REVIEW

Frequency and age effects of secondary health conditions in individuals with spinal cord injury: a scoping review

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Study design: Scoping review.

Objectives: To gain a better understanding of the prevalence, course and association with age of secondary health conditions in individuals with spinal cord injury (SCI).

Setting: Seattle, Washington, USA.

Methods: We performed searches of electronic databases for studies published from 1986–2011 that provided information regarding the prevalence, course or associations with age and duration of secondary health conditions in individuals with SCI.

Results: Ninety-two studies were included. The findings indicate that: (1) individuals with SCI experience a number of secondary health conditions, many of which occur at a higher rate in those with SCI than the normative population; (2) the most common conditions or symptoms are pain, bowel and bladder regulation problems, muscle spasms, fatigue, esophageal symptom and osteoporosis; (3) a number of conditions, including cardiovascular disease, diabetes, bone mineral density loss, fatigue and respiratory complications or infections, occur with higher frequency in older individuals or those with longer SCI duration, relative to younger individuals or those with shorter SCI duration; and (4) there is a marked lack of longitudinal research examining the natural course of health conditions in individuals aging with SCI.

Conclusions: The findings support the conclusion that individuals with SCI show signs of ‘premature aging’ in different organ systems. Longitudinal research is needed to understand when problems are most likely to emerge, and to develop and test the efficacy of interventions to prevent these health conditions and their negative impact.

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INTRODUCTION

Research supports the conclusion that individuals with spinal cord injury (SCI) develop and experience a number of secondary health conditions as a result of having a SCI.^{1–3} The Institute of Medicine defines secondary condition as, ‘a condition that is causally related to a disabling condition (that is, occurs as the result of a primary disabling condition) and that can either be a pathology, an impairment, a functional limitation or an additional disability (p.214).⁴ In addition, clinicians and researchers have noted that many individuals with physical disabilities—including individuals with SCI—show evidence of earlier onset of some health conditions usually associated with aging (for example, diabetes and cardiovascular disease), as well as a steeper slope with respect to the increase in severity or frequency of a number of health conditions in individuals with SCI relative to nondisabled age-matched peers. This pattern is often referred to in the literature as ‘premature aging.’^{2,5–7}

However, although there are a number of important reviews of research on of health conditions in individuals aging with SCI, previous reviews have been either systematic reviews focused on the specific questions regarding evidence for ‘premature aging’² or narrative reviews focused on evidence regarding general bodily systems thought to be influenced by aging.^{8–11} To our knowledge, there is no review that has summarized the state of knowledge

regarding the overall frequency and course of secondary health conditions in individuals with SCI, and the associations of each of these conditions with age and time with SCI (duration). Such a review would be useful for (1) knowing when, following a SCI, these conditions are most likely to emerge and if they are likely to worsen, resolve or remain stable over time; (2) identifying the conditions that might be the most common and important to patients in order to select those that should be the primary targets of treatment for enhancing community participation and quality of life; and (3) identifying knowledge gaps with respect to the incidence, course and impact of these conditions. The purpose of this scoping review is to better understand what is known regarding secondary health conditions in individuals with SCI, focusing on the prevalence, course, association with age and duration, as well as comparison with nondisabled samples.

MATERIALS AND METHODS

Search criteria

A scoping review is a technique to ‘map’ an area of relevant literature that provides comprehensive coverage but extracts a limited amount of information from published studies.¹² A scoping review differs from a systematic review in two important ways. Systematic reviews usually focus on a specific and well-defined question. On the other hand, scoping reviews address broader topics.

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Second, systematic reviews tend to include a relatively narrow range of high-quality studies; whereas, scoping reviews tend not to assess the quality of included studies. Thus, systematic reviews tend to provide more definitive answers to very specific questions, while scoping reviews tend to provide a broader range of information that is less definitive. In this way, scoping reviews can be more useful than systematic reviews for identifying trends and areas in need of future more focused study.

This review extracted information related to (1) the prevalence of secondary health conditions, (2) associations between the prevalence or severity of the conditions and both age and SCI duration and (3) the time course of the conditions. We also limited the search to information about secondary conditions that emerged 1 or more years following the injury. This limitation identifies chronic conditions that are associated with having a SCI, but that are not necessarily related to conditions associated with the original injury that may resolve in the first year. We searched for peer-reviewed studies in PubMed, CINAHL and PsycINFO, using 76 specific search terms to identify articles that might include information about secondary conditions (the list of search terms used is available from the corresponding author), searching for each condition independently. We restricted the search to articles published in English between 1986 and 2011 and that included information about human adults (>18 years of age) with SCI. This initial approach identified 2456 articles.

Criteria and methods for inclusion

Two reviewers screened the abstracts of the 2456 articles identified to find studies published in peer-reviewed journals that met the following inclusion criteria:

1. The primary purpose of the article addressed the prevalence, incidence, frequency or course of a secondary health condition, or association of the condition with age or SCI duration.
2. The primary focus of the article was on a secondary condition or conditions occurring 1 or more years post injury.
3. The sample size of study participants with SCI was greater than 5, and the results for study participants with SCI had to be reported separately.

