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ARTICLE

Factors associated with labor market participation of persons with traumatic SCI in Switzerland: analyzing the predictive power of social background, health, functional independence, and the environment

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Abstract

Study design Cross-sectional study using data from the 2012 community survey of the Swiss Spinal Cord Injury Cohort Study.

Objectives To identify associations between selected factors related to the social background, health, functional independence, and the environment of persons with spinal cord injury (SCI) and their labor market participation.

Setting Community-based, Switzerland.

Methods Labor market participation (i.e., involvement in paid work or not) was determined for a sample of 966 persons with traumatic SCI who were of employable age at the time of the survey. Applying an exploratory approach, potential predictors of labor market participation were selected based on the literature and using a bidirectional stepwise variable selection approach. Descriptive statistics were calculated and weighted bootstrapped multiple logistic regressions were applied to describe the associations between the selected predictor variables and labor market participation, controlling for sociodemographic and SCI-related characteristics.

Results A total of 568 (58.8%) of the participants were involved in paid work at the time of the survey. From the 17 selected predictor variables, general functional independence and Swiss citizenship showed a significant positive association, and chronic pain a negative association with involvement in paid work.

Conclusions Beyond previously established sociodemographic and injury-related risk factors such as female gender, low education, and high lesion severity, functional independence, chronic pain, and nationality proved crucial for labor market participation. These factors should receive particular attention in medical and vocational strategies striving for a sustainable work integration of persons with SCI.

Introduction

Spinal cord injury (SCI) is a severely disabling condition resulting most commonly from a traumatic injury, especially among people of employable age [1, 2]. A major challenge and, at the same time, a key goal of SCI rehabilitation concerns the affected persons' opportunities to return to paid work [3]. Labor market participation (LMP) of persons with SCI varies widely across countries, with employment rates between 11.5 and 74% [4]. These variations depend, among others, on country-specific health and social policy regulations, labor market dynamics, and incentives to return to work [4]. In Switzerland, a recent study showed that 53.4% of individuals with SCI were

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gainfully employed, which was around 30% points less compared to the general population [5].

At the individual level, a variety of non-modifiable and potentially modifiable conditions determine LMP of persons with SCI. A wealth of research revealed an impact of sociodemographics, such as age, sex, marital status, and ethnic origin [6], and injury-related characteristics, such as SCI severity [7]. The same is true for educational and occupational factors, such as pre-injury education, employment status, and job type [6], as well as for personal factors, such as work attitudes or self-efficacy [8, 9]. Secondary health conditions related to SCI (e.g., pain or urinary tract infections) [10] and psychiatric comorbidities (in particular depression) [8] may also impede LMP, while functional independence or mobility have an influence as well [11]. Finally, environmental barriers, such as accessibility issues, transportation services, or practices of discrimination against disability represent additional key determinants of LMP [7]. In Switzerland, a country with well-developed social and health policies, LMP of persons with SCI was shown to be hampered by low education, high lesion severity (i.e., tetraplegia), and secondary health issues like pain, urinary tract infections, and pressure ulcers [5, 10].

While, with the exception of the available scientific reviews, the majority of the above-described empirical investigations, and in particular the ones conducted in Switzerland, focused on only few specific determinants of LMP, it seems important to broaden the range of factors, emphasizing conditions that are amenable to modification and that can eventually inform return-to-work and job retention practices, services, and policies. By taking such a broad perspective, the objective of our study was to identify potentially modifiable factors associated with LMP of persons with SCI living in Switzerland. More specifically, we aimed to examine associations between selected factors related to the social background, health, functional independence, and the environment of affected individuals and their work status (i.e., involvement in paid work or not), controlling for sociodemographic and injury-related characteristics.

Methods

Study design

The study applied an exploratory design and was based on cross-sectional data from the 2012 SwiSCI community survey [12]. Bootstrapped multivariable logistic regression was used to identify associations between predictor variables and work status of persons with SCI. Predictor variables were initially selected based on the literature before refining the selection using a statistical approach.

Population

The 2012 SwiSCI community survey aimed to cover all Swiss residents aged over 16 years with a traumatic or non-traumatic SCI. Individuals with congenital conditions leading to SCI, new SCI in the context of palliative care, neurodegenerative disorders, and Guillain–Barré syndrome were excluded. Due to the lack of a central register of persons with SCI living in Switzerland, the study population was established based on registries provided by specialized SCI rehabilitation centres and organizations for affected persons. Details on the SwiSCI study design and recruitment strategy were published previously [12]. The present study used data from the SwiSCI basic module and included persons with a traumatic SCI who were of employable age at the time of the survey (i.e., 16–63 years for females, 16–64 years for males).

