J Rehabil Med 2017; 49: 489–496

ORIGINAL REPORT

CHRONIC PAIN, DEPRESSION AND QUALITY OF LIFE IN INDIVIDUALS WITH SPINAL CORD INJURY: MEDIATING ROLE OF PARTICIPATION

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Objective: **To test the hypotheses that: (*i*) pain is associated with depressive symptoms and quality of life; and (*ii*) participation restriction, satisfaction, and frequency mediate these relationships.**

Design: **Population-based, cross-sectional study.**

Subjects/patients: **Community-dwelling individuals with spinal cord injury (*n* = 1,549).**

Methods: **Hypotheses were tested in individuals with at least moderate chronic pain on the spinal cord injury – Secondary Conditions Scale (*n* = 834), applying structural equation modelling to data for spinal cord injury subgroups related to lesion severity (paraplegia, tetraplegia, complete, incomplete) and time since injury (≤ 10 vs ≥ 10 years). Model parameters included pain intensity (numerical rating scale), participation frequency, restriction, satisfaction (Utrecht Scale of Evaluation of Rehabilitation–Participation; USER-Participation), depressive symptoms (5-item Mental Health Index of the Short Form Health Survey; MHI-5), and 5 selected quality of life items (World Health Organization Quality of Life Scale; WHOQoL-BREF).**

Results: **Structural equation models confirmed associations of pain with depressive symptoms and quality of life, as well as the mediating role of participation restriction and low satisfaction with participation. These findings were apparent in individuals with tetraplegia or complete lesion and in those ≤ 10 years since paraplegia or incomplete injury.**

Conclusion: **Unrestricted or satisfactory participation was found to be a crucial resource for individuals living less than 10 years with a more severe spinal cord injury, since it represents buffering potential for the negative effects of chronic pain on mental health and quality of life.**

Key words: spinal cord injury; pain; depression; quality of life.

Accepted Apr 13, 2017; Epub ahead of print Jun 8, 2017

J Rehabil Med 2017; 49: 489–496

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The majority of individuals with spinal cord injury (SCI) report persistent pain (1), usually of more than one aetiology (e.g. nociceptive, neuropathic) (2), experienced at multiple body locations and, in one-third of subjects, of severe intensity (2, 3). Theoretical models, such as the fear-avoidance model (4) and model of disability (5), illustrate that pain can lead to avoidance of, and withdrawal from, daily activities, which may result in mental distress (e.g. helplessness, depression) and exacerbation of pain. Empirical studies in SCI corroborate these theories and indicate that pain can significantly restrict occupational participation, recreational and social activities, communication with others, or the acquisition of new information or skills (6, 7). Pain has further been found to be associated with increased risk of developing depression (6), which may be due to the sharing of common biological pathways and neurotransmitter mechanisms (8). However, research in SCI suggests that the ways in which pain restricts participation in daily activities seem to have a much greater negative influence on depression than on pain intensity alone (9). Ultimately, the pain-induced decline in psychosocial functioning may reduce a person's quality of life (6).

The causal pathways linking persistent pain with an increase in depressive symptoms and deterioration in quality of life are poorly understood in the context of SCI. In particular lack of knowledge regarding the mediating role of participation may limit the options for effective pain treatment. The level of participation varies with lesion type (paraplegia, tetraplegia, complete, incomplete) and time since injury[1] (10). Consequently, in testing theoretical assumptions concerning pain in individuals with SCI, lesion severity and time living with a disability must be considered. The aim of this study was therefore to test the following hypotheses in subsamples of individuals with SCI: (*i*) that pain is associated with depressive symptoms and quality of life; and (*ii*) that participation restriction, satisfaction, and frequency mediate these relationships.

[1]Gross-Hemmi MH, Post MWM, Bienert S, Weiss A, Brinkhof MW. Determining the extent and associated factors of participation in persons living with spinal cord injury in Switzerland. Swiss Paraplegic research, 2016 (unpublished).

Journal Compilation © 2017 Foundation of Rehabilitation Information. ISSN 1650-1977 doi: 10.2340/16501977-2241

METHODS

Study design

Cross-sectional survey data were collected between late 2011 and early 2013 for the Swiss Spinal Cord Injury (SwiSCI) cohort study (11). In collaboration with 4 Swiss SCI rehabilitation clinics, the national organization for persons living with SCI (Swiss Paraplegic Association) and SCI-specific home care institutions (ParaHelp), SwiSCI includes individuals 16 years of age or older with permanent residence in Switzerland and a diagnosed traumatic or non-traumatic SCI. Individuals with congenital conditions resulting in para- or tetraplegia (e.g. spina bifida), new SCI in the context of other neurological disorders, such as multiple sclerosis, amyotrophic lateral sclerosis, or Guillain-Barré syndrome, were excluded. SwiSCI follows national and international standards for research in humans and was approved by cantonal ethics committees. All participants gave written informed consent for the use of their data. Details of the SwiSCI study protocol, design, procedure and data quality have been reported previously (12, 13).