Any study that did not meet these criteria was excluded from further review. If the reviewers could not make a determination about inclusion, then data from the article extracted for further consideration. Based upon these criteria, 191 empirical studies were identified and data from these articles were extracted for the review.

Data extraction and outcome measures

The data extracted from the full-text articles included information about the research design, sample demographics, domains measured and any findings regarding the frequency or prevalence, severity, time course, and/or age and duration effects of a health condition. We compiled the information in a Microsoft Access database specifically designed for this project. An additional reviewer confirmed the accuracy of extracted data. By consensus of the authors, we excluded an additional 99 articles, where the full-text did not provide sufficient details about the prevalence, course or association of health conditions with age or duration. Thus, the total number of included articles is 92.

RESULTS

Prevalence and importance

Table 1 summarizes the key findings from the 92 articles regarding prevalence of specific secondary health conditions in adults with SCI. Table 2 summarizes key findings regarding the relative frequency or importance of secondary health in studies where multiple conditions were examined in the same sample (which makes direct comparisons in relative frequency and importance possible).

The most common conditions or symptoms (often reported with a 50% or more prevalence; see Tables 1 and 2) are pain, bowel and bladder regulation problems, muscle spasms, fatigue, heart burn and osteoporosis. Other common problems (often reported with a

25–50% prevalence) include pressure ulcers, obesity, excessive sweating, depression, cardiovascular problems, bone fractures/falls, problems with sexual activity, intermittent dysphagia and dental/oral problems. The least frequent conditions studied—many of which are still serious health conditions when they occur—include diabetes, respiratory problems, including respiratory infections and shortness of breath, heterotopic ossification, sleep problems including obstructive sleep apnea, contractures, low blood pressure, autonomic dysreflexia and thrombosis. People with SCI reported bowel and bladder regulation problems, spasms, pain and problems with sexual activity as most important (see Table 2). The most common secondary conditions that led to hospitalizations are urinary complications, pressure sores, respiratory problems, contractures, bowel complications, pain and fractures.

Age and duration effects

A number of studies examined the concurrent associations between chronological age or time since injury and the frequency or severity of the health conditions studied. Although age and SCI duration are not the same construct, they are related; depending on a person's age at injury, SCI duration and chronological age can be strongly associated. Because of this association, when one of these time-related variables is not controlled for in an analysis—which is the case in almost all of the studies reviewed—it is not possible to know for certain if a significant effect is due to chronological age or duration of SCI.¹³ Still, if age or duration evidence significant associations with the prevalence of the condition, they may be considered important risk factors, even if the presence of a significant association cannot be used to prove that a causal relationship exists. As a corollary, the lack of a significant association can be used as evidence that a causal relationship between age or duration and condition prevalence is unlikely.

Seven consistent findings were identified in studies where the associations were examined in two or more studies. In adults with SCI: (1) bladder problems were not found to be associated with duration; (2) spasms were not associated with duration; (3) cardiovascular disease is more prevalent in older individuals; (4) diabetes was more prevalent in older individuals; (5) bone mineral density (BMD) loss was higher in both older individuals and in individuals with longer duration; (6) older individuals reported more fatigue; and (7) respiratory complications/infections were more prevalent in older individuals.

There were a fair number of conditions where an age or duration effect was examined in only one study, making it difficult to draw conclusions regarding the consistency of these effects. Significant associations were found for age with respect to fecal incontinence (older individuals report more fecal incontinence), body mass index (older individuals report higher BMI) and prevalence of obstructive sleep apnea (obstructive sleep apnea is more prevalent in older individuals). Duration was found to be significantly associated with depression (negative association), fatigue (older at injury associated with more fatigue), contractures (longer duration associated with more contractures) and falls (shorter duration associated with more falls). Non-significant effects were found for age and thrombosis, and non-significant effects were found for duration and constipation.

Nine conditions were identified where a significant association was found in some studies with age or duration, and non-significant association in others. When significant, positive associations (older age or more duration) were found for chronic pain, pressure ulcers, bladder problems, autonomic dysreflexia, spasms, fecal incontinence and heterotopic ossification. Significant negative associations (younger age associated with higher frequency or severity) were

Table 1 Key findings concerning frequency, age, and duration effects, course, and frequency or severity relative to normative values or samples of secondary health conditions in individuals with spinal cord injury