Measures

The study's outcome variable, i.e., *work status at time of the survey*, was coded as a dichotomous variable (0 = not involved in paid work, 1 = involved in paid work).

Predictor variables comprised selected factors related to affected persons' social background, health, functional independence, and the environment. *Social background-related factors* included marital status (i.e., single, married/registered partnership, widowed, or divorced), having a partner (yes/no), pre-SCI employment status (paid work vs. no paid work), and Swiss citizenship (yes/no). *Health-related factors* were measured by the *Spinal Cord Injury Secondary Health Condition Scale* (SCI-SCS) [13], indicating both the participant's total number of secondary health conditions and a severity rating of specific secondary conditions (e.g., pain or pressure ulcers). The presence of common *comorbidities of SCI* (e.g., depression) was measured with a yes/no question. To obtain a more general view of mental health, we also used the 0–100 Rasch-based score of the *SF-36 Mental Health Subscale* (MHI-5) [14]. *Functional independence* was measured with a 0–100 Rasch-based total score of the self-report version of the *Spinal Cord Independence Measure* (SCIM-SR) [15, 16], as well as with single SCIM-SR items addressing self-care, respiration and sphincter management, and mobility. Additional items on *SCI-related extra time for activities of daily living* recoded into 'no extra time', '0–1 h', '2–5 h', and 'more than 5 h' were also included in the analysis. *Environmental factors* were measured by the *Nottwil Environmental Factors Inventory Short Form* (NEFI-SF) [17], which provides a 0–100 rescaled Rasch-based total score [18] and single items on SCI-related environmental barriers (e.g., barriers related to transportation services). The participants' *health insurance status* (i.e., public vs.

private/semi-private) was included as an additional potential environmental determinant of LMP.

Control variables included the *sociodemographics* sex, age at time of the survey (in years), and years of formal education. SCI severity, determined as a combination between SCI level (paraplegia vs. tetraplegia) and SCI degree (complete vs. incomplete), and time since SCI served as *injury-related* control variables.

Data analysis

Variable selection

In a first step, the potential predictor variables related to social background, health, functional independence, and the environment were determined based on the most recent literature reviews on factors associated with LMP of persons with SCI [6, 7]. Control variables included those sociodemographic and injury-related factors that were significantly associated with work status in a previous SwiSCI-based study (i.e., sex, age at time of the survey, years of education, and SCI severity) [5]. In a second step, a parsimonious bidirectional stepwise variable selection approach was applied to the predictor and control variables that were selected based on the literature and covered by the SwiSCI survey. This was done to identify variables with best model fit performance, based on the Akaike information criterion [19]. Variables were selected by block, starting with the sociodemographic and injury-related control variables, followed by the factors related to social background (block 1), health-related factors (block 2), factors related to functional independence (block 3), and environmental factors (block 4). The selection process was weighted to adjust for non-response to the survey [20]. Absence of multicollinearity among the variables was supported by the variance inflation factor [21]. We used the software R version 3.5.0 for statistical analyses.

Descriptive statistics and regression analysis

Once the predictor and control variables for the study were determined, descriptive statistics of the participants' characteristics were calculated, stratified for work status. Subsequently, bootstrapped multiple block-wise logistic regression modelling [22] was used to estimate the strength of association between the control variables, the predictor variables, and the outcome. Predictor variables were regressed by the above-mentioned blocks, adjusted for the sociodemographic and injury-related control variables, before a final regression analysis of all control and predictor variables was carried out. Odds ratios with corresponding 95% confidence intervals were calculated.

The statistical significance of the predictor variables was determined based on a non-response weighted bootstrap with a 70% exclusion threshold [23] that allowed to exclude variables with low predictive value (i.e., above the 5% significance level) and to avoid that relationships between predictor and outcome variables were significant by chance. The number of bootstraps was set to $n = 5000$, resulting in normal histograms of the bootstrap distribution. Model fit was assessed with the Nagelkerke and the G2 deviance Goodness-of-Fit tests [24, 25]. We compared the change in deviances (G2-values) using the chi-squared test, with difference in degrees of freedom between the nested models, and decided for the superiority of the more complex over the simpler model if the resulting p-value was sufficiently low (<0.05). The accuracy of each model in predicting the outcome is given with the percentage of correctly identified levels of the outcome variable (i.e., paid work vs. not) by the different block-wise and the joint regression model.

