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RESEARCH PAPER

Shoulder pain in the Swiss spinal cord injury community: prevalence and associated factors

Fransiska M. Bossuyt[a,b], Ursina Arnet[a,b], Martin W. G. Brinkhof[a,b], Inge Eriks-Hoogland[c], Veronika Lay[a], Rachel Müller[a,b], Mikael Sunnåker[a], and Timo Hinrichs[d]; for the SwiSCI study group

[a]Swiss Paraplegic Research, Nottwil, Switzerland; [b]Department of Health Sciences and Health Policy, University of Lucerne, Lucerne, Switzerland; [c]Swiss Paraplegic Centre, Nottwil, Switzerland; [d]Division of Sports and Exercise Medicine, Department of Sport, Exercise and Health, University of Basel, Basel, Switzerland

ABSTRACT

Purpose: To determine the prevalence of shoulder pain and to identify factors associated with shoulder pain in a nationwide survey of individuals living with spinal cord injury (SCI) in Switzerland.
Methods: Data was collected through the 2012 community survey of the Swiss SCI Cohort Study (SwiSCI) ($N = 1549$; age 52.3 ± 14.8; 29% female). Sociodemographic and socioeconomic circumstances, SCI characteristics, health conditions as well as mobility independence and sporting activities were evaluated as predictor variables. Analyses were adjusted for item non-response (using multiple imputation) and unit-nonresponse (using inverse probability weighting).
Results: The adjusted prevalence of shoulder pain was 35.8% (95% CI: 33.4–38.3). Multivariable regression analysis revealed higher odds of shoulder pain in females as compared to males (odds ratio: 1.89; 95% CI: 1.44–2.47), and when spasticity (1.36; 1.00–1.85) and contractures (2.47; 1.91–3.19) were apparent. Individuals with complete paraplegia (1.62; 1.13–2.32) or any tetraplegia (complete: 1.63; 1.01–2.62; incomplete: 1.82; 1.30–2.56) showed higher odds of shoulder pain compared to those with incomplete paraplegia.
Conclusions: This survey revealed a high prevalence of shoulder pain. Sex, SCI severity, and specific health conditions were associated with having shoulder pain.

➤ IMPLICATIONS FOR REHABILITATION

- Individuals with spinal cord injury have a high prevalence of shoulder pain.
- Females, individuals with complete paraplegia or any tetraplegia and individuals with contractures and spasticity should receive considerable attention in rehabilitation programmes due to their increased odds of having shoulder pain.

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Introduction

Shoulder pain is a common and significant health problem among individuals with chronic spinal cord injury (SCI) [1–3]. The reported prevalence varies widely between 30 and 70% [1–3]. Common diagnoses in individuals with SCI presenting with shoulder pain are: bursitis, tendinopathy, rotator cuff tears, biceps tendon tears [4], acromioclavicular joint arthrosis [5], or subacromial impingement [6]. Shoulder pain can negatively affect mobility, participation in social activities and quality of life [1,2].

The etiology of musculoskeletal shoulder problems in individuals with SCI is multifactorial [7]. According to common understanding, loads applied on the shoulder and the capability to meet these demands play a major role in the development of chronic shoulder problems [7,8]. High and/or repetitive biomechanical loads may be caused by wheelchair use [9], transfers [10], pressure reliefs [11], and repeated overhead activities [12]. Furthermore, susceptibility of the shoulder region resulting from posture [10] or neuromuscular deficits and imbalances [13] is assumed to be influential [8]. Previous epidemiological studies suggest that shoulder pain in individuals with SCI is associated with chronological factors, such as age [4]. There is, however, an inconsistency in the literature as several studies contradicted these findings [1,2]. Shoulder pain may also be associated with lesion characteristics, such as level of injury [14]. Findings on a possible association between physical activity and shoulder pain are inconsistent [e.g., 15,16].

Many studies on shoulder pain in individuals with SCI investigated convenient and, therefore, potentially biased samples. Furthermore, different methodologies of the studies (setting, recruitment strategy, etc.) and small sample sizes might have contributed to discrepancies in findings on prevalence and predictors of shoulder pain. These shortcomings in addition to the major impact of shoulder pain on SCI individuals' functioning highlight the need to investigate population-based data including the variables that potentially contribute to shoulder pain. Respective research could inform and support targeted injury prevention strategies and policy making. As such the aim of this study was to investigate musculoskeletal shoulder pain in the Swiss SCI community. Specifically, the objectives are twofold: (1) to determine the prevalence of musculoskeletal shoulder pain and (2) to identify factors associated with musculoskeletal shoulder pain

CONTACT Timo Hinrichs timo.hinrichs@unibas.ch Division of Sports and Exercise Medicine, Department of Sport, Exercise and Health, University of Basel, Birsstrasse 320 b, CH-4052 Basel, Switzerland

(sociodemographic factors, SCI characteristics, health conditions, mobility independence and sporting activities) in a nationwide survey.

