ORIGINAL ARTICLE

Medication profile and polypharmacy in adults with pediatric-onset spinal cord injury

M Hwang¹, K Zebracki^{2,3} and LC Vogel^{4,5}

Study design: Cross-sectional survey.

Objectives: To describe the medications taken by individuals who had sustained a spinal cord injury (SCI) in childhood or adolescence (age < 19 years) and to report the prevalence of polypharmacy and its association with demographic, injury-related and psychosocial factors.

Setting: Community.

Methods: Structured interviews of adults with pediatric-onset SCI. Routine medications and secondary health conditions (SHCs) experienced were recorded. Polypharmacy was defined as the concomitant use of five or more different types of medications. Bivariate analyses and multiple regression models were conducted to determine associations between polypharmacy and demographic factors, injury-related factors, number of SHCs and psychosocial outcomes (FIM, SF-12v2 Health Survey, CHART, PHQ-9).

Results: A total of 159 participants (male, 63%; tetraplegia, 59%) with mean age 35.0 ± 6.2 years (range, 26.7–50.9 years) were included. Most common routine medications were muscle relaxants (50.3%), bladder medications (48.5%), bowel agents (41.5%), analgesics (26.4%) and antidepressants (16.9%). Polypharmacy was present in 30.8% (n , 49) and was more prevalent in those with tetraplegia (40.2% vs 17.9%; $P=0.003$). Participants with polypharmacy were older, had lower FIM, CHART and SF-12v2 scores, and higher PHQ-9 scores. Regression models indicate the total number of SHCs, time since injury and tetraplegia to be significant positive predictors of polypharmacy.

Conclusion: Duration of SCI and SHCs are risk factors for polypharmacy in this population of adults with SCI. Measures should be taken to prevent the occurrence of SHCs throughout adulthood so as to prevent the potentially adverse physiological effects and psychosocial outcomes associated with polypharmacy.

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INTRODUCTION

Individuals with spinal cord injury (SCI) may experience decreased quality of life and daily functioning as a result of SCI-related manifestations such as neurogenic bladder/bowel and secondary health conditions (SHC).^{1–3} Management of common conditions such as neurogenic bladder, autonomic dysreflexia and pain requires the use of medications including anticholinergics, sympatholytics, anticonvulsants and analgesics, which, in addition to the target organ, can act on the autonomic and central nervous systems, as well as other organ systems.⁴ Such medications can cause adverse effects on their own with risk of adverse reactions increasing when combined with other medications, potentially leading to interference with rehabilitative efforts and daily activities. Recent research reports medications for pain and spasticity to be associated with increased risk of fatigue and falls,^{5–7} whereas psychotropic medications have been associated with reduced life expectancy in individuals with SCI.⁸ Predicting the possibility of adverse drug effects is more challenging in SCI because drug pharmacokinetics can be altered following the injury and the degree of alteration can vary depending on the level and severity of

SCI.⁹ Moreover, with age-related diseases and SHCs increasing over time in persons with SCI,^{10–12} the likelihood of requiring multiple medications also increases, adding to the risk of adverse drug effects.

Polypharmacy is defined as the concomitant use of five or more different types of medications and is associated with negative health outcomes in the elderly and individuals with chronic diseases.^{4,13} A recent study reported high rates of polypharmacy and positive associations with drug-related problems in the SCI population.⁴ Adults who had sustained SCI during childhood are exposed to longer durations of SHCs and are at a higher risk of developing age-related chronic conditions earlier than their able-bodied counterparts.^{12,14} These individuals are more likely to have taken multiple medications throughout childhood and may continue to do so throughout their lifetime, potentially leading to medication-related problems and negative health and psychosocial outcomes. Thus, the objectives of this study were to describe the medications taken by adults with pediatric-onset SCI and to report the prevalence of polypharmacy and its association with demographic, injury-related and psychosocial factors.