Missing data

Data from participants with >30% of missing values or missing information regarding the outcome variable were excluded. The remaining data was then imputed with the R-package missForest [26], which represents a distribution-free missing value imputation technique based on random forests.

Results

Sample characteristics

The basic module of the SwiSCI community survey ($n = 1549$) involved 1001 participants with a traumatic SCI who were of employable age at the time of the survey. Of these, 35 were excluded because of >30% missing values in the control and predictor variables or missing information regarding the outcome variable, leading to a study sample of 966 participants. Sociodemographic and injury-related characteristics of the sample are given in Table 1. The majority of the participants were male (75.6%) and had a complete paraplegia (36.7%). On average, participants sustained their SCI 17.7 years ago and 58.8% of them were gainfully employed at the time of the survey.

Selected variables and descriptive statistics

Table 1 also provides the descriptive statistics for the predictor and control variables that were included in the final analysis, stratified by work status. While the literature-based selection led to a total of 33 variables that were covered by the SwiSCI survey (28 predictor and five control variables), the statistical selection reduced the number of study variables to 21 (17 predictor and four control variables). The

Table 1 Descriptive statistics of the study sample and the selected predictor and control variables, stratified by work status

	Total	In paid work	Not in paid work	Missing
	n (%)	*n* (%)	*n* (%)	*n* (%)
Total	966 (100.0)	568 (58.8)	398 (41.2)	
Control variables: Sociodemographic and injury-related factors				
Sex				0 (0)
Female	236 (24.4)	120 (50.8)	116 (49.2)	
Male	730 (75.6)	448 (61.4)	282 (38.6)	
SCI severity				2 (0.2)
Complete paraplegia	355 (36.7)	222 (62.5)	133 (37.5)	
Incomplete paraplegia	296 (30.6)	193 (65.2)	103 (34.8)	
Complete tetraplegia	128 (13.3)	58 (45.3)	70 (54.7)	
Incomplete tetraplegia	187 (19.4)	95 (50.8)	92 (49.2)	
Continuous variables—Mean (SD)				
Age	46.7 (11.0)	45.8 (10.4)	47.82 (11.8)	0 (0)
Years of education	14 (3.2)	14.7 (3)	13.1 (3.3)	7 (0.7)
Block 1: Social background				
Marital status				3 (0.3)
1 = Single (never married)	363 (37.6)	219 (60.3)	144 (39.7)	
2 = Married or registered partnership	451 (46.7)	271 (60.1)	180 (39.9)	
3 = Widowed	17 (1.8)	5 (29.4)	12 (70.6)	
4 = Divorced	135 (14.0)	73 (54.1)	62 (45.9)	
Having a partner				25 (2.5)
Yes	643 (66.6)	402 (62.5)	241 (37.5)	
No	323 (33.4)	166 (51.4)	157 (48.6)	
Swiss citizenship				0 (0)
Yes	859 (88.9)	526 (61.2)	333 (38.8)	
No	107 (11.1)	42 (39.3)	65 (60.7)	
Block 2: Health-related factors				
Urinary tract infection				28 (3)
0 = No problem	422 (43.7)	269 (63.7)	153 (36.3)	
1 = Mild/infrequent problem	175 (18.1)	106 (60.6)	69 (39.4)	
2 = Moderate/occasional problem	213 (22.0)	124 (58.2)	89 (41.8)	
3 = Significant/chronic problem	156 (16.1)	69 (44.2)	87 (55.8)	
Spasticity				34 (3.5)
0 = No problem	287 (29.7)	186 (64.8)	101 (35.2)	
1 = Mild/infrequent problem	233 (24.1)	146 (62.7)	87 (37.3)	
2 = Moderate/occasional problem	240 (24.8)	139 (57.9)	101 (42.1)	
3 = Significant/chronic problem	206 (21.3)	97 (47.1)	109 (52.8)	
Chronic pain				22 (2.3)
0 = No problem	292 (30.2)	189 (64.7)	103 (35.3)	
1 = Mild/infrequent problem	164 (17.0)	119 (72.6)	45 (27.4)	
2 = Moderate/occasional problem	189 (19.6)	114 (60.3)	75 (39.7)	
3 = Significant/chronic problem	321 (33.2)	146 (45.5)	175 (54.5)	
Bowel dysfunction				25 (2.6)
0 = No problem	361 (37.4)	217 (60.1)	144 (39.9)	
1 = Mild/infrequent problem	244 (25.3)	158 (64.8)	86 (35.2)	