Methods

Study design and study population

This study refers to cross-sectional data collected within the Community Survey 2012 of the nationwide Swiss SCI Cohort Study (SwiSCI). Recruitment procedures and details of study design have been reported previously [17]. In short, included for participation in SwiSCI were individuals diagnosed with traumatic or non-traumatic SCI, aged 16 years or older, and with a permanent residence in Switzerland. Participants were excluded if they had: (1) new SCI in the context of palliative care or (2) an SCI due to congenital conditions, neurodegenerative disorders, or Guillain–Barré syndrome. Ethical approval of the SwiSCI study was granted by the ethics committees of the Cantons of Luzern, Zürich, Basel-Stadt, and Wallis, who are responsible for the participating rehabilitation centres. All participants gave informed consent to the study conditions.

Data collection and analysis

Survey data was collected with three self-report assessment methods (i.e., paper questionnaires, web-based questionnaires, or telephone interviews) from September 2011 to March 2013 [17]. Data analyses and reporting adhere to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [18] and guidelines of the International SCI Core Data Set Committee of ISCoS [19]. The latter guidelines were recently found to be feasible for the SwiSCI community survey sample [20].

Outcome measure

Musculoskeletal shoulder pain was assessed by two hierarchical questions. In the first polar question participants were asked if they had experienced pain in the last week. In the second question participants were asked to indicate the location of any musculoskeletal pain experienced within the last week. Multiple locations were given as options including the region "shoulder". Participants were assigned to the group with shoulder pain if they had experienced pain in the last week and marked the shoulder as pain location. This procedure resulted in the binary outcome measure of this study: musculoskeletal shoulder pain over the past week ("yes"/"no"). While participants were given an explanation of the term "musculoskeletal" ("muscles, joints, bones"), there were no further explanations of the terms "shoulder" or "pain".

Predictor variables

Selection of predictor variables from the SwiSCI dataset for use in data analyses was based on the published evidence on risk factors of shoulder pain (see introduction).

Selected indicators of socio-demographic and economic circumstances were age, education, and net equivalent income. The variable age was stratified into five groups in accordance to the ISCoS guidelines [19] (i.e., 16–30, 31–45, 46–60, 61–75, and 76 + years) as a nonlinear relationship between age and shoulder pain was previously reported [8]. Years of formal education (education) was grouped into four categories according to previous studies [21]: (1) "compulsory school" ($\leq$9 years), (2) "vocational training" (>9 and $\leq$12 years), (3) "secondary education" (>12 and $\leq$16 years), and (4) "university education" (>16 years). Net equivalent income was grouped into the following tertile based categories: (1) "low" (<3500 CHF), (2) "middle" (3500–4643 CHF), and (3) "high" (>4643 CHF).

SCI etiology, severity, and time since injury (TSI) were selected as indicators of SCI characteristics. SCI etiology was classified into "traumatic" and "non-traumatic" and severity into "tetraplegia/complete", "tetraplegia/incomplete", "paraplegia/complete", and "paraplegia/incomplete" in accordance with previous studies [21]. TSI was stratified by groups (i.e., 0–5, 6–15, 16–25, and 26 + years) in accordance to the ISCoS guidelines [19] as a nonlinear relationship between TSI and shoulder pain was previously reported [8].

Spasticity and contractures were included as binary variables ("yes"/"no"). The variables were assessed applying the SCI Secondary Condition Scale, which has been found to be reliable and valid to assess different secondary health conditions in SCI [17]. The term "spasticity" was explained to participants as "muscle cramps", the term "contractures" was explained as "limited range of motion of a joint". Participants selecting the answer "no problem" for contractures and/or spasticity were assigned as not having contractures and/or spasticity. Participants selecting one of the following answers: "mild, infrequent problem", "moderate/occasional problem", or "significant/chronic problem", were assigned as having contractures and/or spasticity.

Independence in moving 10–100 m was selected to indicate the physical demands to upper extremities and was assessed using the self-report version of the Spinal Cord Independence Measure (SCIM), which has been shown reliable and valid [22]. Independency in moving around was grouped into: (1) "total assistance", (2) "electrical wheelchair/partial assistance in manual wheelchair", (3) "independent in manual wheelchair", (4) "walking with aids and/or supervision", and (5) "walking with orthoses or without aids". Aids were defined as walking sticks, crutches, and/or walkers.

The frequency of performing sporting activities (including leisure activities, such as tennis, hand biking or fitness training) in the past four weeks was categorised into: (1) "never", (2) "1–5 times", and (3) "more than 6 times". The categories were based on an item addressing the frequency of leisure activities in the last four weeks of the Utrecht scale for evaluation of rehabilitation-participation [23].

Statistical analyses

To account for item nonresponse (i.e., missing items of predictor variables for a subset of participants) a multiple imputation model was fitted with the assumption that data are missing at random. Results of 20 imputed data sets were combined by using Rubin's Rules [24]. Furthermore, to account for unit nonresponse (i.e., missing of complete questionnaire) inverse probability weights derived from propensity scores were used [17].

Descriptive analyses of shoulder prevalence were stratified by all predictor variables (i.e., sex, age, education, income, SCI etiology, SCI severity, TSI, spasticity, contractures, mobility independence, and frequency of sporting activities). Furthermore, univariable and multivariable logistic regression analyses were used to derive unadjusted and adjusted odds ratios (OR) of shoulder pain for selected predictor variables.