Condition	Articles (no.)	Publication years	Sample size ^a (range)	Prevalence	Summary of key findings
Pain	34	1989–2011	47–2433	Overall pain rate: 31–84% ^{9,37,39–57} Severe pain: 32–53% ^{40,43,47,51} Musculoskeletal pain: 40–59% ^{40,49,55} Neuropathic pain: 46% ⁵⁰ Nociceptive pain: 23% ⁵⁰ Pain relative to injury level Above: 14–30% ^{43,50} At: 11–41% ^{40,43,49,55} Below: 28–76% ^{40,43,49,50,55} Visceral pain: 5–15% ^{40,55} Abdominal pain: 14–31% ^{40,58,59} Hand pain: 22–34% ⁶⁰ Back pain: 23–71% ^{60,61} Shoulder/arm pain: 42–81% ^{62–65}	Age: greater age is sometimes assoc w/more pain ^{40,47,49,55,65,66} and sometimes not. ^{43,56,63,67} Duration: duration assoc w/more hip pain, ⁶⁶ but not with pain in general or shoulder pain; ^{48,56,63} one study found a U-shaped curve, with more arm pain <5 years and >20 years after injury and less pain 5–19 years after injury. ⁶⁵ Course: pain tends to develop months or years after injury; ^{36,40,45,47,50,55,66,68} once pain develops, it tends to remain stable, ^{40,48} except for (1) shoulder pain, which shows a tendency to increase over time, ^{14,66} and (2) leg pain, which demonstrated a decrease over time in one study. ⁶⁶
Skin problems including pressure ulcers (PUs)	18	1986–2010	21–3361	Current PUs: 14–48% ^{9,39,41,52,57,63,69,70} PUs at first admission to SCI unit: 27–42% ^{67,71–73} PUs between injury and d/c from first admission to SCI unit: 56% ⁷¹ PUs in the last 12 months: 30–46% ^{11,49,70,74} Skin problems in the last 5 years: 33% ³⁷	Age: rate of PUs assoc w/age in one study (older >younger), but not others. ^{67,71,75} Duration: rate of PUS assoc w/duration (<5 years and more than 19 years duration > 5–19 years duration), ⁴⁹ (20 > 15 > 10 > 25 > 5 years), ¹¹ (more duration > less duration), (more than 20 years < less than 20 years duration). ⁷⁴ Course: PU prevalence stable over 16 years in one study, ⁷⁵ increased over time in another, ¹¹ and was stable during the first 10 years following injury, and then increased 15 years post injury in a third. ⁷²
Depression	13	1995–2011	64–3678	Current probable major depressive disorder (based on measure score): 10–59% ^{76–80} Current moderate depression (based on measure score): 23–38% ^{81,82} Current moderate severe or severe depression (based on measure score): 9% ⁸¹ Current suicidal ideation: 15% ⁸¹ Depression recorded from medical record during initial rehabilitation: 14% ⁸³ Self-report of depression in the previous 12 months: 22% ³⁷ Of all encounters in a VA system, at least 1 encounter coded as addressing a depression diagnosis: 22% ⁸⁴	Age: age assoc w/depression scores in some studies (aged 25–49 > older and younger), ⁷⁷ (younger at injury > older at injury), ⁷⁶ (younger > older), ⁵¹ but not others. ^{66,80} Duration: duration assoc w/depression scores in one study (1-year post injury > 5-years post injury). ⁷⁶ Course: depressive symptoms increased over time in some studies, ^{66,75} but not others. ⁸²
Bladder problems including urinary tract infections (UTIs), urinary incontinence (UC) and bladder cancer	13	1987–2010	11–43,561	UTIs last year: 46–48% ^{37,49} UC sometimes: 37% ⁵⁷ UC often: 19% ⁵⁷ UC last year: 38% ⁴⁹ Upper UT deterioration: 72% ⁸⁵ 1 + UTIs in previous 3–4 years: 48–54% ⁷⁵ Bladder abnormalities: 18% ⁸⁶ Bladder wall thickening: 11% Cystitis: 3% Bladder stone: 2% Bladder wall trabeculation: 2% Current UTI: 34% ⁴¹ Rate of bladder cancer: 0.003–0.11% ^{17,18}	Age: occurrence of bladder problems sometimes assoc w/age (older > younger), ⁵¹ and sometimes not. ^{66,67} Duration: occurrence of bladder problems not assoc w/duration. ^{51,66} Course: no studies identified.

Table 1 (Continued)