Table 1 (continued)

	Total	In paid work	Not in paid work	Missing
	n (%)	*n* (%)	*n* (%)	*n* (%)
2 = Moderate/occasional problem	196 (20.3)	107 (54.6)	89 (45.4)	
3 = Significant/chronic problem	165 (17.1)	86 (52.1)	79 (48.9)	
Comorbidity: depression				13 (1.3)
Yes	139 (14.4)	57 (41.0)	82 (59.0)	
No	827 (85.6)	511 (61.8)	316 (38.2)	
Block 3: Functional independence				
SCIM-SR 1: Eating and drinking				5 (0.5)
1 = I need parenteral feeding or I have a gastrostomy	2 (0.2)	1 (50.0)	1 (50.0)	
2 = I need total assistance with eating/drinking	15 (1.6)	3 (20.0)	12 (80.0)	
3 = I need partial assistance with eating/drinking or for putting on/taking off adaptive devices	22 (2.3)	8 (36.4)	14 (63.6)	
4 = I eat/drink independently, but I need adaptive devices or assistance for cutting food, pouring or opening containers	151 (15.6)	74 (49.0)	77 (51.0)	
5 = I eat/drink independently without assistance or adaptive device	776 (80.3)	482 (62.1)	294 (37.9)	
SCIM-SR 5: Dressing lower body				4 (0.4)
1 = I need total assistance	156 (16.1)	62 (39.7)	94 (60.3)	
2 = I need partial assistance, even with easy-to-dress clothes	37 (3.8)	13 (35.1)	24 (64.9)	
3 = I do not need assistance with easy-to-dress clothes, but I need adaptive devices or a specific setting with them	10 (1.0)	3 (30.0)	7 (70.0)	
4 = I am independent in dressing my lower body with easy-to-dress clothes and only need assistance or adaptive devices or a specific setting with difficult-to-dress clothes	106 (11.0)	48 (45.3)	58 (54.7)	
5 = I am completely independent in dressing my lower body	657 (68.0)	442 (67.3)	215 (32.7)	
SCI-related extra time for managing support				161 (16.7)
No extra time	224 (23.2)	169 (75.4)	55 (24.6)	
<1 h	253 (26.2)	163 (64.4)	90 (35.6)	
1–2 h	148 (15.3)	93 (62.8)	55 (37.2)	
2–5 h	187 (19.4)	90 (48.1)	97 (51.9)	
>5 h	154 (15.9)	53 (34.4)	101 (65.6)	
Continuous variable—Mean (SD)				
SCIM-SR total score (0–100)	67.9 (13.9)	71.4 (13.5)	62.8 (12.7)	2 (0.2)
Block 4: Environmental factors				
NEFI-SF 3: Barriers related to social attitudes				15 (1.6)
1 = No influence	736 (76.2)	454 (61.7)	282 (38.3)	
2 = Made my life a little harder	198 (20.5)	97 (49.0)	101 (51.0)	
3 = Made my life a lot harder	32 (3.3)	17 (53.1)	15 (46.9)	
NEFI-SF 4: Barriers related to family attitudes				24 (2.5)
1 = No influence	862 (89.2)	525 (60.9)	337 (39.1)	

Table 1 (continued)

	Total	In paid work	Not in paid work	Missing
	n (%)	*n* (%)	*n* (%)	*n* (%)
2 = Made my life a little harder	89 (9.2)	37 (41.6)	52 (58.4)	
3 = Made my life a lot harder	15 (1.6)	6 (40.0)	9 (60.0)	
NEFI-SF 11: Barriers related to financial situation				23 (2.4)
1 = No influence	692 (71.6)	435 (62.9)	257 (37.1)	
2 = Made my life a little harder	195 (20.2)	107 (54.9)	88 (45.1)	
3 = Made my life a lot harder	79 (8.2)	26 (32.9)	53 (67.1)	
Health insurance status				30 (3)
Public	781 (80.8)	447 (57.2)	334 (42.8)	
Private/semi-private	185 (19.2)	121 (65.4)	64 (34.6)	
Continuous variable—Mean (SD)				
NEFI-SF total score (0–100)	33.4 (19.6)	29.5 (20)	39.1 (17.6)	1 (0.1)