Results of the multivariable logistic regression with the imputed data corrected by using propensity scores are reported as OR together with 95% confidence intervals (CIs). Wald tests were applied as global tests to evaluate the statistical significance of variables. We performed pairwise post-hoc tests with

Bonferroni correction for multiple testing to evaluate differences between the respective variable categories.

As part of sensitivity analysis the impact of multiple imputation procedures was evaluated by comparing modelling results with the results of complete case analysis (cf. STROBE guidelines [18]) and unweighted analysis. Only discordant results of these secondary analyses are reported. All statistical analyses were performed with STATA version 13 (StataCorp LP, College Station, TX).

Results

Based on the inclusion and exclusion criteria, 3144 eligible individuals were initially identified in cooperation with the national association for individuals with SCI (Swiss Paraplegics Association), three specialised Swiss SCI-rehab centres, and a SCI-specific home care institution (ParaHelp). A total of 1549 individuals participated in this study corresponding to a response rate of 49%. Non-response bias was found to be minimal and was extensively described previously [17].

The 1549 individuals participating in this study reported an age of 52.3 ± 14.8 years (median, interquartile range (IQR): 52, 42–63) and TSI of 16.4 ± 12.7 years (median, IQR: 13, 6–25). In total, 546 individuals reported to have had shoulder pain in the last week. Adjusted for item nonresponse and unit nonresponse, the prevalence of shoulder pain in the Swiss population with SCI was 35.8% with a 95% CI of 33.4–38.3%. Table 1 shows the participants' characteristics and proportions of participants with shoulder pain within each category.

Results of the univariable (unadjusted model) and multivariable (adjusted model) logistic regression analysis are reported in Table 2. The variables sex, SCI severity, spasticity, and contractures were significantly associated with shoulder pain after adjusting for all predictor variables. More specifically, females had 1.89 (95% CI: 1.44–2.47) times higher odds of having shoulder pain as compared to males. Individuals with complete paraplegia (OR 1.62; 95% CI: 1.13–2.32) or any tetraplegia (complete: 1.63; 1.01–2.62; incomplete: 1.82; 1.30–2.56) had higher odds of having shoulder pain as compared to those with incomplete paraplegia. Pairwise comparison of SCI severity revealed no significant differences between complete paraplegia and any tetraplegia (complete and incomplete). To improve interpretation of meaningful differences, the prevalence of shoulder pain for each of these categories computed at the mean of each predictor variable are displayed as margins in Figure 1. When the secondary health conditions spasticity and/or contractures were apparent, individuals had 1.36 (95% CI: 1.00–1.85) and 2.47 (95% CI: 1.91–3.19) times higher odds of having shoulder pain (vs. not apparent), respectively. Because we did not specifically ask for the location of spasticity and contractures, an additional multivariable regression analysis stratified by lesion level (paraplegia and tetraplegia) was performed. The analysis revealed higher odds of having shoulder pain in individuals with a tetraplegia reporting contractures (OR 2.85; 95% CI: 1.75–4.64) and spasticity (OR 1.94, 95% CI: 1.04–3.61) compared to individuals with a paraplegia reporting contractures (OR 2.30, 95% CI: 1.70–3.12) and spasticity (OR 1.31, 95% CI: 0.93–1.85) (analysis on the imputed data set including weights derived from propensity scores).

The univariable analysis suggested that (electrical as well as manual) wheelchair users had higher odds of having shoulder pain compared to those who walk without aids. Furthermore, univariable findings showed that individuals above 16 years of TSI had higher odds of having shoulder pain compared to those who have less TSI. However, these findings were not significant after adjustment for all predictor variables.

Results of complete case analysis or unweighted analysis that were performed as part of sensitivity analysis were similar to the presented results and did not affect inferences from the study.

Discussion

This study showed an overall prevalence of shoulder pain of 36% in a population-based sample of individuals living with SCI in Switzerland. Furthermore, an association between shoulder pain and sex, SCI severity, and health conditions (spasticity and contractures) was revealed.

Prevalence

The reported prevalence of shoulder pain in this study is in line with previous findings [2,4,25,26]. Some studies reported, a higher prevalence of up to 73% [1,27]. The discrepancies in results might be caused by different methodologies of the studies (setting, recruitment strategy, definition of shoulder pain, etc.), mostly investigating small sized and convenient, and, therefore, potentially biased samples. Furthermore, a higher proportion of paraplegic individuals (69%) in this study could explain our findings as it was shown that individuals with tetraplegia, compared to paraplegia, had significantly more shoulder pain [28,29]. Compared to the prevalence of shoulder pain in the general population reported by a systematic review (point prevalence between 7 and 27%; 1-month prevalence between 19 and 31% [30]), the prevalence (1 week) in our sample of individuals with SCI was somewhat higher.

Predictor variables

Females had almost twice the odds of having shoulder pain compared to males. This finding is in agreement with previous studies investigating the association of sex and shoulder pain in individuals with SCI [15,31]. In explaining sex differences in individuals with SCI, the importance of biomechanical and neurophysiological factors was considered by Schultz et al. [32]. They described how (1) structural differences, such as a shorter humerus and lower muscle mass in females could lead to differences in biomechanics, and how (2) differences in the reflex function of males and females could influence neurophysiologics. Explanations given for the higher prevalence of general pain in females with SCI was (1) the increased levels of gonadal hormones post-pubertally [33] and (2) higher prevalence of nociceptive pain [34].