Condition	Articles (no.)	Publication years	Sample size ^a (range)	Prevalence	Summary of key findings
Blood circulatory problems including hypertension, hypotension, cardiovascular disease (CVD), thrombosis, autonomic dysreflexia (AD)	10	1989–2010	13–545	CVD: 30–35% ⁸⁷ Coronary heart disease: 7–24% ^{20,87,88} Hypertension: 6–25% ^{19,20,87–89} Cerebrovascular disease: 1% ⁸⁷ Dysrhythmia: 16% ⁸⁷ Valvular disease: 7% ⁸⁷ Congestive heart failure: 8% ⁸⁷ Hypotension last year: 12% ⁴⁹ Thrombosis past year: 3% ⁴⁹ AD last year (in a sample of individuals with injuries at all levels): 18% ³⁷ History of myocardial infarction: 6% ¹⁹ AD (in a sample of individuals with cervical spinal cord injuries), time period not specified: 30% ³⁶	Age: CVD assoc w/age (older > younger); ^{51,67,87} Hypertension assoc w/age (older > younger); ⁵¹ Thrombosis not assoc w/age; ⁶⁷ AD assoc w/age in one study (older < younger), ⁵¹ but not in another. ⁶⁷ Duration effects: no research identified. Course: rates of CVDs increased over time post injury. ⁸⁷
Muscle spasms	8	1989–2008	31–781	Current muscle spasms: 53–87% ^{39,52} Muscle spasms last 12 months: 57–71% ^{37,49,51} Current severe spasms: 37% ⁹⁰ Current mild to moderate spasms: 40% ⁹⁰	Age: spasms assoc w/age in one study (younger > older) ⁵¹ but not in another. ⁶⁷ Duration effects: spasms not assoc w/duration. ^{49,51} Course: spasticity increased during inpatient rehabilitation, ⁶⁷ and may be more frequent during initial rehabilitation than in the months following discharge from initial rehabilitation. ⁹¹
Diabetes	7	1989–2010	70–3737	Frequency: 5–22% ^{6,19–21,89,92,93}	Age: Diabetes assoc w/age (older > younger). ^{92,93} Duration effects: no studies identified. Course: no studies identified.
Bowel problems, including constipation (constp) and fecal incontinence (FI)	7	1997–2005	78–1668	Current constp: 58% ⁵⁹ Constp last year: 32% ⁴⁹ Daily FI: 1–4% ^{59,94} Occasional FI: 49% ⁵⁹ FI in the last year: 22–31% ^{49,95} FI 'sometimes': 32% ⁵⁷ FI 'often': 5% ⁵⁷ FI few times/week: 4% ⁹⁴ FI few times/month: 15% ⁹⁴ FI few times/year: 56% ⁹⁴	Age: FI assoc w/age (older > younger); ⁶⁶ constp not assoc w/age. ⁶⁶ Duration: FI assoc w/duration in some studies, ^{66,94} but not others; ⁵² constp not assoc w/duration. ⁶⁶ Course: no studies identified.
Osteoporosis/low bone mineral density (BMD)	6	1990–2010	8–1092	Osteoporosis: 61% ⁹⁶ Osteopenia: 20% ⁹⁶ Femur osteoporosis: 82% ⁹⁰ Femur osteopenia: 13% ⁹⁰ Lumbar spine osteoporosis: 17% ⁹⁰ Lumbar spine osteopenia: 18% ⁹⁰	Age: age not assoc w/spine osteopenia or spine BMD loss, but is assoc w/lower hip BMD and general BMD loss. ^{96,97} Duration: duration significantly assoc w/lumbar, hip, spine, knee, femur and general BMD loss. ^{96–98} Course: leg BMD decreases more over time more in non-standing individuals (24%) than in standing individuals; differences became significant by the second year post injury; ³⁸ BMD appears to achieve a steady state at 2 years post injury. ⁹⁹
Obesity and high body mass index (BMI)	6	1999–2010	26–7959	Current obesity: 4–32% ^{63,93,100–102}	Age: BMI assoc w/age (older > younger). ¹⁰¹ Duration: BMI assoc w/duration (longer duration > shorter duration). ¹⁰³ Course: BMI increased over a 5-year period following d/c from inpatient rehabilitation. ¹⁰¹
Fatigue	6	1995–2007	16–1668	Current fatigue: 19–74% ^{37,44,57,95} Severe current fatigue: 36% ⁵⁷	Age: age assoc w/fatigue (older > younger). ^{60,104} Duration: duration assoc w/fatigue (more duration > less duration). ¹⁰⁴ Course: no studies identified.

Table 1 (Continued)