Missing = Number and percentage of missing values before imputation

SCIM-SR Spinal Cord Independence Measure-self Report, *SCI* spinal cord injury, *NEFI-SF* Nottwil Environmental Factors Inventory-Short Form

results of the Akaike-based stepwise statistical selection, including generalized variance inflation factors describing multicollinearity among the predictor and control variables, are available in the Supplementary Material. The four selected control variables included the sociodemographics *sex*, *age*, and *years of formal education*, as well as the injury-related factor *SCI severity*. The three predictor variables in block 1 (social background) involved *marital status*, *having a partner* and *Swiss citizenship*, while the five predictor variables in block 2 (health-related factors) comprised the secondary conditions *urinary tract infection*, *spasticity*, *chronic pain*, as well as *bowel dysfunction* and the comorbidity *depression*. The four predictor variables in block 3 (functional independence) were the *SCIM-SR total score*, the SCIM-SR variables '*eating and drinking*' (a proxy for fine hand use) and '*dressing lower body*' (a proxy for trunk stability), and the item '*SCI-related extra time for managing support*' (i.e., organizing home care or assistive devices). Finally, the five predictor variables from block 4 (environmental factors) included the *NEFI-SF total score*, three NEFI-SF items on barriers related to *societal attitudes*, *family attitudes*, and the *financial situation* as well as the participants' *health insurance status*.

Excluded by the statistical selection were the following variables. From the control variables *time since SCI*; from block 1 *pre-SCI employment status*; from block 2 the *total number of secondary health conditions*, the SCI-SCS items *sleep problems*, *decubitus* and *bladder dysfunction*, and the *SF-36 score for mental health*; from block 3 the SCIM-SR mobility item '*moving around* > 100 m' and two items on *SCI-related extra-time for self-care* and *outdoor transportation*; and from block 4 two NEFI-SR items on barriers related to *accessibility of public locations* and *long-distance transport*.

Logistic regression: Factors associated with work status

Relevant predictors of paid work were those variables that became significant (p-value < 0.05) in more than 70% of the 5000 bootstrapped logistic regression analyses. In the unadjusted analysis of the control variables *sex*, *years of education*, and *SCI severity* were significantly related with LMP (see Table 2). Persons with more years of education (OR 1.19, 95% CI 1.13–1.24) had a higher and females (OR 0.56, 95% CI 0.41–0.78) as well as individuals with complete and incomplete tetraplegia (OR 0.46, 95% CI 0.3–0.72; OR 0.59, 95% CI 0.41–0.88, respectively) a lower likelihood of paid work.

In the joint analysis of all selected variables, which was adjusted mutually and for the control variables, the predictor variables *Swiss citizenship* (block 1), *chronic pain* (block 2), and *SCIM-SR total score* (block 3) were significantly associated with paid work (see Table 3). Participants with Swiss citizenship (OR 2.43, 95% CI 1.51–4.28) and higher functional independence (OR 1.04, 95% CI 1.02–1.07) were more likely and those with more chronic pain (OR 0.81, 95% CI 0.71–0.94) less likely to perform paid work.

In the block-wise analyses that were adjusted for the control variables, more predictor variables became statistically significant (see Table 3). In block 1, in addition to Swiss citizenship (OR 2.5, 95% CI 1.68–3.99), *having a partner* (OR 1.88, 95% CI 1.32–2.8) was significantly

Table 2 Results of the logistic regression of the sociodemographic and injury-related control variables with work status

Control variable	OR (95% CI)	Probability
Sex *[Ref: Male]*		
Female	0.56 (0.41–0.78)	95%*
Age	0.99 (0.97–1)	60%
Years of education	1.19 (1.13–1.24)	100%*
SCI severity *[Ref: Complete paraplegia]*		
Incomplete paraplegia	1.15 (0.83–1.64)	13%
Complete tetraplegia	0.46 (0.3–0.72)	95%*
Incomplete tetraplegia	0.59 (0.41–0.88)	78%*

*p-value < 0.05 in >70% of the 5000 bootstrapped regression analyses

related to involvement in paid work, while in block 2 *urinary tract infection* (OR 0.85, 95% CI 0.75–0.96) and *depression* (OR 0.53, 95% CI 0.37–0.8) reduced the probability of paid work beyond chronic pain (OR 0.82, 95% CI 0.73–0.93). In block 3, in addition to the SCIM-SR total score (OR 1.06, 95% CI 1.03–1.08), *SCI-related extra time for managing support > 5 h per week* (OR 0.45, 95% CI 0.28–0.78) was related to a reduced likelihood of paid work. In block 4, finally, the NEFI-SF total score (OR 0.98, 95% CI 0.97–0.98), reflecting an overall proxy for environmental barriers, was associated with a reduced probability of gainful employment.