Participants were invited to complete self-report questionnaires in paper-pencil form, via online secure server or telephone interviews. Participants were first asked to complete a short questionnaire about demographic, injury-related and socioeconomic characteristics. A second questionnaire about health, functioning, participation and well-being was subsequently sent to participants who consented and returned the first questionnaire. A total of 1,549 individuals out of 3,144 initial participants completed the second questionnaire, indicating a cumulative response rate of 49.3% presenting marginal non-response bias (12, 13). For the current study, data from the first and the second questionnaires were analysed.

Variables and instruments

Injury severity was assessed by asking participants to indicate level (tetraplegia, paraplegia) and completeness (complete, incomplete) of the lesion. Referring to the American Spinal Injury Association Impairment Scale (AIS) (14) responses were combined to: complete tetraplegia (C1–C8, AIS A), incomplete tetraplegia (C1–C8, AIS B, C or D), complete paraplegia (T1–S5, AIS A) and incomplete paraplegia (T1–S5 AIS B, C, or D).

To evaluate pain, participants were asked to indicate if they had experienced pain in the past week ("yes" or "no"). If "yes", respondents were further invited to indicate the mean pain intensity on a 10-level numeric rating scale (NRS), ranging from "no pain" to "worst possible pain". NRS is recommended as a core outcome measure of pain intensity in clinical research (15). To address pain chronicity, 1 item of the Spinal Cord Injury Secondary Conditions Scale (SCI-SCS) (16) was used. The SCI-SCS has been found to be a reliable and valid measure to assess the most frequently occurring secondary health conditions in SCI, including chronic pain (16). Respondents are asked to indicate on a 4-point scale the perceived frequency and severity of chronic pain in the past 3 months ("not existing or insignificant problem" [no], "mild or infrequent problem" [mild], "moderate or occasional problem" [moderate], or "significant or chronic problem" [significant]).

Participation was assessed using the 32-item Utrecht Scale of Evaluation of Rehabilitation-Participation (USER-Participation) (17). The USER-Participation consists of 3 subscales measuring frequency, restriction and satisfaction of participation, and has been found to adequately assess participation in individuals with SCI (18). The frequency scale includes 4 items assessing hours of productive activities per week (e.g. work, household) and 7 items assessing frequency of leisure activities in the last 4 weeks (e.g. sports, meeting with friends and family). The 11-item restriction scale asks respondents to indicate perceived difficulty in performing certain activities (e.g. work, leisure activities and visit family and friends) on a 4-point scale, ranging from "not possible" to "no difficulty at all". The response option "not applicable" is available in case the respective activity was not performed by the respondent but not due to SCI. The 10-item satisfaction scale addresses satisfaction with work-related, leisure and social activities using a 6-point scale, ranging from "not satisfied at all" to 5 "very satisfied". A "not applicable" response option is available for "work/education" and "relationship". Sum scores of each scale are based on all applicable items and are converted to a 0–100 scale. To assure proper metrics, a Rasch-conversion key (18) from anchored analyses (addressing items with structural missing, i.e. "work/education" and "relationship") was used to transform sum scores of the restriction subscale. Higher scores indicate higher frequency of participation, less restriction and higher satisfaction, respectively.

Depressive symptoms were assessed applying the 5-item Mental Health Index MHI-5 of the Short Form Health Survey (SF-36) (19). The MHI-5 was shown reliable and valid to assess depressive symptoms in individuals with disabilities (20). The questionnaire asks respondents to indicate frequency of feeling "nervous", "down in the dumps", "calm and peaceful", "downhearted and blue", or "happy" in the last 4 weeks. Responses are given on a 5-point scale, ranging from "always" to "never". Sum scores were converted into a 0–100 scale, with lower scores indicating lower mental health or higher levels of depressive symptoms.

Quality of life was measured using 5 selected items of the World Health Organization Quality of Life Scale (WHOQoL-BREF), which convey good reliability and validity for the assessment of quality of life in individuals with SCI (21). Respondents are asked to rate their satisfaction with overall quality of life and 4 different life domains (i.e. health, daily activities, relationships, and living conditions) on a 5-point response scale ranging from "very dissatisfied" to "very satisfied". Mean scores were calculated (higher scores indicate higher quality of life).

Analyses

Structural equation modelling (SEM) was performed in "R" (22) and its "lavaan (Latent Variable Analyses)" package (23) to investigate the hypotheses for the association between pain, participation, depressive symptoms and quality of life. SEM aims to investigate how well a specified model is explained by the sample data (24). Parcels were applied to incorporate measurement errors into the model to reduce bias of the parameter estimates (25). For depressive symptoms, 2 parcels, each including negative items and connoted positive items, respectively, were constructed. For quality of life, 1 parcel included the overall quality of life item, the other parcel consisted of the 4 domain items. Requirements to avoid biased results by applying SEM include a sufficiently large sample size, normally distributed data and non- multicollinearity among variables of interest (26). Testing the hypotheses in 834 individuals with at least a moderate chronic pain problem is above the minimal recommended sample size ($n = 200$) for SEM (26). Sample size of subgroups recommended by the International Spinal Cord Society (ISCoS) (27) with regards to lesion severity (i.e. paraplegia complete, paraplegia incomplete, tetraplegia complete,

tetraplegia incomplete) and times since injury (groups of 5 years, i.e. 1–5, 6–10, 11–15 years) were too small to apply SEM. We therefore tested the models in individuals with tetraplegia vs. paraplegia, incomplete vs. complete and individuals living with SCI less than 10 years compared with longer than 10 years. Concerning data distribution, absolute values of skewness (all ≤2) and kurtosis (all ≤7) were acceptable (26) (Table II). Finally, no multicollinearity (Pearson's correlations ≤0.85) among variables included in the model was apparent (Table III).