Condition	Articles (no.)	Publication years	Sample size ^a (range)	Prevalence	Summary of key findings
Respiratory problems, including respiratory infections (RI) and shortness of breath (SoB)	6	2000–2008	91–781	RI last year: 8–13% ^{37,49} Current SoB: 34% ⁴⁴ Current 'respiratory problem': 12% ³⁹ Respiratory problem last year: 19% ⁴⁹ Difficulty coughing up sputum: 13% ⁴⁹ Breathless: 11% ⁴⁹	Age: RIs assoc w/age (older > younger); ⁶⁷ 'respiratory complications w/age'. ⁵¹ Duration: no studies identified. Course: a slight decrease in lower RIs over the course of 5 years, but no change in rate of upper RIs over 5 years. ¹⁰⁵
Bone fractures/falls	5	2001–2005	41–1092	Fractures: 21–34% ^{22,96,106} Fractures per year: 2% ²² Falls in the past year: 21–31% ^{37,107} Injured due to falls past year: 14% ¹⁰⁷ Death due to falls past year: .002% (1 out of 659) ¹⁰⁷	Age: no studies identified. Duration: falls assoc w/duration (shorter > longer duration). ¹⁰⁷ Course: no studies identified.
Problems with sexual activity	4	1989–2007	78–454	Sex problems in the last year: 39% ⁴⁹ Decreased sexual functioning since injury: 73% ⁵² Current complications with sexual activity: 45% ¹⁰⁸ Women reporting lack of adequate lubrication during sexual stimulation: 28% ¹⁰⁹ Women reporting lack of genital sensation: 41% ¹⁰⁹	Age: no studies identified. Duration: no studies identified. Course: no studies identified.
Heterotopic ossification (HO)	4	1998–2008	204–782	Rate of HO: 6–18% ^{49,51,110}	Age: rate of HO assoc w/age in some studies (younger > older), ^{51,110} but not others. ⁶⁷ Duration: rate of HO assoc w/duration in some studies (more duration > less duration), ⁵¹ but not others. ⁴⁹ Course: no studies identified.
'Sleep problems' including obstructive sleep apnea (OSA)	3	1998–2007	33–747	Rate of OSA: 15% ¹¹¹ Rate of OSA in individuals with cervical SCI: 53% ¹¹²	Age: rate of OSA assoc w/age (older > younger). ²³ Duration: no studies identified. Course: no studies identified.
Contractures	3	2000–2005	91–1668	Rate of contractures in the last 12 months: 9–23% ^{37,49} Rate of contractures occurring 'sometimes' (53%) or 'often' (32%): 85% ⁵⁷	Age: no studies identified. Duration: rate of contractures assoc w/duration (older than 19 years > younger than 19 years). ⁴⁹ Course: no studies identified.
Excessive sweating	2	2002–2005	454–1668	Rate of 'excessive sweating' in the past 12 months: 28% ⁴⁹ Rate of 'excessive sweating' 'sometimes' (36%) or 'often' (11%): 47% ⁵⁷	Age: no studies identified. Duration: no studies identified. Course: no studies identified.
Esophageal symptoms, including dysphagia	1	1993	93	Rate of heart burn: 61% ¹¹³ Rate of esophageal chest pain: 33% ¹¹³ Rate of intermittent dysphagia: 30% ¹¹³	Age: no studies identified. Duration: no studies identified. Course: no studies identified.
Dental problems	1	2009	192	Current oral problems needing treatment: 47% ¹¹⁴ Oral pain past 12 months: 47% ¹¹⁴	Age: no studies identified. Duration: no studies identified. Course: no studies identified.

^aSample size refers to sample of participants in the study with SCI.

found for falls and depression. For sexual activity, excessive sweating, esophageal symptoms and dental problems, we were not able to identify any study that examined its association with age or duration.

Time course of secondary health conditions

The time course of conditions was only rarely studied using longitudinal research designs (Table 1). Pain is the condition most often

studied with respect to course. The findings indicate that once chronic pain develops in persons with SCI, it tends to remain stable. Arm/shoulder and leg pain are notable exceptions; arm pain tends to worsen over time and leg pain may decrease over time.

There are fewer findings regarding the course of the other conditions. The course of pressure ulcers has been studied, but the findings are inconsistent. Two studies indicate that the prevalence of

Table 2 Relative importance ratings or rankings of different secondary health conditions in individuals with spinal cord injury

Author(s)	Sample description	Comparison method	Key findings
Bloeman-Vrencken <i>et al.</i> ⁴⁹	Four hundred fifty-four respondents to a survey sent to 'members of the Dutch Association of Spinal Cord Injured patients'	Relative frequency and relative % of respondents who mentioned a problem (of 13 'secondary impairments in individuals with SCI might experience') in top 5 most important	The relative frequency of the 'secondary impairments' and % of respondents who mentioned the problem in the top 5 of importance were, in order, bladder regulation problems (71 and 52%), bowel regulation problems (61 and 42%), spasms (57 and 33%), pain (55 and 40%), edema in legs (49 and 16%), problems with pressure sores (36 and 21%), increasing weight (32 and 14%), excessive sweating (28 and 9%), contractures (23 and 7%), breathing/respiratory tract problems (19 and 7%), heterotopic ossification (13 and 4%), low blood pressure (12 and 2%) and thrombosis (3 and 1%).
Klotz <i>et al.</i> ⁵⁷	One thousand six hundred sixty-eight respondents to a survey sent to individuals with tetraplegia	Relative frequency that a condition was listed as a 'reason for rehospitalization' following the initial hospitalization	The rates of reasons for rehospitalizations were, in order, urinary complications (32%), systematic follow-up (28%), pressure sores (20%), respiratory complications (14%), contractures (14%) bowel complications (10%), pain (9%) and secondary fractures (8%).
Hitzig <i>et al.</i> ⁵¹	Seven hundred eighty-one participants in a telephone survey of individuals with SCI living in Ontario, Canada	Relative frequency of 18 'health complications'	The relative rates of the 18 'health complications' were, in order, spasticity (71%), shoulder pain (59%), chronic pain (58%), bladder infections (57%), arthritis/joint pain (53%), bowel problems (43%) depression (35%), distress (33%), pressure ulcers (29%), high blood pressure (23%), autonomic dysreflexia (20%), respiratory complications (16%), bladder/kidney problems (13%), neurological deterioration (13%), heterotopic ossification (6%), fractures (7%), cardiac complication (7%) and drug addiction (4%).
Krause ¹¹⁵	Four hundred forty nine participants in a longitudinal survey	Relative importance ratings (1 = no problem; 5 = major problem) of 'problems... typically experienced by people with SCI'	The relative importance of specific health-related problems were, in order, pain (2.76), spasms (2.37), sex life (2.20), emotional pain (1.78), sweats and chills (1.73), depression (1.67), skin sores (1.65) and sadness (1.64).
Prysak <i>et al.</i> ³⁷	Ninety-one veterans with SCI	Relative frequency of experiencing '17 specific secondary conditions' in the previous 12 months	The relative frequency of each condition in the last 12 months was, in order, spasms (70%), shoulder pain or other repetitive stress injury (52%), fatigue (51%), urinary tract infections (48%), chronic pain (45%), skin problems (33%), anxiety (24%), depression (22%), falls or other injuries (21%), autonomic dysreflexia (18%), respiratory infections (13%), reactions to medications (12%), contractures (9%), burns (9%), asthma (3%) and osteoporosis (2%).