The secondary health conditions spasticity and contractures were found to be highly associated with shoulder pain. In an earlier study, contractures of the shoulder joint have been shown to be related to shoulder pain [35]. The significant association of spasticity and quality of life after adjusting for sociodemographic and injury variables [36] and the high incidence of pain found in individuals with spasticity [37] are in line with our findings and confirm the importance to further investigate the association of spasticity and shoulder pain. It should be noted that spasticity and contractures might also be related to each other and that their association with shoulder pain is probably bidirectional [38,39]. As expected, when stratifying our analyses by tetraplegia/paraplegia, the associations between spasticity/contractures and shoulder pain were higher in individuals with tetraplegia, as it can be assumed that a certain proportion of reported contractures and spasticity was located in the upper extremities. The remaining association between contractures and shoulder pain in individuals with paraplegia might partly be explained by the explanation of

Table 1. Participants' characteristics and proportion of participants with shoulder pain.

	Total ($N = 1549$) n (%)	Shoulder pain ($N = 1512$)[a]		
		n	Raw %[b] (95% CI)	Weighted %[c] (95%CI)
Total		546	36.1 (33.7–38.5)	35.8 (33.4–38.3)
Socio-demographic/-economic factors				
Sex				
Male	1107 (71.5)	359	33.2 (30.4–36.1)	32.6 (29.8–35.5)
Female	442 (28.5)	187	43.4 (38.7–48.2)	43.6 (38.9–48.5)
Age (years)				
16–30	129 (8.3)	33	25.8 (18.5–34.3)	26.2 (19.1–34.7)
31–45	377 (24.3)	135	36.7 (31.7–41.8)	36.2 (31.3–41.3)
46–60	571 (36.9)	219	39.2 (35.1–43.4)	39.9 (35.8–44.1)
61–75	378 (24.4)	135	36.3 (31.4–41.4)	35.6 (30.8–40.7)
76+	94 (6.1)	24	28.2 (19.0–39.0)	28.4 (19.6–39.2)
Education				
Compulsory school	143 (9.4)	54	40.0 (31.7–48.8)	40.0 (31.8–48.8)
Vocational training	377 (24.9)	134	36.1 (31.2–41.2)	35.4 (30.5–40.6)
Secondary education	721 (47.5)	239	33.9 (30.4–37.5)	33.4 (29.9–37.1)
University education	276 (18.2)	108	40.1 (34.2–46.3)	40.4 (34.6–46.6)
Missing	32	31	–	–
Net equivalent income (CHF/month)				
Low ($\leq$3500)	584 (42.3)	214	37.1 (33.1–41.2)	36.4 (32.4–40.5)
Medium ($>$3500 to $\leq$4643)	338 (24.5)	120	35.7 (30.6–41.1)	35.9 (30.8–41.4)
High ($>$4643)	459 (33.2)	158	34.8 (30.4–39.4)	34.7 (30.3–39.3)
Missing	168	145	–	–
Spinal cord injury characteristics				
Etiology				
Traumatic	1202 (78.4)	435	36.9 (34.1–39.7)	36.8 (34.0–39.7)
Non-traumatic	332 (21.6)	103	32.4 (27.3–37.8)	31.5 (26.6–37.0)
Missing	15	15	–	–
SCI severity				
Paraplegia/incomplete	577 (37.5)	162	29.0 (25.3–33.0)	28.8 (24.8–32.5)
Paraplegia/complete	486 (31.6)	191	40.0 (35.5–44.5)	40.2 (35.8–44.8)
Tetraplegia/incomplete	314 (20.4)	128	41.4 (35.9–47.1)	42.0 (36.4–47.8)
Tetraplegia/complete	160 (10.4)	61	39.4 (31.6–47.5)	38.2 (30.7–46.3)
Missing	12	12	–	–
Time since injury (years)				
0–5	363 (23.9)	103	29.1 (24.4–34.1)	28.6 (24.0–33.5)
6–15	473 (31.1)	157	34.1 (29.8–38.7)	34.1 (29.8–38.7)
16–25	325 (21.4)	129	41.2 (35.7–46.9)	40.8 (35.4–46.5)
26+	361 (23.7)	147	41.1 (35.9–46.4)	40.4 (35.4–45.7)
Missing	27	27	–	–
Health conditions				
Spasticity				
No	374 (26.0)	103	27.8 (23.3–32.6)	27.7 (23.2–32.6)
Yes	1062 (74.0)	410	39.1 (36.1–42.1)	38.8 (35.8–41.9)
Missing	113	92	–	–
Contractures				
No	704 (48.9)	181	26.1 (22.8–29.5)	26.3 (23.0–29.8)
Yes	736 (51.1)	338	46.3 (42.6–50.0)	45.8 (42.1–49.5)
Missing	109	88		
Physical demands to upper extremities				
Independence in moving around 10–100 m				
Walking with orthoses or without aids	288 (19.5)	80	27.8 (22.7–33.3)	28.4 (23.3–34.0)
Walking with aids and/or supervision	238 (16.1)	79	33.6 (27.6–40.0)	33.0 (27.1–39.5)
Independent in manual whc	686 (46.5)	265	39.1 (35.4–42.9)	39.1 (35.4–42.9)
Electrical/partial assistance in manual whc	204 (13.8)	85	42.3 (35.4–49.4)	43.2 (36.2–50.4)
Total assistance	59 (4.0)	20	34.5 (22.5–48.1)	32.8 (21.9–45.9)
Missing	74	53	–	–
Sporting activities/exercise				
Never/past 4 weeks	408 (27.9)	157	39.1 (34.3–44.0)	38.1 (33.3–43.1)
1–5x/past 4 weeks	480 (32.8)	177	37.3 (33.0–41.9)	37.7 (33.4–42.3)
$\geq$6x/past 4 weeks	575 (39.3)	190	33.2 (29.4–37.2)	32.9 (29.1–37.0)
Missing	86	64	–	–