¹Department of Research, Shriners Hospitals for Children, Chicago, IL, USA; ²Department of Psychology, Shriners Hospitals for Children, Chicago, IL, USA; ³Department of Psychology, Loyola University Chicago, Chicago, IL, USA; ⁴Department of Pediatrics, Shriners Hospitals for Children, Chicago, IL, USA and ⁵Department of Pediatrics, Rush Medical College, Chicago, IL, USA

Correspondence: Dr M Hwang, Department of Research, Shriners Hospitals for Children, Research, 2211 N Oak Park Avenue, Chicago 60707, IL, USA.

E-mail: mhwang@shrinersnet.org

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MATERIALS AND METHODS

This study used cross-sectional data from a larger longitudinal study on outcomes of adults with pediatric-onset SCI. Participants were adults who had sustained a SCI before the age of 19 years and received rehabilitation services at one of the SCI specialty programs of Shriners Hospitals for Children (Chicago, Philadelphia or Northern California). Informed consent was obtained from those willing to participate, and structured telephone interviews were conducted annually. This study was approved by the institutional review board.

Data were taken from the most recent interviews conducted after 1 January 2011. Demographic and injury-related information including age, time since injury and American Spinal Injury Association Impairment Scale (AIS) severity¹⁵ were collected. SCI-related medical complications, SHCs experienced in the year before the interview and routinely taken medications were recorded. The medications were classified into 29 categories, depending on their intended function (Table 1): allergy; analgesic; antibiotics; anticholesterol agents; antidepressants; antihypertensives; antihypotensives; antithrombotics; antipsychotics; anxiolytics; aspirin; bladder medications (BladM); bone; bowel agents (BwlA); bronchodilators; contraceptives; diabetes-control medications; iron supplements; mood stabilizers; muscle relaxants (MsclR); psychostimulants; sexual function medications; sleep aids; steroids; substance abuse control agents; thyroid agents; upper gastrointestinal; vitamins; and other supplements.

Standardized outcome measures were used to assess the relationship between polypharmacy and psychosocial outcomes: FIM (FIM is a trademark of Uniform Data System for Medical Rehabilitation ('UDSMR'), a division of UB Foundation Activities Inc. The use of the FIM instrument to collect the data for this research study was authorized and conducted in accordance with the terms of a special purpose license granted to Licensee by UDSMR. The patient data

collected in the course of this research study have not been processed by UDSMR, and no implication is intended that such data have been or will be subjected to UDSMR's standard data processing procedures or that it is otherwise comparable to data processed by UDSMR.) for functional independence,¹⁶ SF-12v2 Health Survey to measure perceived physical and mental health,¹⁷ Craig Handicap Assessment and Recording Technique (CHART) to assess community participation¹⁸ and the Patient Health Questionnaire (PHQ-9) to evaluate depressive symptoms.¹⁹

Analyses

Descriptive statistics were used to present demographic and injury-related data, the type and number of medications taken and the number of SHCs reported by the participants. Common concomitant two- and three-medication combinations (for example, antihypertensive-BladM, analgesic-BladM-antidepressant) were also determined. For this study, polypharmacy was considered present when the participant reported concomitant use of five or more different types of medications. χ^2 -tests were used to compare the distribution of polypharmacy between sex, race (Caucasian vs non-Caucasian), completeness of injury (complete vs incomplete), level of injury (tetraplegia vs paraplegia) and AIS severity groups (C1-4 ABC, C5-8 ABC, T1-S5 ABC, AIS D). *T*-tests were performed to compare age, duration of injury, number of SHCs and standardized outcome measure scores between participants with and without polypharmacy. Binomial logistic regression analyses were conducted to determine independent factors predictive of polypharmacy using the variables that were significant on bivariate analyses. Multiple regression models were used to determine which outcome measures were significantly associated with the presence of polypharmacy when controlling for other injury-related factors.

Statement of ethics

We certify that all applicable institutional and governmental regulations concerning ethical use of human volunteers were followed during the course of this research.