The accuracy of the regression models in predicting involvement in paid work was above chance, i.e., >0.5, for all block-wise as well as for the joint analysis (see Table 4). The sociodemographic and injury-related control variables predicted correctly 67% of the outcomes. The respective figure for functional independence was also 67%, the one for health-related and environmental factors 63% each, and the one for factors related to social background 62%. The joint analysis model including all control and predictor variables improved the correct identification to 73%. The two statistical model fit criteria (Nagelkerke, G2 deviance) confirmed the superiority of the control variables and the predictor variables related to functional independence over the factors related to social background, health, and the environment in predicting the outcome and underlined the superiority of the joint model over the block-specific models. Yet the ΔG2 deviance statistics showed a significant additional value of the different block-specific models ($p < 0.001$) in predicting work status compared with the sociodemographic and injury-related control variables.

Discussion

Based on a cross-sectional study of a large sample of persons with traumatic SCI living in Switzerland, we observed that their social background, health, functional independence, and environment have an additional effect on involvement in paid work beyond sociodemographic and injury-related characteristics. In particular, individuals with high functional independence, less pain, and Swiss citizenship were more likely to be gainfully employed. To a lesser extent, having a partner was related to a higher probability of paid work, while urinary tract infections, depression, longer SCI-related extra time for managing support, and the overall experience of environmental barriers were associated with reduced LMP.

Our findings are largely in line with previous results of studies conducted in economically advanced countries [4, 7]. While in Switzerland the employment rate of persons with SCI is relatively high compared to other countries [4], which might be attributed to a high general employment rate in the Swiss labor market but also to well-established specialized return-to-work services for SCI, the rate is still considerably lower compared to the general population [5]. By complementing formerly established sociodemographic and injury-related risk factors for poor LMP of persons with SCI living in Switzerland (i.e., being female, having a low education, and a high lesion severity) [5], our results add important knowledge on predominantly modifiable determinants of LMP that could inform about targets for future employment retention strategies.

Specific secondary conditions (in particular chronic pain, but also urinary tract infection) and comorbidities (depression) were previously reported as risk factors for reduced LMP [8, 10, 27]. Yet in our study the block of health-related factors contributed much less to the explanation of LMP than the functional independence block. A strong relationship between functional independence and LMP was previously found in an exploratory analysis [11], but our results suggest that the ability to perform activities of daily living may even be a more accurate predictor of LMP than health-related impairments. Our study also revealed that the amount of SCI-related extra time required for activities of daily living (in particular for managing support) affects LMP, above and beyond the mere amount of functional independence. These observations underline the importance of functional independence trainings for improving LMP, and they point to the relevance of considering SCI-related extra time needs in work capacity evaluations. At the same time, more research is needed to establish specific aspects of functional independence that represent potential targets of interventions for ensuring LMP.

At the level of the individuals' social background, we identified a positive relationship between having a Swiss citizenship and being gainfully employed. A similar association was reported in a study conducted in the US [28]. Negative attitudes of Swiss employers toward hiring foreign citizens with disabilities but also smaller social networks of

Table 3 Associations of the predictor variables with work status for the block-wise and the joint regression analysis