How well a specified model is explained by the sample data is determined by a number of fit indices. The χ^2 test shows model misspecification (26) where a non-significant χ^2 ($p>0.05$) indicates that the specified model does not diverge significantly from the observed associations in the data. The comparative fit index (CFI) compares the fit of the specified model to the fit of an independent model (model in which the variables are assumed to be uncorrelated). CFI ≥0.90 indicates acceptable model fit (0=worst possible model; 1=best possible model) (28). Root mean square error of approximation (RMSEA) indicates how well the specified model fits the population's covariance matrix taking sample size and model complexity into account. RMSEA ≤0.10 with an upper bound of the 90% confidence interval (95% CI) of ≤0.10 designate acceptable model fit (29). Finally, standardized root mean square residual (SRMR) indicates the sum (mean) difference between the observed correlations and the correlations implied in the model (a mean of 0 indicates no difference, thus perfect model fit). SRMR ≤0.10 indicates acceptable model fit (28). To examine the strength of the associations between variables in the model, we used standardized estimates for path coefficients. Path coefficients may be interpreted as regression coefficients (β) (26), with values greater than 0.50 referring to a strong, approximately 0.30 to a medium and approximately 0.10 to a weak association (30). To determine potential mediation effects, significance ($p\leq0.05$) of indirect associations (i.e. effects of pain on depressive symptoms and quality of life via participation frequency, restriction and satisfaction) was tested.

Preparatory analyses included descriptive statistics (stratified by severity of chronic pain, lesion severity, and time since injury), correlations and comparisons among variables of interest performed in PASW Statistics (Version 18.0 for Windows, SPSS Inc., Chicago, IL, USA) and Stata (Version 13.1 for Windows, College Station, TX, USA). To evaluate the impact of outliers, sensitivity analyses consisted of comparing descriptive statistics of the total sample with potential sample outliers (i.e. participants who reported having no pain in the past week while indicating significant chronic pain ($n=18$)). Results indicated no significant differences concerning demographics and injury-related characteristics, but outliers were more frequent in the older age group (61+ years). Concerning item non-response, descriptive analyses were performed on complete case data reporting percentage of missing data. To consider missing data in SEM, full information maximum likelihood (FIML) estimation were used (31). The FIML approach computes a case-wise likelihood function using only those variables that are observed. The FIML algorithm does not impute missing values, but rather "borrows" information from the observed portion of the data, which is conceptually analogous to replacing missing data points with the conditional expectation of missing data, given the observed data.

Comparative analyses between individuals with a chronic pain problem and those with no chronic pain problem were performed applying analyses of variance (ANOVA) reporting F statistics. The two groups were determined based on adjusted Wald test, ($F(1,1548)=2.60$; $p=0.11$) indicating that the 2 ordinal scaled categories (i.e. "not existing or insignificant problem" [no] and "mild or infrequent problem" [mild]) were indistinguishable. Consequently, the 2 groups "no" and "mild" chronic pain were collapsed into a single group and compared with the group with "moderate/significant" chronic pain problem.

RESULTS

Table I shows that the majority of the study sample was male (72%) with a median of age of 52 years (interquartile range (IQR) 42–63 years). Almost two-thirds of the sample had paraplegia (complete 32%, incomplete 38%). Median time since injury was 14 years (IQR 6–25 years). With regards to chronic pain, 36.9% (95% CI 34.3–39.5) reported a significant, 21.0% (95% CI: 18.9–23.2) a moderate, 15.6% (95% CI: 13.7–17.6) a mild and 26.5% (95% CI: 24.3–28.9) no chronic pain problem (overall 73.5% reported chronic pain). A total of 834 participants (57.9%) reported at least a moderate chronic pain problem (mean pain intensity 6.23 (SD 1.88)), of whom 49.2% scored lower than the proposed MHI-5 cut-off point 74 identifying cases of major depression (32) and 57.2% scored lower than the suggested MHI-5 cut-off point 76 representing cases of mental disorder (33).

Participants with moderate to significant chronic pain reported higher participation restrictions ($F(1,719)=39.42$, $p<0.001$), lower satisfaction with ($F(11,202)=53.60$, $p<0.001$) and lower frequency of participation ($F(1,723)=49.27$, $p<0.001$), higher levels of depressive symptoms ($F(11,322)=110.71$, $p<0.001$) and lower quality of life ($F(11,384)=145.60$, $p<0.001$) compared with individuals with no or mild chronic pain problem (Table II).