RESULTS

A total of 159 individuals had completed their most recent interview after January 2011. The demographic characteristics of the participants

Table 1 Medications taken by participants

Category	Examples
Allergy	Antihistamines
Analgesics	Acetaminophen, NSAIDs, anticonvulsants, narcotics/opioids, etc
Antibiotics	Nitrofurantoin, trimethoprim-sulfoxazole, fluoroquinolones, etc
Anticholesterol	Fibrates, statins
Antidepressants	Tricyclic antidepressants, serotonergics, etc
Antihypertensives	Diuretics, calcium-channel blockers, β -blockers, α -blockers, etc
Antihypotensives	Fludrocortisone, midodrine
Antithrombotics	Warfarin, heparin, etc
Antipsychotics	Risperidone, olanzapine, etc
Anxiolytics	Benzodiazepines, buspirones, etc
Aspirin	—
Bladder	Anticholinergics/antimuscarinics
Bone	Bisphosphonates
Bowel agents	Bisacodyl, docusate, senna, etc
Bronchodilators	Albuterol, ipratropium bromide, cromolyn sodium, etc
Contraceptives	—
Diabetes	Insulin, sulfonylureas, biguanides
Iron supplements	—
Mood stabilizers	Lithium
Muscle relaxants	Baclofen, tizanidine, dantrolene, etc
Psychostimulants	Methylphenidate
Sexual function	Sildenafil, tadalafil, etc
Sleep-aids	Melatonin, zolpidem, diphenhydramine, etc
Steroids	Prednisone, dexamethasone, etc
Substance abuse	Disulfiram
Thyroid agents	Levothyroxine
Upper gastrointestinal	Proton-pump inhibitors, H ₂ -blockers, antacids
Vitamins	—
Other supplements	Calcium, homeopathic medications

Table 2 Demographic characteristics of participants (N=159)

Characteristics	Mean $\pm$ s.d. or N (%)
<i>Gender</i>	
Male	100 (62.9)
Female	59 (37.1)
<i>Age at interview (years)</i>	35.0 $\pm$ 6.2 (range, 26.7–50.9)
<i>Time since injury (years)</i>	21.2 $\pm$ 7.2 (range, 9.2–44.0)
<i>Race</i>	
Caucasian	132 (83.0)
African American	7 (4.4)
Hispanic	12 (7.5)
Other	8 (5.0)
<i>Level</i>	
Paraplegia	67 (42.1)
Tetraplegia	92 (57.9)
<i>AIS Severity</i>	
C1-4 AIS ABC	24 (15.1)
C5-C8 AIS ABC	57 (35.8)
T1-S5 AIS ABC	62 (39.0)
AIS D	12 (7.5)
Unknown	4 (2.5)
<i>Medication group by number of routine medications</i>	
<5	110 (69.2)
$\geq$ 5	49 (30.8)

Abbreviation: AIS, ASIA (American Spinal Injury Association) Impairment Scale.

are presented in Table 2. Mean age at interview was 35 years; mean duration of SCI was 21 years. The most commonly used medications (excluding vitamins) were MscIR (50.3%), BladM (48.5%), BwlA (41.5%), analgesics (26.4%), antidepressants (16.9%), antibiotics (16.4%) and UGI medications (15.7%; Figure 1). The frequencies of other medications not presented in Figure 1 were as follows: aspirin (2.5%), thyroid agents (2.5%), steroids (2.5%), antipsychotics (1.9%), bronchodilators (1.9%), antihypotensives (1.3%), bone medications (1.3%) and substance abuse control agents (0.6%). Among the 42 participants taking analgesics, seven individuals routinely took two or more different types of pain medications. The distribution of the types of analgesics taken were as follows: narcotics/opioids (for example, codeine, Oxycontin, Vicodin), 14.5% (n , 23); anticonvulsants (for example, gabapentin, pregabalin), 11.3% (n , 18); NSAIDs (for example, ibuprofen, naproxen), 1.3% (n , 2); cannabis, 1.9% (n , 3); and unidentified, 1.9% (n , 3). The most frequent two-medication combinations were MscIR-BladM (30.2%), followed by MscIR-BwlA (28.9%) and BladM-BwlA (23.3%; Table 3). Most common three-medication combinations were MscIR-BladM-BwlA (18.2%), MscIR-analgesic-BladM (11.9%), MscIR-analgesic-BwlA (11.9%) and MscIR-BladM-antidepressant (8.8%).

