 2, and 5 years post discharge from inpatient rehabilitation for SCI found neuropathic pain, musculoskeletal pain, and UTI to be the most frequently reported SHCs.⁴ In a separate investigation of 212 people with SCI followed up to 1 year after spinal unit discharge, the majority of participants reported neuropathic and musculoskeletal pain and spasticity. Approximately 49% of participants experienced UTIs and 36% were bothered by pressure sores.¹⁵ While spasticity, pain, and pressure sores are frequently identified in the first years following SCI,^{30,31} estimates of prevalence vary.⁴ This may be attributable to differences in data collection methods (e.g. physical examination versus self-report), the types of SHCs investigated, duration of follow-up, and population characteristics.

The increase in participants reporting SHCs over time in our study is to be expected in light of prior evidence that SHCs increase with time since SCI.^{32,33} Increasing disability over time among people with SCI has also been documented.³² The degree of disability reported by people with SCI, including participants in the present study, is profound; previous research examining normative data for the 12-item WHODAS 2.0 suggests that individuals scoring 10–48 on this measure are in the top 10% of the population with respect to their scores, and are likely to have clinically significant disability.²⁶ Seventy-seven percent of our study participants reported a score over 10 approximately 6 months after their injury, and this had increased to 100% of participants by 30 months post-injury. By comparison, a large longitudinal cohort study of individuals with diverse types of injuries found that only 13% of 2184 participants had scores greater than 10 on the WHODAS 24 months after injury.³⁴ In our study, the presence of a number of SHCs was cross-sectionally associated

Table 4. Relationship between the experience of secondary health conditions and disability scores at each interview.

	6 Months			18 Months			30 Months		
	<i>B</i>	SE (<i>B</i>)	<i>P</i>	<i>B</i>	SE (<i>B</i>)	<i>P</i>	<i>B</i>	SE (<i>B</i>)	<i>P</i>
Leg swelling	3.07	1.73	0.08	5.18	1.75	0.00	3.32	1.78	0.07
Leg spasms	3.30	2.04	0.11	2.60	2.10	0.22	5.41	2.11	0.01
Shortness of breath	4.17	1.97	0.04	3.43	1.72	0.05	6.36	1.70	0.00
Difficulty coughing	5.85	1.90	0.00	3.55	2.04	0.09	6.38	2.09	0.00
Constipation	3.62	1.77	0.04	1.69	1.73	0.33	0.63	1.87	0.74
Diarrhea	0.75	1.88	0.69	-2.08	1.86	0.27	3.36	2.07	0.11
Indigestion	2.64	2.03	0.20	3.54	1.99	0.08	2.90	1.89	0.13
Urinary tract infection	5.60	1.79	0.00	3.72	1.88	0.05	6.31	1.88	0.00
Urinary incontinence	4.54	1.79	0.01	3.45	1.98	0.09	1.78	1.88	0.35
Bladder problems	1.50	1.92	0.44	4.41	1.82	0.02	1.85	2.03	0.36
Headaches	3.98	1.85	0.03	4.07	1.75	0.02	3.80	1.74	0.03
Back pain	4.82	1.88	0.01	5.12	1.68	0.00	1.96	1.82	0.29
Shoulder pain	4.55	1.81	0.01	1.96	1.80	0.28	3.89	1.90	0.04
Pain below SCI	4.58	1.95	0.02	3.85	1.80	0.04	5.12	1.82	0.01

Note. SHC, secondary health condition. Results of each model are presented after adjusting for sex, age, and AIS grade. *B* is the regression coefficient representing the increase in mean disability score among those with a SHC compared to those without, SE (*B*) is the standard error of *B*, and *P* is the P-value testing for *B* = 0.

with higher disability scores, in addition to large increases in subsequently reported disability. For example, experiencing headaches at 6 months was related to more than a five-point increase in average disability scores at 30 months, while difficulty coughing and UTI were also linked to an almost five-point increase in disability scores at this time point.

Three previous studies identified clear cross-sectional relationships between number of SHCs and health, with a higher number of SHCs related to reduced function

and poor overall health status.¹⁶⁻¹⁸ However, it appears that no other studies identified the contribution of individual SHCs to disability status. Nevertheless, there is evidence to suggest that different SHCs can have unique relationships with other outcomes among people with SCI. For example, a prospective U.S. cohort study made use of data within the National Death Index to demonstrate that a history of chronic pressure ulcers, amputations, a depressive disorder, symptoms of infections, and hospitalization within the past year were significant predictors of lost life expectancy and mortality in a sample of 1361 adults with traumatic SCI.⁸ Pressure ulcers have been identified as particularly problematic; 65% of 381 Canadian individuals with traumatic SCI who were experiencing pressure ulcers reported reduced activity, including participation in community and daily activities, and a higher number of consultations with family doctors, nurses, occupational therapists, and wound care nurses/specialists.³⁵

The prospective nature of our study made it possible to examine relationships between SHCs reported early after SCI and disability over time. Difficulty coughing, constipation, UTI, headaches, back pain, and pain below the SCI at 6 months predicted higher levels of disability at subsequent follow-ups. Respiratory complications have been identified as a leading cause of mortality³⁶ and economic burden³⁷ in people with SCI. Previous research has also found constipation to be related to lower quality of life,⁵ while difficulties with bowel function have been associated with reduced mobility, greater dependence on others for toileting, and high psychological distress among individuals

Table 5 Relationship between the experience of secondary health conditions at 6 months and disability scores at each subsequent interview.