[a]Information on shoulder pain was missing in 37 cases.
[b]Not adjusted for potential bias.
[c]Propensity scores were used as weights to adjust for potential bias due to unit non-response.
Missing values are not included in the given percentages.
CHF: Swiss francs; SCI: spinal cord injury; whc: wheelchair.

the term "contractures" given to our participants. "Contractures" was explained as "limited range of motion of a joint". It has been shown in a previous study [40], that (a) there is a high prevalence (29%) of limited range of motion of the shoulder in individuals with paraplegia (even though markedly lower than in those with tetraplegia, 70%) and (b) there is an association between limited range of motion of the shoulder and shoulder pain. We are not aware of an explanation for the remaining association, although non-significant, between spasticity and shoulder pain in individuals with paraplegia.

Table 2. Multivariable regression analyses for the binary outcome "musculoskeletal shoulder pain in the past week" (yes vs. no) (imputed dataset; $N = 1549$; unadjusted model and model adjusted for all variables and corrected for non-response-bias by using propensity scores).

	Shoulder pain							
	Unadjusted model				Adjusted model[a]			
		95% CI				95% CI		
	OR	Lower	Upper	*p*	OR	Lower	Upper	*p*
Socio-demographic/economic factors								
Sex				**<0.001**				**<0.001**
Male	1	–	–	–	1	–	–	–
Female	1.60	1.26	2.03	–	1.89	1.44	2.47	–
Age (years)	–	–	–	0.055	–	–	–	0.110
16–30	1	–	–	–	1	–	–	–
31–45	1.57	0.99	2.48	–	1.44	0.87	2.40	–
46–60	1.83	1.18	2.85	–	1.79	1.09	2.94	–
61–75	1.53	0.97	2.43	–	1.53	0.91	2.56	–
76+	1.16	0.62	2.17	–	1.09	0.55	2.17	–
Education	–	–	–	0.248	–	–	–	0.216
Compulsory school	1	–	–	–	1	–	–	–
Vocational training	0.86	0.57	1.31	–	0.82	0.52	1.29	–
Secondary education	0.79	0.53	1.17	–	0.88	0.57	1.36	–
University education	1.05	0.68	1.64	–	1.18	0.72	1.95	–
Net equivalent income	–	–	–	0.800	–	–	–	0.374
Low	1	–	–	–	1	–	–	–
Medium	0.97	0.72	1.31	–	0.84	0.61	1.17	–
High	0.91	0.70	1.19	–	0.82	0.61	1.11	–
Spinal cord injury characteristics								
Etiology	–	–	–	0.111	–	–	–	0.158
Non-traumatic	1	–	–	–	1	–	–	–
Traumatic	1.25	0.95	1.65		1.27	0.91	1.75	
SCI severity	–	–	–	**<0.001**	–	–	–	**0.004**
Paraplegia/incomplete	1	–	–	–	1	–	–	–
Paraplegia/complete	1.66	1.27	2.17	–	1.62	1.13	2.32	–
Tetraplegia/incomplete	1.78	1.32	2.42	–	1.82	1.30	2.56	–
Tetraplegia/complete	1.56	1.06	2.28	–	1.63	1.01	2.62	–
Time since injury	–	–		**0.003**	–	–	–	0.148
0–5	1	–	–	–	1	–	–	–
6–15	1.28	0.94	1.74	–	1.27	0.92	1.76	–
16–25	1.70	1.22	2.36	–	1.54	1.06	2.24	–
26+	1.68	1.23	2.31	–	1.21	0.83	1.77	–
Health conditions								
Spasticity	–	–	–	**<0.001**	–	–	–	**0.050**
No	1	–	–	–	1	–	–	–
Yes	1.61	1.22	2.11	–	1.36	1.00	1.85	–
Contractures	–	–	–	**<0.001**	–	–	–	**<0.001**
No	1	–	–	–	1	–	–	–
Yes	2.32	1.84	2.92	–	2.47	1.91	3.19	–
Physical demands to upper extremities								
Independence in moving around 10–100 m	–	–	–	**0.006**	–	–	–	0.210
Walking with orthoses or without aids	1	–	–	–	1	–	–	–
Walking with aids and/or supervision	1.26	0.85	1.86	–	1.02	0.66	1.57	–
Independent in manual whc	1.63	1.19	2.22	–	1.40	0.95	2.08	–
Electrical/partial assistance in manual whc	1.94	1.31	2.88	–	1.32	0.83	2.12	–
Total assistance	1.26	0.68	2.36	–	0.79	0.39	1.63	–
Sporting activities/exercise	–		–	0.185	–	–	–	0.357
Never/past 4 weeks	1	–	–	–	1	–	–	–
1–5x/past 4 weeks	0.97	0.73	1.30	–	1.03	0.75	1.41	–
≥6x/past 4 weeks	0.79	0.60	1.05	–	0.85	0.62	1.15	–