The distribution of the total number of SHCs and the number of routine medications taken per participant are presented in Table 4. A total of 110 individuals (69.2%) reported taking less than five medications, among whom only eight took no medication; 49 individuals (30.8%) reported taking five or more concomitant medications, comprising the polypharmacy group. There were no significant differences in the frequency of polypharmacy between men and women (29.0% vs 33.9%; $\chi^2 = 0.518$, $P = 0.418$), between Caucasians and non-Caucasians (30.3% vs 33.3%; $\chi^2 = 0.097$, $P = .756$) or

between those with complete and incomplete injuries (31.3% vs 32.4%; $\chi^2 = 0.016$, $P = 0.898$). There were significant differences in polypharmacy frequency among the AIS severity groups: C1-4 ABC, 54.2%; C5-8 ABC, 35.1%; T1-S5 ABC, 19.4%; AIS D, 25.0% ($\chi^2 = 10.606$, $P = 0.014$); polypharmacy was more prevalent in tetraplegia than in paraplegia (40.2% vs 17.9%; $\chi^2 = 9.048$, $P = 0.003$). Comparison of demographic factors and psychosocial outcome scores between individuals with and without polypharmacy revealed significantly older age, longer duration of injury and greater number of SHCs in polypharmacy; FIM motor score, SF12v2 physical component score and the CHART physical independence, mobility, occupation and social integration scores were significantly lower, whereas the PHQ-9 score was higher in the polypharmacy group (Table 5).

Regression models revealed greater number of SHCs, increasing duration of injury and tetraplegia to independently predict increased odds of polypharmacy (Table 6). Regression models also revealed that polypharmacy was predictive of decreased CHART mobility scores, decreased SF12v2 physical component scores and increased PHQ-9 scores when controlling for the number of SHCs, age, duration of injury and AIS severity (Table 7). The presence of polypharmacy was not predictive of FIM, SF12v2 mental component or CHART physical independence, cognitive independence, occupation, social integration and economic self-sufficiency scores.

Table 4 Distribution of the number of secondary health conditions and routine medications reported per participant ($N = 159$)

Number	SHC n (%)	Routine medications n (%)
0	4 (2.5)	8 (5.0)
1	9 (5.7)	16 (10.1)
2	14 (8.8)	30 (18.9)
3	29 (18.2)	29 (18.2)
4	28 (17.6)	27 (17.0)
5	25 (15.7)	14 (8.8)
6	13 (8.2)	15 (9.4)
7	19 (11.9)	7 (4.4)
8	9 (5.7)	6 (3.8)
9	4 (2.5)	1 (0.6)
10	4 (2.5)	4 (2.5)
11	1 (0.6)	1 (0.6)
12	0	0
13	0	0
14	0	1 (0.6)
Median	4	3
Mode	3	2
Range	11	14

Abbreviation: SHC, secondary health conditions.

Figure 1 Types of routine medications taken by participants at last interview. UGI, upper gastrointestinal; AntiHTNsive, antihypertensive.

Table 3 Frequency of concomitant 2-medication combinations

	Muscle relaxant	Bladder agent	Bowel agent	Analgesic	Antidepressant
Bladder agent	48 (30.2%)	—	—	—	—
Bowel agent	46 (28.9%)	37 (23.3%)	—	—	—
Analgesic	31 (19.5%)	19 (11.9%)	21 (13.2%)	—	—
Antidepressant	17 (10.7%)	22 (13.8%)	15 (9.4%)	13 (8.2%)	—
UGI medication	18 (11.3%)	15 (9.4%)	14 (8.8%)	11 (6.9%)	7 (4.4)

N(%)

Table 5 Comparison of demographics, injury-related factors and psychosocial outcome scores by the presence of polypharmacy