	18 Months			30 Months		
	<i>B</i>	SE (<i>B</i>)	<i>P</i>	<i>B</i>	SE (<i>B</i>)	<i>P</i>
Leg swelling	2.68	1.77	0.13	2.57	1.81	0.16
Leg spasms	2.55	2.07	0.22	3.59	2.05	0.08
Shortness of breath	1.61	2.04	0.43	3.48	1.96	0.08
Difficulty coughing	2.95	2.05	0.15	4.70	2.01	0.02
Constipation	3.59	1.83	0.05	4.13	1.81	0.03
Diarrhea	1.11	1.98	0.58	1.27	1.99	0.53
Indigestion	1.94	2.14	0.37	1.69	2.12	0.43
Urinary tract infection	3.90	1.87	0.04	4.82	1.79	0.01
Urinary incontinence	1.10	1.90	0.56	2.83	1.85	0.13
Bladder problems	2.50	1.98	0.21	1.87	2.01	0.35
Headaches	3.86	1.87	0.04	5.49	1.84	0.00
Back pain	3.96	1.94	0.04	2.57	1.93	0.19
Shoulder pain	2.08	1.89	0.27	1.55	1.87	0.41
Pain below SCI	4.71	1.93	0.02	3.74	1.95	0.06

Note. SHC, secondary health condition. Results of each model are presented after adjusting for sex, age, and AIS grade. *B* is the regression coefficient representing the increase in mean disability score among those with a SHC compared to those without, SE (*B*) is the standard error of *B*, and *P* is the P-value testing for *B* = 0.

with chronic SCI.³⁸ Urinary tract infections have been associated with increased risk for nosocomial infections, and interfere with rehabilitation following SCI; they can also lead to secondary urologic conditions.³⁹ Headaches have previously been identified as a source of pain among individuals with SCI, and are often associated with the experience of autonomic dysreflexia.⁴⁰ In a prospective cohort study of 100 people, those with neuropathic pain below the level of SCI were most likely to report their pain as severe or excruciating in the first 6 months following SCI.⁴¹ A follow-up of 73 participants at 5 years post-SCI found that those with pain rated their global self-rated health and mood as significantly worse than those with no pain.⁴² Our findings demonstrate that these SHCs also predict greater perceived disability 30 months post-SCI.

Strengths and limitations

This study has several strengths, including a prospective design, a high participation rate, and limited loss to follow-up over a long study period. All participants were early post-injury when recruited; because of this we can be sure that variation in years living with SCI is not responsible for the relationships found. In addition, we adjusted for SCI impairment, an important confounder given well-established associations between AIS grade and disability.²⁰

There are also several limitations to consider. Our study sample was small which reduced statistical power and limited the number of potential confounders we could examine in each regression model. Furthermore, the sample was restricted to individuals aged 16–65 years, which affects the degree to which results can be generalized to all people living with SCI. Our SHC measure did not include an exhaustive list of SHCs. For example, pressure sores were not assessed at each time point; which are known to have important relationships with outcomes among people with SCI.^{43,44} People of Māori or Pacific ethnicity, or with a more severe AIS grade, were less likely to complete all three interviews. Given that these characteristics were associated with higher mean disability scores at each interview, it is possible that our findings may underestimate the relationship between SHCs and subsequent disability. It is also possible that the 12–18-month intervals between interviews may have resulted in the under-reporting of SHCs. Nevertheless, our findings provide new knowledge regarding the long-term impact of SHCs on self-reported disability. Relationships between these SHCs and other outcomes, such as quality of life and psychological wellbeing, should be explored in future longitudinal investigations.

Implications

The results of this study have several clinical implications. They suggest that in order to minimize disability in the first 2.5 years post-SCI, back pain, pain below the SCI level, difficulty coughing, constipation, UTI, and headaches are important SHCs to identify and treat. Shortness of breath, urinary incontinence, and shoulder pain are also important to address in the first 6 months post-SCI because of the direct relationship between these SHCs and disability. Optimum management of SHCs could be achieved through regular follow-up care for people with SCI following discharge from inpatient rehabilitation units, with care provided by multidisciplinary SCI specialists. The high prevalence of SHCs that continue to be reported many years following initial SCI⁵ suggest that current methods of follow-up care may be insufficient, and that enhanced monitoring is needed.^{32,45} People with SCI identify SHCs to be a top priority,⁴³ and report high levels of unmet need with regard to SHC management. For example, assistance to alleviate pain was identified as a primary area of unmet need in a community sample comprised of people with SCI from the United Kingdom, Germany, Austria, and Switzerland.⁴⁶ While there is preliminary evidence for the effectiveness of patient education designed to decrease the prevalence of pressure ulcers⁴⁷ and UTIs,⁴⁸ further research is required to explore a broader range of interventions for SHCs, using rigorous methodological approaches.⁴⁹

Conclusions

Secondary health conditions are prevalent in the initial months following a SCI and remain so up to 30 months later. Secondary health conditions are related to disability post-SCI, with back pain, pain below the SCI level, difficulty coughing, constipation, UTI, and headaches predictive of increased future disability. The high prevalence of SHCs, and their relationships with disability over time, suggest that interventions to prevent SHCs among people with SCI are urgently needed. Enhanced follow-up of people with SCI following discharge into the community may increase access to rehabilitation opportunities for those in need. This may help to prevent the development of SHCs and improve the management of existing conditions, reducing long-term disability as a consequence.

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