Pain intensity correlated with higher depressive symptoms ($r=-0.19$, $p<0.01$), higher participation restriction ($r=-0.25$, $p<0.01$), less satisfaction ($r=-0.20$, $p<0.01$), lower participation frequency ($r=-0.11$, $p<0.01$), and lower quality of life ($r=-0.27$, $p<0.01$). These correlations substantiate structural associations between the variables included in SEM (Table III).

Testing the 3 potential mediators (participation frequency, restriction and satisfaction) in all individuals who indicated having at least a moderate chronic pain problem ($n=834$) showed acceptable model fit indices. However, significant χ^2 tests indicated that the specified models do not represent observed associations in the data (all χ^2 tests <0.05).

Testing the 3 potential mediators (participation frequency, restriction and satisfaction) in subgroups of disability severity (paraplegia, tetraplegia, incomplete, complete) and time since injury (more than 10 years, less than 10 years) showed different indications of model fit (Table IV). Models for individuals with

Table I. Descriptive characteristics of study sample stratified by severity of chronic pain, lesion severity, and time since injury ($n = 1,549$)

Indicator variable [missing, *n* (%)]	*n* (%)	Chronic pain problem in the past 3 months			
		No *n* (%; 95% CI)	Mild *n* (%; 95% CI)	Moderate *n* (%; 95% CI)	Significant *n* (%; 95% CI)
Chronic pain [104 (6.7)]		387 (26.5; 24.3–28.9)	224 (15.6; 13.7–17.6)	305 (21.0; 18.9–23.2)	529 (36.9; 34.3–39.5)
Sex [0]					
Male	1,107 (71.5)	287 (27.6; 25.0–30.4)	179 (17.2; 15.0–19.7)	220 (21.2; 18.8–23.8)	353 (34.0; 31.1–36.9)
Female	442 (28.5)	100 (24.6; 20.7–29.1)	45 (11.1; 8.3–14.5)	85 (20.9; 17.2–25.2)	176 (43.3; 38.6–48.2)
Age, median, IQR [0]	52.0, 42–63				
16–30 years	129 (8.3)	56 (44.8; 36.2–53.7)	34 (27.2; 20.0–35.8)	15 (12.0; 7.3–19.1)	20 (16.0; 10.5–23.6)
31–45 years	377 (24.3)	100 (27.6; 23.4–32.5)	76 (21.0; 17.1–25.5)	75 (20.7; 16.8–25.2)	111 (30.7; 26.1–35.6)
46–60 years	571 (36.9)	131 (23.9; 20.5–27.7)	72 (13.2; 10.6–16.3)	122 (22.3; 19.0–26.0)	222 (40.6; 36.5–44.8)
≥ 61 years	472 (30.5)	124 (26.3; 22.5–30.4)	42 (8.9; 6.6–11.8)	100 (21.2; 17.7–25.1)	206 (43.6; 39.2–48.1)
Marital status [12 (0.8)]					
Single (never married)	450 (29.3)	129 (30.3; 26.1–34.8)	91 (21.4; 17.7–25.5)	92 (21.6; 17.9–25.8)	114 (26.8; 22.8–31.2)
Married	806 (55.9)	197 (26.2; 23.1–29.4)	99 (13.1; 10.9–15.8)	157 (20.8; 18.1–23.9)	300 (39.8; 36.4–43.4)
Divorced	198 (12.9)	37 (20.6; 15.2–27.2)	26 (14.4; 10.0–20.4)	39 (21.7; 16.2–28.3)	78 (43.3; 36.2–50.7)
Widowed	74 (4.8)	19 (28.4; 18.7–40.6)	4 (6.0; 2.2–15.2)	14 (20.9; 12.6–32.6)	30 (44.8; 33.1–57.1)
Registered partnership	9 (0.6)	5 (55.6; 19.5–86.6)	2 (22.2; 3.9–67.0)	1 (11.1; 0.9–62.6)	1 (11.1; 0.9–62.6)
Education in years/median, IQR [32 (2.1)]	13.0, 12–15				
Compulsory schooling	143 (9.4)	30 (25.6; 18.5–34.4)	18 (15.4; 10.0–23.2)	18 (15.4; 10.0–23.2)	51 (43.6; 34.8–52.8)
Vocational training	377 (24.8)	104 (29.9; 25.2–34.9)	35 (10.1; 7.3–1.7)	72 (20.7; 16.7–25.3)	137 (39.4; 34.3–44.6)
Secondary education	721(47.5)	182 (26.5; 23.4–30.0)	103 (15.0; 12.5–17.9)	155 (22.6; 19.6–25.9)	246 (35.9; 32.3–39.5)
University education	276 (18.2)	69 (25.7; 20.8–31.4)	62 (23.1; 18.4–28.6)	56 (20.9; 16.4–26.2)	81 (30.2; 25.0–36.0)
Occupational status[a] [12 (0.8)]					
Employed	684 (44.5)	209 (31.8; 28.3–35.4)	138 (21.0; 18.0–24.2)	140 (21.3; 18.3–24.6)	171 (26.0; 22.8–29.5)
Unemployed[b]	362 (23.6)	103 (30.3; 25.6–35.4)	41 (12.0; 9.0–16.0)	71 (21.0; 16.9–25.6)	125 (36.8; 31.8–42.0)
Invalidity pension	752 (48.9)	166 (23.2; 20.3–26.5)	91 (12.7; 10.5–15.4)	160 (22.4; 19.5–25.6)	297 (41.6; 38.0–45.3)
Retired	380 (24.7)	71 (21.6; 17.5–26.5)	43 (13.1; 9.9–17.2)	76 (23.2; 18.9–28.1)	138 (42.1; 36.8–47.5)
Lesion severity [12 (0.8)]					
Paraplegia, incomplete	577 (37.5)	142 (26.7; 23.1–30.6)	73 (13.7; 11.0–16.9)	109 (20.5; 17.2–24.1)	208 (39.1; 35.0–43.3)
Paraplegia, complete	486 (31.6)	112 (24.4; 20.7–28.6)	79 (17.2; 14.0–21.0)	92 (20.0; 16.6–24.0)	176 (38.3; 34.0–42.9)
Tetraplegia, incomplete	314 (20.4)	77 (26.0; 21.3–31.3)	46 (15.5; 11.8–20.2)	75 (26.3; 20.7–30.6)	98 (33.1; 28.0–38.7)
Tetraplegia, complete	160 (10.4)	54 (36.5; 29.1–44.6)	25 (16.9; 11.6–23.9)	27 (18.2; 12.8–25.4)	42 (28.4; 21.6–36.3)
Time since injury, median, IQR [27 (1.7)]	13.5, 6–25				
≤ 5 years	308 (20.2)	82 (28.4; 23.4–33.9)	43 (14.9; 11.2–19.5)	65 (22.5; 18.0–27.7)	99 (34.3; 29.0–40.0)
6–15 years	493 (32.4)	103 (25.2; 21.3–29.7)	65 (15.9; 12.7–19.8)	71 (17.4; 14.0–21.4)	169 (41.4; 36.7–46.3)
16–25 years	332 (21.8)	79 (27.7; 22.8–33.2)	55 (19.3; 15.1–24.3)	56 (19.6; 15.4–24.7)	95 (33.3; 28.0–39.0)
≥ 26 years	389 (25.5)	94 (28.6; 23.9–33.7)	46 (14.0; 10.6–18.2)	73 (22.2; 18.0–27.0)	116 (35.3; 30.3–40.6)
Lesion aetiology [15 (1.0)]					
Traumatic	1,202 (78.4)	316 (27.8; 25.3–30.5)	190 (16.7; 14.7–19.0)	236 (20.8; 18.5–23.3)	393 (34.6; 31.9–37.4)
Non–traumatic	332 (21.6)	69 (23.3; 18.8–28.5)	31 (10.5; 7.4–14.5)	66 (22.3; 17.9–27.4)	130 (43.9; 38.3–49.7)