Abbreviation: SCI, spinal cord injury.

pressure ulcers is stable over time—in one study, for as long as 16 years—while another study indicated stability in the prevalence of pressure ulcers only in the first 10 years following injury, followed by an increase in prevalence. Findings regarding the course of depression are likewise inconsistent, with the results suggesting either stability or a gradual increase in depressive symptoms over time. Note that this finding of a gradual increase in depression symptoms (in one study only) over time is inconsistent with the findings of a negative association between depression and age in non-SCI samples.

The prevalence of cardiovascular disease was shown to increase over time in one longitudinal study. This longitudinal finding is

consistent with the significant positive concurrent associations found between both age and SCI duration and cardiovascular disease. Also, BMI was shown to increase over a 5-year period in one longitudinal study, consistent with the significant positive associations between both age and duration and BMI in concurrent correlation analyses.

Comparison of prevalence or severity of conditions relative to normative samples

Of the 20 health conditions examined in this review, only eight (40%) were compared with normative values or to a normative sample (of

individuals without SCI).^{6,14–23} In all but one case, health conditions were found to be more frequent or severe in the SCI sample than in the normative group. These included pain, depression, cystitis (as a bladder problem), cardiovascular disease, diabetes, fractures, sleep problems and esophageal problems. Only prevalence of bladder cancer was not more frequent in the SCI sample relative to the normative sample.^{17,18} In no case was a health condition found to be less prevalent in the SCI sample.

DISCUSSION

The key findings from this study are that (1) individuals with SCI experience a large number of serious secondary health conditions, many of which occur at a significantly higher rate in persons with SCI than the normative population; (2) the most common conditions are pain, bowel and bladder regulation problems, muscle spasms, fatigue, heart burn and osteoporosis; (3) a number of these conditions—including cardiovascular disease, diabetes, BMD loss, fatigue and respiratory complications/infections—occur with higher frequency in older individuals or those with greater SCI duration, relative to younger individuals or those with shorter SCI duration; and (4) there is a lack of longitudinal research examining the natural course of secondary health conditions in individuals with SCI, and the findings from the limited studies are often inconsistent, with only cardiovascular disease and weight (as measured by BMI) showing increases over time. These findings have important clinical and research implications.

Conditions that are most common and important to patients

In terms of overall frequency and rated importance to patients, three health conditions stood out: pain, bladder problems and bowel problems. Both neuropathic (pain caused by a lesion or disease of the somatosensory system) and nociceptive pain types are common, and the most frequent pain sites are back and shoulder/arm. Pain is also a reason for rehospitalization. Individuals with SCI listed it as the single more important secondary conditions in one study, and pain was listed as among the ‘top 5’ important conditions by patients in another study (just after bladder and bowel regulation problems).

This finding regarding pain underscores what many clinicians know from their daily practice: pain is a very serious problem in many individuals with SCI that is highly refractory to treatments that are currently available.²⁴ The finding supports the need to continue to identify effective pain treatments and pain prevention strategies for SCI-related pain.

In particular, ‘arm pain’ that tends to worsen over time may reflect shoulder and arm pain resulting from manual wheelchair use, and perhaps also incorrect transfer approaches. This finding supports the need for studies that will examine the association between and impact of over-use and specific transfer skills on fall frequency. Such research could then inform the development of interventions that would address accommodations needed to ensure safe transfers as people age or as changes occur in their weight. The transfer techniques that a patient uses at age 25 may not be suitable for the same patient at age 60.