OR: odds ratio; CI: confidence interval; yrs: years; SCI: spinal cord injury; whc: wheelchair.
[a]Model adjusted for all variables in the table and corrected for non-response-bias by using propensity scores.
p-values <0.05 are bolded.

Individuals with incomplete paraplegia had significantly lower odds of developing shoulder pain compared to individuals with complete paraplegia or any tetraplegia (incomplete and complete). The latter three groups did not differ from each other in terms of proportion with shoulder pain. Previous studies confirmed current findings and explained the association of higher lesion levels [29] and complete lesions [41] with shoulder pain by (1) increased susceptibility of impaired balance in the muscles stabilising the shoulder in tetraplegia and (2) the increased need of wheelchair use in individuals with complete lesions [8].

Individuals who were independent in a manual wheelchair or needed electrical/partial assistance in a manual wheelchair had increased odds of having shoulder pain. This was not confirmed in the multivariable analysis possibly due to the confounding effect of SCI severity on the association between shoulder pain and mobility independence. The increased odds of having shoulder pain, in the group requiring electrical/partial assistance in a manual wheelchair might be related to the influence of biomechanical changes on shoulder pain due to other activities besides wheelchair use, such as overhead reaching, transfers, ischial pressure relief, etc. [26]. Although, not investigated in this study, it

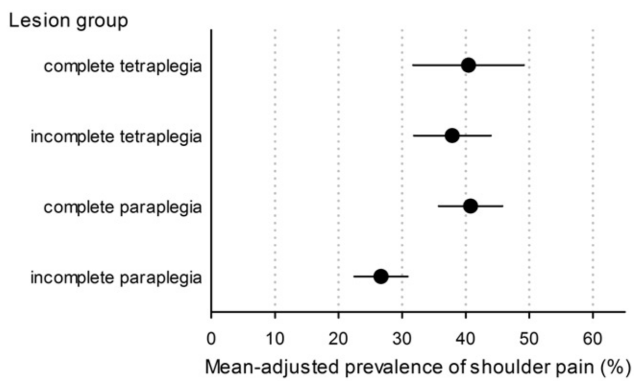

Figure 1. Prevalence of shoulder pain, adjusted to the mean value of each predictor variable, reported as a percentage for different lesion groups.

might be the case that some individuals who developed pain might have switched from a manual to electrical wheelchair.

This study could only confirm an association of TSI with shoulder pain in the univariable analysis which suggests that other variables, as possibly health conditions or SCI severity, are mediating the association of TSI. It is difficult to compare findings with previous studies as they display inconsistent results both approving [4,25] and disapproving [2,3] an association of age and TSI with shoulder pain. Nevertheless, these chronological factors are found to contribute to degeneration in terms of (1) merely age-related processes, and (2) "wear and tear" from living with SCI superimposed on age [21]. The tendency to higher odds of shoulder pain in the middle age group might be influenced by survival bias (i.e., focus on individuals which are still alive and neglecting individuals which might have passed away) or by the fact that individuals eventually avoid activities associated with shoulder pain [28,31].

This study did not find a significant association of shoulder pain and frequency of sport participation. This is in contrast with other cross-sectional studies which reported that a reduced physical activity level was associated with increased shoulder pain [15,28]. These studies differed from this study by their (1) definition of activity level (i.e., including leisure, household, and work-related activities), (2) inclusion criteria (i.e., only individuals with SCI propelling a manual wheelchair), and (3) statistical analysis (results were not controlled for predictor variables). A recent prospective cohort study did also not show a significant association between (objectively measured) physical activity and shoulder pain, but found that reduced muscle strength was a significant risk factor to develop shoulder pain in individuals with paraplegia [16]. A comparison between wheelchair athletes and non-athletic wheelchair users revealed twice the odds of having shoulder pain among the non-athletes [42]. Furthermore, a home-based exercise programme was shown to be associated with increased muscle strength and had a positive impact on shoulder pain in individuals with SCI [43]. Previous findings support that physical activity and targeted exercise leading to increased shoulder muscle strength have a protective effect on the shoulder. Unfortunately, due to its cross-sectional design, our study does not relevantly contribute to the knowledge on this relationship. Cause and effect can be imagined in either direction: not only could physical activity have a (beneficial or harmful) effect on the shoulder, it is also likely that individuals adapt their activity levels to their shoulder symptoms.