Percentages in table are calculated excluding missing values. [a]More than one selection/specification possible.
[b]Unemployed includes also "in education", "unpaid work", "homemaker", "other situations".
95% CI: 95% confidence interval; IQR: interquartile range.

Table II. Descriptive characteristics of outcome variables participation, depressive symptoms and quality of life for participants who indicated a moderate/significant chronic pain problem ($n = 834$) and for participants with no/mild chronic pain problem ($n = 611$)

Variable	Range	No/mild chronic pain problem		Moderate/significant chronic pain problem					
		Missing *n* (%)	Mean (SD)	Missing *n* (%)	Mean (SD)	Skewness[a]	Kurtosis[a]	Between-group differences *p*	F(df)
Pain intensity (NRS)	1–10			88 (10.55)	6.23 (1.88)	–0.11	1.78		
Participation (USER-Participation)									
Frequency									
Hours of productive activities per week[b]	1–6	61 (9.98)	2.20 (0.68)	112 (13.43)	1.91 (0.61)	0.29	–0.63		
Frequency of leisure activities in the last 4 weeks[c]	1–6	39 (6.38)	3.46 (0.81)	84 (10.01)	3.27 (0.81)	0.10	–0.25		
Frequency total score	0–100		47.38 (9.43)		43.46 (9.05)	–0.16	–0.31	< 0.01	53.60 (11,202)
Restrictions	0–100	[d]	76.61 (20.82)	[d]	66.88 (20.63)	–0.37	–0.60	< 0.01	39.47 (1,719)
Satisfaction	0–100	[d]	75.69 (15.71)	[d]	66.73 (18.58)	–0.97	1.18	< 0.01	49.27 (1,723)
Depressive symptoms (MHI-5)	5–30	37 (6.06)	77.76 (15.37)	86 (10.31)	67.88 (18.00)	–0.65	0.18	< 0.01	110.71 (11,322)
Quality of life (5 selected items WHOQOL-BREF)	1–5	17 (2.78)	3.97 (0.67)	44 (5.28)	3.52 (0.71)	–0.45	–0.38	< 0.01	145.60 (11,384)

[a]Distribution criteria for structural equation modelling: skewness ≤ 2; kurtosis ≤ 7.
[b]1 = None at all; 2 = 1–8 h; 3 = 9–16 h; 4 = 17–24 h; 5 = 25–35 h; 6 = 36 h or more.
[c]1 = Never; 2 = 1–2 times; 3 = 3–5 times; 4 = 6–10 times; 5 = 11–18 times; 6 = 19 times or more.
[d]Rasch derived scores.
IQR: interquartile range; NRS: numeric rating scale; SCI-SCS: Spinal Cord Injury Secondary Conditions Scale; USER-Participation: Utrecht Scale of Evaluation of Rehabilitation-Participation; MHI-5: Mental Health Index; WHOQOL-BREF: World Health Organization Quality of Life Scale.