Bowel and bladder problems were also identified as among the most common and important to patients in this review. The severity of these problems can be contrasted to the lack of research to develop and evaluate the efficacy of treatments to improve these problems. For example, a PubMed search using the keywords ‘bowel’ or ‘bladder’ and ‘SCI’ in the title, and limiting the search to clinical trials (performed on 7 March 2013) yielded very few studies (28), only 21 of which were actually pilot or clinical trials examining the efficacy

of different approaches to bowel or bladder problems. However, some silver lining can be found by an increase in this research, given that almost as many clinical trials (7) were published in the 4 years from 2009–2012 as were published in the 8 years before this (8 clinical trials; from 2001–2008). This trend for an increasing number of research studies on bowel and bladder problems should be supported.

Other common conditions or symptoms identified in this review include muscle spasms, fatigue, heart burn, osteoporosis/bone density loss, pressure ulcers, obesity, excessive sweating, depression, cardiovascular disease including high blood pressure, bone fractures/falls, problems with sexual activity, esophageal chest pain, intermittent dysphagia and dental/oral problems. Although some of these conditions (for example, pressure ulcers) often get significant attention by clinicians who are familiar with SCI, others (for example, dental problems) may receive less attention. Clinicians should therefore be particularly vigilant in monitoring for these conditions, and treat as indicated, in order to maximize the health and well-being of the individuals with SCI they serve.

In our view, the loss of bone density seen with age is a particularly serious problem that deserves additional research and clinical attention. Although research has yet to examine an association between low BMD and higher risk for fractures in individuals with SCI, osteoporosis is a known risk factor for fractures in the general population.²⁵ Everything possible should be done for bone health. Moreover, in our view, regular therapy check-ups to observe and teach transfer methods that match the age and abilities of the individual would be useful.

Findings regarding age and duration effects

The findings regarding the associations between chronological age/SCI duration and the prevalence of the secondary health conditions studied are somewhat complicated to interpret given both the statistical confounding between age and SCI duration and the potential selection bias effects of survey results. For example, it is possible that any significant association found between age or duration and a condition could potentially be due to the effects of *either* age or duration (or even both), given that the predictor variables are associated with one another. Determination of the unique effects of either on a health condition requires that the other be controlled in the analyses; ideally age at SCI onset should also be controlled in such analyses. This can be performed via a series of three regression analyses, with a measure of the health condition as the criterion variable, one of three age variables (chronological age, age at SCI onset and time since injury onset) as the primary predictor, and one of the other age variables as a control variable.¹³ The analyses must be performed as a series of three analyses with two of the age predictor variables entered in any one equation, because of the multicollinearity problems that would occur if all three were entered in the same equation. However, the majority of studies that tested for significant associations failed to control for these confounding factors. The second issue—potential selection bias—is related to the possibility that different age groups of responders in survey studies may not be representative of the same population (for example, see studies by Christensen *et al.*²⁶). For example, responders to surveys of populations who do not have SCI have been shown to be healthier than non-responders.^{27,28} If this finding were to extend to populations with SCI, then the older cohorts of survey responders might be expected to be among the ‘healthier’ individuals, relative to younger responders. This would result in an under-estimate of the association between age or duration and the frequency or severity of health conditions. This may explain, at least in part, some of the

inconsistent findings in the studies reviewed here, with age or duration sometimes being shown to be associated with a health condition and sometimes not.

Despite these limitations and caveats, however, a number of age and SCI duration effects were found which allows for preliminary conclusions. Those conditions with the most consistent positive associations with age and/or duration include cardiovascular disease, diabetes, BMD loss, fatigue and respiratory complications. Those conditions with less but still some support (that is, effects found in one study only or significant in some studies but not others) for being more frequent or severe in older individuals or those with longer duration, include fecal incontinence, obstructive sleep apnea and contractures. Depression and falls showed inconsistent associations with SCI duration, but when significant effects were found, they were negatively associated with age or duration (more severe or common in younger as opposed to older individuals). Only two conditions demonstrated a consistent lack of significant association with age or duration: bladder problems and spasms.

As a group, the findings provide preliminary support for the conclusion that older age and longer SCI duration tend to be associated with more frequent and severe health conditions. This conclusion, given the concomitant finding that many secondary conditions are more frequent in individuals with SCI relative to those without a SCI, are consistent with the 'premature aging' hypothesis.^{2,5-7}

Implications for research, policy and practice

Research. In addition to the need to continue to develop and evaluate the efficacy of prevention programs and treatments for secondary health conditions in individuals with SCI, there is a need for longitudinal studies to more accurately evaluate the natural course of health conditions in individuals with SCI. This scoping study identified a list of conditions that are common in individuals with SCI. The challenge now is to track those conditions and determine when they are likely to emerge and how they impact function, in order to know when to provide treatments that could help prevent them. Unfortunately, only 22 (24%) of the 92 studies included in this review utilized a longitudinal design. Such designs are urgently needed for the field to better understand the natural course and effects of secondary conditions on the quality of life in individuals with SCI. This knowledge would help us better anticipate when the needs of individuals with SCI are most likely to arise.