Several limitations need to be acknowledged. Because of the cross-sectional design, associations do not allow causal inferences, but rather provide a basis for generating hypotheses for future studies. It also allows investigating a broad range of potential correlates. The study relied on self-report which can be subject to recall and social desirability bias (e.g., sporting activity). It should also be kept in mind that this study was part of a large survey with an extensive data collection aiming to capture the whole spectrum of human functioning (according to the International Classification of Functioning, Disability and Health (ICF) [44]). Therefore, for feasibility reasons, a number of measures were very crude, including sporting activity, severity of SCI, spasticity, contractures and shoulder pain. Even though participants were specifically asked to report on musculoskeletal pain, ability to distinguish between musculoskeletal and neuropathic pain (i.e., pain at or below the level of injury [45]) can be questioned. This could have caused an overestimation of the amount of individuals with tetraplegia reporting shoulder pain. The study did not evaluate the etiology of shoulder pain. The origin of pain did not necessarily have to be located within the shoulder region itself; the pain might also have originated from pathologies located at adjacent structures, such as the cervical or the thoracic spine. The intensity and duration of shoulder pain have not been specifically evaluated and controlled for. We also did not capture whether participants sought for and/or received treatment for shoulder pain. Finally, we did not specifically ask for the location of contractures and spasticity. Associations between contractures/spasticity of the upper extremities and shoulder pain could be assumed to be even higher than the reported associations between contractures/spasticity in general and shoulder pain. Despite these limitations, this study is the first to deliver valid data on the prevalence of shoulder pain and characteristics of affected individuals with SCI in Switzerland by analysing a representative, population-based sample.

In conclusion, individuals living with SCI in Switzerland have a high prevalence of shoulder pain. Female sex, having a tetraplegia or complete paraplegia and specific health conditions (spasticity, contractures) were associated with having shoulder pain and should be taken into account when designing prevention programmes. Future longitudinal studies will have to search for modifiable factors that are on the causal chain (as mediators and moderators) leading to the described associations.

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References

[1] Jensen MP, Hoffman AJ, Cardenas DD. Chronic pain in individuals with spinal cord injury: a survey and longitudinal study. Spinal Cord. 2005;43:704–712.

[2] Gironda RJ, Clark ME, Neugaard B, et al. Upper limb pain in a national sample of veterans with paraplegia. J Spinal Cord Med. 2004;27:120–127.

[3] Turner JA, Cardenas DD, Warms CA, et al. Chronic pain associated with spinal cord injuries: a community survey. Arch Phys Med Rehabil. 2001;82:501–509.

[4] Gellman H, Sie I, Waters RL. Late complications of the weight bearing upper extremity in the paraplegic patient. Clin Orthop. 1988;233:132–135.

[5] Eriks-Hoogland I, Engisch R, Brinkhof MW, et al. Acromioclavicular joint arthrosis in persons with spinal cord injury and able-bodied persons. Spinal Cord. 2013;51:59–63.

[6] Bayley JC, Cochran TP, Sledge CB. The weight-bearing shoulder. The impingement syndrome in paraplegics. J Bone Joint Surg Am. 1987;69:676–678.

[7] Figoni SF. Overuse shoulder problems after spinal cord injury: a conceptual model of risk and protective factors. Clin Kinesiol. 2009;63:12–22.

[8] Dyson-Hudson TA, Kirshblum SC. Shoulder pain in chronic spinal cord injury, part I: epidemiology, etiology, and pathomechanics. J Spinal Cord Med. 2004;27:4–17.

[9] Kulig K, Rao SS, Mulroy SJ, et al. Shoulder joint kinetics during the push phase of wheelchair propulsion. Clin Orthop Relat Res.1998;354:132–143.

[10] Gagnon D, Nadeau S, Noreau L, et al. Quantification of reaction forces during sitting pivot transfers performed by individuals with spinal cord injury. J Rehabil Med. 2008;40:468–476.

[11] Reyes ML, Gronley JK, Newsam CJ, et al. Electromyographic analysis of shoulder muscles of men with low-level paraplegia during a weight relief raise. Arch Phys Med Rehabil. 1995;76:433–439.

[12] Herberts P, Kadefors R, Hogfors C, et al. Shoulder pain and heavy manual labor. Clin Orthop Relat Res. 1984;191:166–178.

[13] Burnham RS, May L, Nelson E, et al. Shoulder pain in wheelchair athletes. The role of muscle imbalance. Am J Sports Med. 1993;21:238–242.

[14] Salisbury SK, Nitz J, Souvlis T. Shoulder pain following tetraplegia: a follow-up study 2-4 years after injury. Spinal Cord. 2006;44:723–728.

[15] Gutierrez DD, Thompson L, Kemp B, et al. The relationship of shoulder pain intensity to quality of life, physical activity, and community participation in persons with paraplegia. J Spinal Cord Med. 2007;30:251–255.

[16] Mulroy SJ, Hatchett P, Eberly VJ, et al. Shoulder strength and physical activity predictors of shoulder pain in people with paraplegia from spinal injury: prospective cohort study. Phys Ther. 2015;95:1027–1038.

[17] Brinkhof MWG, Fekete C, Chamberlain JD, et al. Swiss national community survey of functioning after spinal cord injury: protocol, characteristics of participants and determinants of non-response. J Rehabil Med. 2016;48:120–130.