Table III. Pearson correlation between outcome participation, depressive symptoms and quality of life ($n = 834$)

	PI	PF	PR	PS	D	QoL
Pain intensity (PI)	1.000					
Participation frequency (PF)	−0.111**	1.000				
Participation restrictions (PR)	−0.254**	0.496**	1.000			
Participation satisfaction (PS)	−0.203**	0.345**	0.506**	1.000		
Depressive symptoms (D)	−0.188**	0.229**	0.350**	0.566**	1.000	
Quality of life (QoL)	−0.271**	0.324**	0.462**	0.640**	0.631*	1.000

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

tetraplegia ($n = 242$) and individuals with complete lesion ($n = 337$) showed good fit. Models with good fit indices were also found for individuals living less than 10 years with paraplegia ($n = 223$) or incomplete lesion ($n = 220$).

Participation restriction was a mediator between pain intensity and depressive symptoms and quality of life, respectively, in individuals with tetraplegia (indirect effect: $\beta = 0.09$; $p < 0.03$; $\beta = 0.13$; $p < 0.01$), individuals with complete lesion (indirect effect: $\beta = 0.13$; $p < 0.01$; $\beta = 0.06$; $p < 0.04$) and individuals living less than 10 years with paraplegia (indirect effect: $\beta = 0.19$; $p < 0.01$; $\beta = 0.11$; $p < 0.01$) and/or incomplete lesion (indirect effect: $\beta = 0.17$; $p < 0.01$; $\beta = 0.17$; $p < 0.01$) (Fig. 1). Participation satisfaction mediated the effects of pain intensity on depressive symptoms and quality of life, in individuals with tetraplegia (indirect effect: $\beta = 0.14$; $p < 0.01$; $\beta = 0.16$; $p < 0.01$) and individuals living less than 10 years with an incomplete lesion (indirect effect: $\beta = 0.17$; $p < 0.01$; $\beta = 0.15$; $p < 0.01$) (Fig. 2). Participation frequency did not mediate the effects of pain intensity on depressive symptoms and quality of life, instead, pain intensity showed a direct effect on depressive symptoms (Fig. 3).

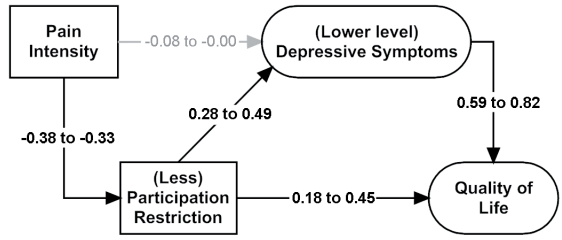

Fig. 1. Model scheme showing the mediating role of participation restriction in the relationships of pain intensity with depressive symptoms and quality of life. Pertinent spinal cord injury (SCI) subgroups include individuals with tetraplegia ($n = 242$), with a complete lesion ($n = 337$), living less than 10 years with paraplegia ($n = 223$) or with an incomplete lesion ($n = 220$). Numbers on connecting arrows indicate the range of path coefficients across SCI subgroups, with bold font indicating significant associations, grey font indicating insignificant associations.

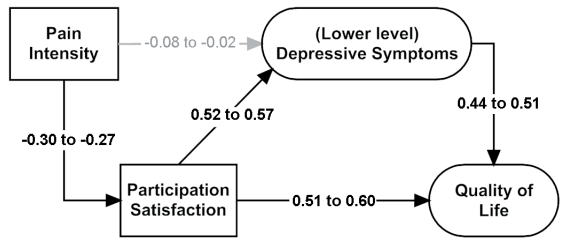

Fig. 2. Model scheme showing the mediating role of participation satisfaction in the relationships of pain intensity with depressive symptoms and quality of life. Pertinent spinal cord injury (SCI) subgroups include individuals with tetraplegia ($n = 242$) and individuals living less than 10 years with an incomplete lesion ($n = 220$). For further information see Fig. 1.

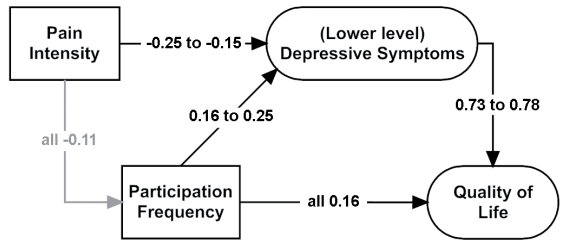

Fig. 3. Model scheme showing the mediating role of participation frequency in the relationships of pain intensity with depressive symptoms and quality of life. Pertinent spinal cord injury (SCI) subgroups include individuals with tetraplegia ($n = 242$) and individuals living less than 10 years with an incomplete lesion ($n = 220$). For further information see Fig. 1.