	Analysis Block 1: Social background		Analysis Block 2: Health-related factors		Analysis Block 3: Functional independence		Analysis Block 4: Environmental factors		Joint analysis (all blocks): All factors	
Variables	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability
Block 1: Social background										
Marital status *[Ref: Single]*										
Married or registered partnership	0.63 (0.44–0.94)	66%							0.85 (0.55–1.39)	11%
Widowed	0.27[a]	63%							0.33[a]	35%
Divorced	0.72 (0.49–1.13)	32%							0.91 (0.57–1.57)	6%
Partner *[Ref: No]*										
Yes	1.88 (1.32–2.8)	92%*							1.64 (1.1–2.59)	62%
Swiss citizen *[Ref: No]*										
Yes	2.5 (1.68–3.99)	99%*							2.43 (1.51–4.28)	92%*
Block 2: Health-related factors										
Urinary tract infection			0.85 (0.75–0.96)	76%*					0.9 (0.78–1.04)	33%
Spasticity			0.88 (0.78–1)	51%					0.93 (0.81–1.08)	16%
Chronic pain			0.82 (0.73–0.93)	90%*					0.81 (0.71–0.94)	80%*
Bowel dysfunction			1.03 (0.91–1.18)	6%					1.1 (0.94–1.28)	21%
Comorbidity: Depression			0.53 (0.37–0.8)	89%*					0.65 (0.42–1.05)	46%
Block 3: Functional independence										
SCIM-SR total score					1.06 (1.03–1.08)	100%*			1.04 (1.02–1.07)	95%*
SCIM 1: Eating and drinking					0.74 (0.54–1.06)	39%			0.78 (0.55–1.17)	23%
SCIM 5: Dressing lower body					0.99 (0.85–1.16)	6%			0.96 (0.8–1.16)	8%
SCI-related extra time for managing support *[Ref: No extra time]*										
0–1 h					1.13 (0.74–1.8)	9%			1.04 (0.65–1.78)	6%
1–2 h					1.17 (0.73–1.99)	9%			1.27 (0.75–2.36)	12%
2–5 h					0.62 (0.4–1.02)	52%			0.72 (0.43–1.28)	22%
>5 h					0.45 (0.28–0.78)	87%*			0.54 (0.31–1.03)	51%
Block 4: Environmental factors										
NEFI: 0–100 score							0.98 (0.97–0.98)	100%*	0.99 (0.98–1)	46%
Barriers related to social attitude							1.31 (0.98–1.8)	40%	1.29 (0.92–1.87)	30%
Barriers related to attitude of family							0.77 (0.53–1.16)	26%	0.86 (0.56–1.41)	12%
Barriers related to financial situation							0.85 (0.67–1.08)	28%	0.87 (0.66–1.17)	18%

Table 3 (continued)

Variables	Analysis Block 1: Social background		Analysis Block 2: Health-related factors		Analysis Block 3: Functional independence		Analysis Block 4: Environmental factors		Joint analysis (all blocks): All factors	
	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability	OR (95% CI)[b]	Probability
Health insurance *[Ref: Public]*										
Private/semi-private							1.31 (0.95–1.89)	33%	1.41 (0.97–2.15)	39%

Block-wise analysis is adjusted for sociodemographic and injury-related control variables. Joint analysis is mutually adjusted and adjusted for sociodemographic and injury-related control variables.

SCIM-SR Spinal Cord Independence Measure-Self Report, *SCI* spinal cord injury, *NEFI-SF* Nottwil Environmental Factors Inventory-Short Form

*p-value < 0.05 in more than 70% of the 5000 bootstrapped regression analyses

[a]Confidence interval (CI) of the pooled odds ratio (OR) could not be determined due to the small number of persons in the subgroup and the resulting large standard measurement error

[b]CIs are not referring to the standard measurement error but the variability of the ORs within the bootstrap

non-Swiss participants might be an explanation for this finding. Yet, in Switzerland, it is most likely that low educational and occupational skills have confined foreign citizens to physically demanding pre-SCI jobs, which represent a strong risk factor for poor LMP [7], and that insufficient language competencies have reduced their opportunities to work in cognitively oriented jobs post-SCI. Along this interpretation, disability insurance providers should promote customized vocational integration programs for foreign citizens with SCI, for instance by providing language courses, to integrate this group sustainably in the labor market.

At the level of specific environmental factors, we could not reveal any significant associations with LMP, suggesting that environmental barriers such as poor accessibility or discrimination practices toward persons with SCI are less of an issue in Switzerland. However, environmental factors such as financial disincentives by disability insurances that were shown to play a key role for LMP in high-resources countries [11, 29] were not covered by our survey. Such factors might also be taken into account when planning strategies to improve LMP of persons with SCI.

Practical and research implications

Compared with previous empirical analyses, our study used a broader approach to provide information on mostly modifiable, but also on non-modifiable factors that affect LMP of persons with SCI living in an economically advanced country like Switzerland. We showed a specific contribution of single factors pertaining to affected persons' social background, health, functional independence, and the environment but also an added value of these areas overall in explaining LMP beyond previously established sociodemographic and injury-related determinants. Taken together, these factors map risk constellations for poor LMP and represent key targets for medical interventions, employment retention strategies, and wider prevention policies. With regard to modifiable factors, we highlighted the importance of strengthening functional independence, as well as of controlling and minimizing secondary health conditions and comorbidities such as pain, urinary tract infections, and depression to improve the employment opportunities of persons with SCI. In terms of non-modifiable factors, we showed that non-Swiss citizens are at risk of not being gainfully employed and should thus receive particular attention in terms of language courses to improve their prospects for participating in jobs beyond the physically oriented sectors of the labor market.