As noted in this review, there were some inconsistencies in the findings, and the reasons for these inconsistencies are not entirely clear. It is possible that they reflect the true nature of the relationships between age, duration, and secondary health conditions—that the associations may be stronger or weaker in different samples of individuals, and are therefore moderated by some as-yet unidentified variable or variables. In addition, the studies reviewed used a large variety of designs and measures. Differences in these factors may explain some of the inconsistencies across studies. We anticipate that such inconsistencies may become less over time as researchers develop and begin to use measures developed specifically for individuals with SCI. For example, the International Spinal Cord Society has identified specific measures for assessing a large variety of conditions, such as urinary track function,²⁹ bowel function,³⁰ cardiovascular function³¹ and pain,³² among others. However, given the real possibility that different investigators may continue to use different measures, the field would benefit from more 'cross walking' of measures to allow for comparisons.³³

Policy. At least two clear policy implications emerge from the findings from this scoping review. First, the findings point to the need to include questions about disability status in the large ongoing national health data collection studies such as the National Health Interview Survey and the Behavioral Risk Factor Surveillance System. The inclusion of just one question regarding the presence of a specific diagnosis associated with disability, especially if the list of possible diagnoses represented a variety of types (for example, multiple sclerosis, SCI and muscular dystrophy) would allow us to answer many critical questions regarding the frequency, impact and course of health conditions in individuals aging with disabilities without the need for any additional longitudinal surveys. Second, the findings demonstrate a significant health need in an important part of the population, and therefore a critical need for additional funding for both research (to better understand the factors contributing to the prevalence and impact of secondary conditions in individual aging with disabilities) as well as for providing preventative services and treatment to minimize their prevalence and negative impact.

Practice. The findings from this scoping review provide strong support for the need for greater efforts to prevent and buffer the negative impacts of these conditions. Many of the most common conditions identified, such as cardiovascular disease, diabetes, BMD loss, fatigue, obstructive sleep apnea appear to be related to a sedentary lifestyle, obesity or both. Significant effort may be needed to develop and evaluate the efficacy of ways for individuals with SCI to (1) increase weight-bearing and both improve and maintain cardiovascular fitness³⁴ and (2) help individuals with SCI avoid gaining weight as they age. Treatments that successfully address these factors may prevent or ameliorate a large number of the secondary conditions that in our review were associated with increasing age.

Limitations of the review

The current review has a number of limitations that should be considered when interpreting the results. First, given the limitations associated with a scoping review, there are very likely studies that provide information about the frequency or course of secondary health conditions in individuals with SCI that were not identified or included in this review. However, the search strategy used likely identified the majority of the key studies, and thus the findings probably accurately reflect the types and overall prevalence of the conditions discussed. In addition, two factors related to age—age at injury and year of injury (era or birth cohort effects)—were not examined in this review. Both of these likely have an important role for at least some of the health conditions.^{10,35} Another important issue likely related to the prevalence, severity and impact of secondary conditions is the level and severity of the lesion. Support for this conclusion can be seen in the findings of this review. For example, autonomic dysreflexia was more frequent in a sample of individuals with cervical injury³⁶ than in a sample of made of individuals with injuries at all levels.³⁷ Similarly, one of the studies reviewed reported that leg BMD decreases more rapidly over time in non-standing individuals than in standing individuals.³⁸ However, examination of the associations between lesion severity and secondary conditions was not one of the foci of this review, and data were not extracted specifically to address this question. A systematic review that examines these addition specific factors is warranted. Relatedly, like all literature reviews of this nature, we were limited by the search engines and search terms, with regards to what evidence we identified, and our analysis is limited by the articles identified. Systematic

reviews focusing on one or more of the following specific topics would be helpful to obtain determine (1) the frequency and course of secondary conditions in the first year following injury, (2) the associations between age at injury and year of injury and the prevalence and course of secondary conditions, and (3) the specific frequency, course and association with age of some of the more common secondary conditions, such as pain, pressure ulcers, depression and urinary tract infections.

Summary and conclusions

The current scoping review provides important summary information regarding the frequency and course of secondary health conditions in individuals with SCI. The most common secondary conditions and symptoms that were identified are pain, bowel and bladder regulation problems, muscle spasms, fatigue, heart burn and osteoporosis. Many of these and the other secondary conditions identified occur at a higher rate in older than in younger individuals with SCI, and occur with a greater frequency in individuals with SCI than in individuals who do not have a SCI. However, there is a marked lack of longitudinal studies that provide evidence regarding the natural course of these conditions and their impact on quality of life. The findings underscore the need for such studies, as well as studies that develop and test interventions that would prevent the onset of these health conditions, lower their severity and minimize their impact.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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