Table IV. Fit indices of structural equation modelling (SEM) in all individuals who indicated having at least a moderate chronic pain problem ($n = 834$), in individuals with chronic pain and a tetraplegia (n=242), chronic pain and a complete lesion ($n = 337$) and individuals with chronic pain living less than 10 years with a paraplegia and/or incomplete lesion

	Participation											
	Restriction				Satisfaction				Frequency			
SCI subgroups	χ^2 (p-value)	CFI	RMSEA (90% CI)	SRMR	χ^2 (p-value)	CFI	RMSEA (90% CI)	SRMR	χ^2 (p-value)	CFI	RMSEA (90% CI)	SRMR
All	10.12 (0.00)	0.98	0.10 (0.05–0.17)	0.02	13.79 (0.00)	0.98	0.12 (0.07–0.19)	0.03	21.74 (0.00)	0.96	0.16 (0.10–0.22)	0.03
Tetraplegia	**4.73 (0.58)**	**1.00**	**0.00 (0.00–0.07)**	**0.02**	**6.00 (0.42)**	**1.00**	**0.00 (0.00–0.08)**	**0.02**	**10.66 (0.10)**	**0.99**	**0.06 (0.00–0.11)**	0.03
Complete	**12.12 (0.06)**	**0.99**	**0.06 (0.00–0.07)**	**0.02**	12.55 (0.05)	0.99	0.06 (0.00–0.10)	0.03	15.68 (0.02)	0.98	0.07 (0.03–0.11)	0.03
Paraplegia, TSI ≤ 10 years	**9.12 (0.17)**	**0.99**	**0.05 (0.00–0.07)**	**0.02**	13.62 (0.03)	0.98	0.08 (0.02–0.13)	0.04	14.74 (0.02)	0.98	0.08 (0.03–0.13)	0.03
Incomplete, TSI ≤ 10 years	**3.85 (0.70)**	**1.00**	**0.00 (0.00–0.07)**	**0.02**	**8.60 (0.20)**	**0.99**	**0.04 (0.00–0.11)**	**0.03**	**12.11 (0.06)**	**0.99**	**0.07 (0.00–0.12)**	**0.03**

Bold: models showing adequate fit. SCI: spinal cord injury; TSI: time since injury; CFI: comparative fit index; RMSEA: root mean square error of approximation; CI: confidence interval; SRMR: standardized root mean square residual.

DISCUSSION

The present community-based study in SCI showed that individuals with moderate to significant chronic pain participate less, are more restricted in and less satisfied with participation, and have higher levels of depressive symptoms, and lower quality of life than individuals with no or mild chronic pain. Unrestricted or satisfactory participation was found to be a crucial resource for individuals living less than 10 years with a more severe SCI, since it represents buffering potential for the negative effects of chronic pain on mental health and quality of life.

The current findings confirm pain theories, but the buffering potential of participation appeared conditional on the severity of disability. In particular, individuals with a more severe SCI (tetraplegia or complete lesion) seem to benefit from participation in terms of being protected from the negative effects of pain on mental health and quality of life, but not individuals with a less severe disability. Although individuals with a more severe disability have been found to be more restricted in and less satisfied with participation compared with individuals with a less severe SCI[1] (10), it seems particularly important for these individuals to participate and make use of its protective potential (34). In individuals with less severe disability other buffering mechanisms than participation might be present. Since individuals with a less severe disability are likely more independent and less restricted in participation, perceived social support might be more powerful mediator between pain intensity and well-being. For example, perceived social support was found to be associated with positive pain outcomes in SCI samples (35). On the other hand, pain-contingent social support (i.e. solicitous responses, e.g. offers to take over tasks or encouragement to become less active) was identified as potential risk factor for poorer pain outcomes in SCI (35).

The buffering potential of unlimited and satisfying participation was also particularly effective in persons living with SCI for less than 10 years. In acute SCI rehabilitation, pain was found to be independent of depression at admission, but significantly related at discharge (36). In the following 2–3.5 years, mental health and quality of life were found to improve over time in individuals with pain, and changes in quality of life were found to be correlated with changes in how pain interferes with daily activities (37, 38). For individuals living longer than 10 years with a disability, along with the adjustment process, other factors might protect the individual from the negative effect of pain on mental health and quality of life. Coping responses containing an acceptance of the pain and a change from a passive coping to gain pain relief (e.g. avoidance, asking for assistance) to engagement in active coping (e.g. task persistence, ignoring pain) were found to be associated with better pain outcomes and improved functioning (35).

Findings further underlined the relative unimportance of participation frequency in terms of protecting the person from the negative effects of pain. It seems to be more important that the affected person feels free to do and enjoy a certain activity. Although participation frequency is an important objective indicator concerning the extent of engagement in certain activities, validity of frequency performing certain activities as a measure of participation has been found to be limited in individuals with SCI (18). In addition, as in many other life domains, quality (satisfaction) seems to be more beneficial for physical and mental health than quantity (frequency), as it has been shown with regards to social activity and support (39).