Despite our comprehensive approach on factors associated with LMP, our joint model of analysis correctly predicted only about 70% of the involvement of persons with SCI in paid work. Further research should thus

Table 4 Accuracy and goodness of fit of the different models of analysis in predicting work status

Models of analysis	Accuracy Mean (SD)	Nagelkerke Mean (SD)	G2-Deviance Mean (SD)	DF Total-residual	ΔG2* (df) Control vs. adjusted (added value of blocks)	ΔG2* *p*-value Control vs. adjusted (added value of blocks)
Sociodemographics and injury-related factors	0.67 (0.02)	0.14 (0.03)	107.17 (20.12)	6		
Analysis Block 1: Social background						
Unadjusted model	0.62 (0.02)	0.06 (0.02)	41.28 (12.06)	5		
Adjusted model	0.68 (0.02)	0.18 (0.03)	138.75 (22.12)	11	31.58 (5)	<0.001
Analysis Block 2: Health-related factors						
Unadjusted model	0.63 (0.02)	0.07 (0.02)	55.09 (14.26)	5		
Adjusted model	0.69 (0.02)	0.21 (0.03)	160.63 (24.02)	11	53.46 (5)	<0.001
Analysis Block 3: Functional independence						
Unadjusted model	0.67 (0.02)	0.17 (0.03)	128.36 (21.45)	7		
Adjusted model	0.7 (0.02)	0.24 (0.03)	191.61 (25.48)	13	84.44 (7)	<0.001
Analysis Block 4: Environmental factors						
Unadjusted model	0.63 (0.02)	0.09 (0.02)	68.73 (15.77)	5		
Adjusted model	0.68 (0.02)	0.21 (0.03)	166.4 (23.85)	11	59.23 (5)	<0.001
Joint analysis (all blocks): All factors	0.73 (0.02)	0.32 (0.03)	266.71 (29.21)	28		

DF degrees of freedom

*ΔG2 is the difference in the mean G2 from the bootstrap of the nested models, i.e., an approximation of the true mean ΔG2

additionally study the effects of personal factors (e.g., job-seeking self-efficacy, coping strategies), occupational factors (e.g., pre-injury job type), and additional key factors such as driving ability that were all dismissed in the present study on LMP. Moreover, the effects of employment and career trajectories on sustainable return to work and employment of persons with SCI should be examined by longitudinal research.

Study limitations

The present study is subject to several limitations. First, the cross-sectional design does not allow any conclusion about the directionality of reported associations. As the mean time between SCI onset and participation in the survey is around 18 years and because detailed information on the participants' work history is missing, it is not possible to interpret our findings in the context of employment trajectories following a traumatic SCI and associations may be biased in several regards. Longitudinal studies are needed to provide more robust findings on risk or protective constellations predicting LMP. Second, our study did not use detailed information on the participants' current and previous jobs. For instance, we did not analyse whether non-working participants have experienced elevated levels of stress or lower job satisfaction at their previous jobs, which could have negatively affected their job retention probability. Third, the G2 deviance values comparing the power of different block-specific models in predicting LMP might be biased because the models contained a different number of prediction variables and some of them included total scores while others did not. Finally, the role of personal factors in explaining LMP has not been elaborated due to missing information in this data set, although previous research indicated an important contribution of motivational and attitudinal factors [9].

Conclusion

Based on a large sample of persons with traumatic SCI living in Switzerland and using a broad exploratory approach, our cross-sectional study revealed the importance of functional independence, chronic pain, and nationality for affected persons' LMP. Beyond previously established sociodemographic and injury-related risk factors for reduced LMP, these factors should receive particular attention in medical and vocational strategies striving toward a sustainable vocational integration. However, future longitudinal research focusing on career trajectories is required to better understand the various factors promoting or hampering long-term employment retention of persons with SCI.

Data availability

Owing to our commitment to SwiSCI study participants and their privacy, datasets generated during the current study are not made publicly available. The SwiSCI Study Center requires, on behalf of the SwiSCI Study Group, contact prior to any planned data usage (contact@swisci.ch).

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Author contributions US, BT, and JS designed the study. CB conducted the statistical analysis. US and CB prepared the article. JS and BT substantially contributed to the data interpretation and article preparation.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study was approved by the ethics committees of the four Swiss cantons with specialized SCI centers (Lucerne, Zurich, Basel-Stadt, and Valais) [20].

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