	< 5 medications (n = 110)	≥ 5 medications (n = 49)	t-test; P-value
Age at interview (years)	34.2 ± 5.8	36.6 ± 6.8	0.034
Time since injury (years)	20.3 ± 6.7	23.2 ± 7.9	0.017
Number of SHCs	4.0 ± 2.1	5.9 ± 2.4	<0.001
FIM Motor	61.88 ± 24.87	45.08 ± 24.87	<0.001
FIM Socio-cognitive	34.81 ± 0.46	34.67 ± 0.72	0.229
FIM Total	96.69 ± 24.85	79.76 ± 25.04	<0.001
CHART Physical ID	90.58 ± 15.82	83.10 ± 17.11	0.009
CHART Cognitive ID	97.49 ± 7.84	94.69 ± 11.69	0.131
CHART Mobility	92.52 ± 15.03	80.12 ± 20.04	<0.001
CHART Occupation	75.71 ± 31.61	58.37 ± 29.95	0.001
CHART Social Integration	93.79 ± 13.44	88.29 ± 15.83	0.037
CHART Economic SS	80.97 ± 29.11	71.88 ± 36.34	0.209
SF12v2 Physical	46.25 ± 9.25	36.80 ± 10.57	<0.001
SF12v2 Mental	55.71 ± 8.41	52.57 ± 10.83	0.075
PHQ-9 Total	2.28 ± 2.99	5.24 ± 5.42	0.001

Abbreviation: SHC, secondary health condition; ID, independence; SS, self-sufficiency, PHQ, Patient Health Questionnaire

Table 6 Predictors of polypharmacy

	B	S.E.	P-value	OR	95% CI
Number of SHCs	0.342	0.092	<0.001	1.408	1.176–1.685
Age at interview	–0.023	0.050	0.642	0.977	0.885–1.078
Duration of injury	0.105	0.048	0.028	1.111	1.011–1.220
Tetraplegia	1.249	0.483	0.010	3.486	1.352–8.984

Abbreviations: CI, confidence interval; OR, odds ratio; SHC, secondary health conditions. Hosmer–Lemeshow Goodness of Fit Test: $\chi^2 = 8.335$, $df = 8$, $P = 0.401$; $R^2 = 0.284$; correct prediction 76.1% SHC.

Table 7 Outcome measures significantly associated with polypharmacy

Outcome measure	Predictor	B	s.e.	β	P-value	95% CI
CHART mobility ^a	Number of SHCs	–1.786	0.623	–0.235	0.005	–3.017 to –0.554
	Polypharmacy	–7.585	3.091	–0.200	0.015	–13.694 to –1.477
	Age at interview	–0.749	0.327	–0.266	0.023	–1.394 to –0.104
	Duration of injury	0.367	0.287	0.150	0.203	–0.200 to –0.934
	AIS severity	0.639	1.696	0.031	0.707	–2.711 to 3.990
SF12 physical ^b	Number of SHCs	–0.987	0.358	–0.214	0.007	–1.696 to –0.279
	Polypharmacy	–6.396	1.778	–0.279	<0.001	–9.909 to –2.883
	Age at interview	–0.413	0.188	–0.242	0.029	–0.784 to –0.042
	Duration of injury	0.117	0.165	0.079	0.478	–0.209 to –0.443
	AIS severity	1.358	0.975	0.107	0.166	–0.569 to 3.285
PHQ-9 ^c	Number of SHCs	0.386	0.150	0.214	0.011	0.089 to –0.682
	Polypharmacy	2.536	0.745	0.283	0.001	1.065 to 4.008
	Age at interview	0.064	0.079	0.096	0.415	–0.091 to –0.220
	Duration of injury	–0.041	0.069	–0.071	0.555	–0.177 to –0.096
	AIS severity	0.672	0.409	0.136	0.102	–0.136 to 1.479

Abbreviations: CI, confidence interval; PHQ, Patient Health Questionnaire; SHC, secondary health conditions.

^aF(5, 149) = 6.662, $P < 0.001$; $R^2 = 0.183$.

^bF(5, 149) = 10.716, $P < 0.001$; $R^2 = 0.264$.

^cF(5, 149) = 5.398, $P < 0.001$; $R^2 = 0.153$.