Finally, this study found no direct association between pain intensity and depressive symptoms, which contradicts findings referring to shared biochemical mechanisms of depression and pain (8). Evidence in SCI suggests that levels of depression are more responsive to participation restrictions in everyday life than to pain intensity per se (9). In general, participation provides sources for positive reinforcement and experience of positive affect (e.g. being esteemed, valued and having a sense of belonging and purpose in life) and is strongly related to well-being (40). In contrast, social isolation (i.e. absence of fulfilling and quality relationships, lack of feeling of social belonging, limited social engagement and contacts) is a strong predictor for the development of major depression (41).

Clinical implications

Contemporary treatment of chronic pain is multimodal and informed by a biopsychosocial model of pain that includes pharmacological, psychological, and social interventions. Based on the findings of the present study, intervention should focus on strengthening the buffering potential of participation, in particular a reduction in perceived participation restrictions and an increase in satisfaction with participation. Instrumental, emotional and informational social support (39), including peer counselling (42), are external resources associated with higher levels of participation and life satisfaction after SCI and represent potential intervention targets and contents. Internal resources, such as disability-management self-efficacy (43),

[1]Gross-Hemmi MH, Post MWM, Bienert S, Weiss A, Brinkhof MW. Determining the extent and associated factors of participation in persons living with spinal cord injury in Switzerland. Swiss Paraplegic research, 2016 (unpublished).

pain acceptance (44), optimism (45), social skills and problem solving (39), mindfulness and gratitude (45), represent additional intervention targets with the potential to enhance participation in individuals with SCI and chronic pain. Based on the current findings these interventions should be conducted early after SCI and in particular for individuals with severe disability in order to minimize the impact of pain on mental health and quality of life.

Study limitations

Cross-sectional data were used in the current study to explore associations depicted in pain theory. Causality cannot be inferred and additional longitudinal studies are necessary to identify the position of pain, participation, depressive symptoms and quality of life on the causal time chain. For example, many pain models indicate an exacerbation of pain via a negative feedback loop involving depression. However, the question of what was first, pain or depression, cannot be answered per se, since research confirms both directions with an elevated risk for individuals with chronic pain to develop depression and depressed individuals to have an increased risk for developing chronic pain (e.g. (46)). In the latter case, other mediation mechanisms between depression and pain, such as selective attention on pain symptoms (5), can be assumed. We examined lesion severity and time since injury as potential moderator, since both were found to influence participation. Pain type (i.e. nociceptive, neuropathic) influences pain experience and may also affect participation. Although it is fundamental to carefully determine pain aetiology and classify pain type for pain treatment, the majority of individuals with SCI and chronic pain report more than one pain type (3), which precludes the evaluation of moderation by distinct type of pain. Study limitations also included the use of self-report measures for all variables included in the tested models, since larger associations are more likely to occur due to shared method variance. In addition, non-response analyses were based on current age, sex, language (German, French, Italian), membership of Swiss Paraplegic Association, lesion level and time since injury. However, non-response might also depend on other factors not available for the non-response analysis. In general, it can be expected that survey participants are more likely the selected "happy few" with long-term high-quality participation. In addition, chronic pain is a risk factor for mortality (47), this survival-bias is probably present for survey participation. Finally, our community-based study sample may not be representative of the target population. However, this risk was minimized by recruiting participants using a combination of several databases, including rehabilitation hospitals, the Swiss patient association and a home-care institution for SCI (12).

Conclusion

Unrestricted or satisfactory participation was found to be a crucial resource for individuals living less than 10 years with a more severe SCI, since it represents buffering potential for the negative effects of chronic pain on mental health and quality of life. The potential protective effect of participation can be strengthened via fostering external (e.g. social support, peer counselling) and internal resources (e.g. self-efficacy, optimism, social skills). To inform the development of targeted interventions, there is a need for longitudinal evidence in support of the causal relationships between pain, participation, depressive symptoms and quality of life.

ACKNOWLEDGEMENTS

This study has been financed in the framework of the Swiss Spinal Cord Injury Cohort Study (SwiSCI, www.swisci.ch), supported by the Swiss Paraplegic Foundation. The members of the SwiSCI Steering Committee are: Xavier Jordan, Bertrand Léger (Clinique Romande de Réadaptation, Sion); Michael Baumberger, Hans Peter Gmünder (Swiss Paraplegic Center, Nottwil); Armin Curt, Martin Schubert (University Clinic Balgrist, Zürich); Margret Hund-Georgiadis, Kerstin Hug (REHAB Basel, Basel); Hans Georg Koch, (Swiss Paraplegic Association, Nottwil); Hardy Landolt (representative of persons with SCI, Glarus); Nadja Münzel (ParaHelp, Nottwil); Mirjam Brach, Gerold Stucki (Swiss Paraplegic Research, Nottwil); Martin Brinkhof (SwiSCI Study Center at Swiss Paraplegic Research, Nottwil).

The authors declare no conflicts of interest.

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