[18] von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370:1453–1457.

[19] DeVivo MJ, Biering-Sorensen F, New P, et al. Standardization of data analysis and reporting of results from the International Spinal Cord Injury Core Data Set. Spinal Cord. 2011;49:596–599.

[20] Hinrichs T, Prodinger B, Brinkhof MWG, et al. Subgroups of epidemiological studies on spincal cord injury: evaluation of international recommendations in the Swiss Spinal Cord Injury Cohort Study. J Rehabil Med. 2015;48:141–148.

[21] Hinrichs T, Lay V, Arnet U, et al. Age-related variation in mobility independence among wheelchair users with spinal cord injury: a cross-sectional study. J Spinal Cord Med. 2015;39:180–189.

[22] Fekete C, Eriks-Hoogland I, Baumberger M, et al. Development and validation of a self-report version of the Spinal Cord Independence Measure (SCIM III). Spinal Cord. 2013;51:40–47.

[23] Mader L, Post MW, Ballert CS, et al. Metric properties of the Utrecht scale for evaluation of rehabilitation-participation (user-participation) in persons with spinal cord injury living in Switzerland. J Rehabil Med. 2015;48:165–174.

[24] Little RJA, Rubin DB. Statistical analysis with missing data. New York: John Wiley; 1987.

[25] Pentland WE, Twomey LT. Upper limb function in persons with long term paraplegia and implications for independence: part II. Paraplegia.1994;32:219–224.

[26] Jain NB, Higgins LD, Katz JN, et al. Association of shoulder pain with the use of mobility devices in persons with chronic spinal cord injury. PM R. 2010;2:896–900.

[27] Subbarao JV, Klopfstein J, Turpin R. Prevalence and impact of wrist and shoulder pain in patients with spinal cord injury. J Spinal Cord Med. 1995;18:9–13.

[28] Curtis KA, Drysdale GA, Lanza RD, et al. Shoulder pain in wheelchair users with tetraplegia and paraplegia. Arch Phys Med Rehabil. 1999;80:453–457.

[29] Widerstrom-Noga EG, Felipe-Cuervo E, Yezierski RP. Relationships among clinical characteristics of chronic pain after spinal cord injury. Arch Phys Med Rehabil. 2001;82:1191–1197.

[30] Luime JJ, Koes BW, Hendriksen IJ, et al. Prevalence and incidence of shoulder pain in the general population; a systematic review. Scand J Rheumatol. 2004;33:73–81.

[31] Andersson HI, Ejlertsson G, Leden I, et al. Chronic pain in a geographically defined general population: studies of differences in age, gender, social class, and pain localization. Clin J Pain. 1993;9:174–182.

[32] Schultz MM, Lee TQ, Nance PW. Musculoskeletal and neuromuscular implications of gender differences in spinal cord injury. Top Spinal Cord Inj Rehabil. 2001;7:72–86.

[33] Fillingim RB. Sex, gender, and pain: women and men really are different. Curr Rev Pain. 2000;4:24–30.

[34] Norrbrink Budh C, Lund I, Hultling C, et al. Gender related differences in pain in spinal cord injured individuals. Spinal Cord. 2003;41:122–128.

[35] Dalyan M, Sherman A, Cardenas DD. Factors associated with contractures in acute spinal cord injury. Spinal Cord. 1998;36:405–408.

[36] Westerkam D, Saunders LL, Krause JS. Association of spasticity and life satisfaction after spinal cord injury. Spinal Cord. 2011;49:990–994.

[37] Shaikh A, Phadke CP, Ismail F, et al. Relationship between botulinum toxin, spasticity, and pain: a survey of patient perception. Can J Neurol Sci. 2016;43:311–315.

[38] Adams MM, Hicks AL. Spasticity after spinal cord injury. Spinal Cord. 2005;43:577–586.

[39] St George CL. Spasticity. Mechanisms and nursing care. Nurs Clin North Am. 1993;28:819–827.

[40] Eriks-Hoogland IE, de Groot S, Post MW, et al. Passive shoulder range of motion impairment in spinal cord injury during and one year after rehabilitation. J Rehabil Med. 2009;41:438–444.
[41] Noreau L, Proulx P, Gagnon L, et al. Secondary impairments after spinal cord injury: a population-based study. Am J Phys Med Rehabil. 2000;79:526–535.
[42] Fullerton HD, Borckardt JJ, Alfano AP. Shoulder pain: a comparison of wheelchair athletes and nonathletic wheelchair users. Med Sci Sports Exerc. 2003;35: 1958–1961.
[43] Mulroy SJ, Thompson L, Kemp B, et al. Strengthening and optimal movements for painful shoulders (STOMPS) in chronic spinal cord injury: a randomized controlled trial. Phys Ther. 2011;91:305–324.
[44] World Health Organisation. International classification of functioning, disability and health: ICF. Geneva, Switzerland: WHO; 2001.
[45] Morreale RD, Donadio V, Boriani S, et al. Neuropathic pain following spinal cord injury: what we know about mechanisms, assessment and management. Eur Rev Med Pharmacol Sci. 2013;17:3257–3261.