DISCUSSION

This study describes the types of routine medications, the prevalence of polypharmacy and factors associated with polypharmacy in adults with pediatric-onset SCI. This population is unique in that these individuals have been living with their SCI and the associated SHCs since childhood, most likely requiring medications earlier and longer compared with the adult-onset SCI population. Among the 29 categories of medications investigated, MscLRs such as baclofen (Lioresal) and tizanidine (Zanaflex) were most common, and BladM and BwlA followed in frequency, indicating the high prevalence of spasticity, and neurogenic bladder and bowel dysfunction, which accompany SCI. Over one-fourth of the study population required routine use of analgesics, among which opioids and anticonvulsants were most frequent, reflecting pain characteristics that were of severe intensity and neuropathic nature. The three most commonly used medications cited above are targeted to control symptoms that are direct consequences of the insult to the spinal cord, that is, abnormal muscle tone and loss of bladder and bowel control. Analgesics, the fourth commonly used medications, are aimed at managing the neuropathic pain common in SCI but may also be added over time with the development of musculoskeletal pain and overuse syndromes. Antidepressants, antibiotics, UGI medications, anxiolytics and anti-hypertensives followed in frequency. These medications reflect common conditions that occur secondary to SCI such as urinary tract infections and psychological, gastrointestinal and cardiovascular disorders. Depression and anxiety in the spinal cord injury population have prevalence rates of 21–37% and 19–29%, respectively, and these conditions have been positively associated with SHCs, health care utilization and more frequent use of prescription medications.^{20–23} The prevalence of major depressive disorder in the pediatric-onset SCI population has been reported to be significantly lower compared with that of the adult-onset SCI, as well as the general population;^{24,25} however, given the fact that antidepressants were the fifth most common routine medication, close follow-up of mental health is warranted over time, especially in relation to development of SHCs.^{24,25} The increased risk of peptic ulcers and gastroesophageal reflux disease is well documented in SCI and has been attributed to

unopposed vagal stimulation, decreased mucosal perfusion and persistent supine position.^{26,27} Although antihypertensives were taken by only 11.9% of our study population (mean age, 35 years), the use of cardiovascular medications may likely increase over time when considering the increased odds of developing cardiovascular disorders with age.^{11,28}

The order of frequency of medications used in this study population differed significantly from a Canadian population of 151 individuals with chronic SCI²⁹ in which mild analgesics (ibuprofen, acetaminophen) (59.6%) and bowel medications were most frequent (59.6%), followed by opioid agents (57.6%) and benzodiazepines (51.0%), antidepressants (38.4%), bladder medications (37.7%), antibiotics (37.7%), stomach medications (35.1%), cardiovascular medications (34.4%), anticoagulants (33.8%) and anti-inflammatory agents (31.8%). The Canadian population also had significantly higher rates of use of most classes of medication compared with our study sample. These disparities may be attributed to differences in age or prevalence of SHCs between the two groups; however, no information regarding age or SHC was presented for the Canadian group. Better access to medications provided through the Canadian National Health Insurance Program may also be a factor explaining the higher rates of medication use in the Canadian study.

The rate of polypharmacy in our study population was 30.8%, the majority of which were taking five or six concomitant medications (Table 4). Using a commercially available data set from 4800 hospitals in the US, Kitzman *et al.*⁴ reported a polypharmacy prevalence rate of 56% in individuals with SCI ($n=13\,160$) compared with 27% in the control group ($n=13\,148$). Similar to our results, there was no difference in polypharmacy rates between sexes; there was also no significant difference between tetraplegia (61%) and paraplegia (65%), whereas in our study population individuals with tetraplegia had significantly higher prevalence of polypharmacy (40.2%) compared with those with paraplegia (17.9%). Furthermore, the prevalence of polypharmacy in our study group more closely approximates that of the control group in Kitzman's study and is much lower compared with the SCI group. These differences in polypharmacy rates may be due to differences in population demographics, injury-related factors or the presence of SHCs; however, these were not reported in the Kitzman study. Nonetheless, the large sample size reported by Kitzman *et al.* may better represent the SCI population in general and provides a solid reference for the prevalence of polypharmacy.

A specific concern of polypharmacy is the interaction between different medications and their combined effect on the individual, especially as adverse drug effects appear to be more common in the SCI population compared with control subjects using the same medications.⁴ This is of particular interest as drug metabolism can be altered by the SCI making it more difficult to predict its effects.⁹ Furthermore, different medications used to manage symptoms of co-existing conditions may cause opposing physiological effects, potentially reducing the therapeutic efficacy of the medications used. For example, approximately one-fourth of our study population was found to take BladM and BwIA concomitantly; the antimuscarinic action of BladM, which aim to inhibit involuntary bladder contractions and thus manage urinary incontinence, can also inhibit bowel motility potentially aggravating constipation symptoms.³⁰ This in turn might necessitate an increased dosage of BwIA for its desired effect. It is beyond the scope of this study to discuss the potential interactions of the observed multidrug combinations, but possible drug-drug interactions and medication effects on nontarget organs must be considered during the prescription process and clinical visits.

Polypharmacy was found to be significantly associated with several demographic factors and psychosocial outcomes (Table 5). Among the demographic and injury-related factors, tetraplegia, time since injury and the number of SHCs were found to be independent predictors of polypharmacy. Individuals with tetraplegia are more likely to have higher incidences of SHCs, which may require more medications for symptom management.^{11,31} With increasing duration of time living with a SCI, the likelihood of developing a new SHC also increases, and, chronic conditions may persist or worsen over time, necessitating more pharmacologic management.³² Although the severity and duration of injury are not modifiable factors, SHCs are potentially modifiable as many can be prevented or delayed, and worsening of pre-existing conditions can be controlled with diligent care. Thus, efforts to prevent and promptly manage SHCs may be the most practical and effective means to avoid polypharmacy. Among the psychosocial outcome measures, the presence of polypharmacy was found to be significantly associated with decreased community mobility (CHART mobility scale), decreased physical health (SF12v2 physical component) and increased depressive symptoms (PHQ-9), when controlling for age, duration of injury, number of SHCs and AIS severity. These findings indicate that polypharmacy negatively impacts both the physical and mental aspects of health and quality of life independent from the presence of SHCs. In addition, these findings underscore the importance of meticulous health assessment and judicious prescription practices on the part of the health care provider in avoiding polypharmacy in individuals with SCI.

There are a few limitations of this study. Using a structured interview to obtain information on medication use may have resulted in loss of data due to recall bias, and, some medications may have been classified incorrectly, especially when a certain medication has more than one indication for use. For example, aspirin can be used for a variety of purposes, including pain management, antiplatelet effect or prevention of cardiovascular disease. Similarly, diphenhydramine (an antihistamine) can be used either as an allergy medication or a sleep aid. When possible, the purposes of medications were inquired and noted during the interview; however, when this was not available, the participant's medical records and previous interview notes were used to classify the medication into one of the 29 categories. Data on any adverse drug effects were not available, and the medications taken were not correlated to specific SHCs, both of which would have provided a better understanding of the relationship between polypharmacy and health outcomes. The small sample size of the study population may not have adequately represented the adults with pediatric-onset SCI population. With continued recruitment of participants and follow-up interviews, however, it is anticipated that a larger sample would emerge for improved representation and would also allow for observation of changes in the distribution of frequency of medications used over time and in relation to development of new SHCs.

CONCLUSION

Polypharmacy was present in 30% of our population and was significantly associated with increased duration of SCI, SHCs and negative psychosocial outcomes. Efforts to prevent the development of SHCs would be critical in decreasing the prevalence of polypharmacy. Continued longitudinal investigations to determine changes in patterns of medication use will provide insight into the development and progression of SHCs, the impact of chronic drug use and polypharmacy on quality of life and ultimately optimal treatment options in adults with pediatric-onset SCI.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

MH developed the research aim, collected the data, conducted the statistical analysis and was a major contributor to the manuscript. KZ developed the research aim and contributed to the manuscript. LCV developed the research aim and contributed to the manuscript.

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