

ORIGINAL ARTICLE

Key demands and characteristics of occupations performed by individuals with spinal cord injury living in Switzerland

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Study design: Descriptive qualitative and quantitative study using cross-sectional data from the Swiss Spinal Cord Injury Cohort Study (SwiSCI).

Objective: To determine the key demands and characteristics of occupations performed by individuals with spinal cord injury (SCI).

Setting: Swiss community.

Methods: Job titles indicated by SwiSCI participants were linked to occupational titles from the Occupational Information Network (O*NET) and then frequency-analyzed across sociodemographic and injury-related factors. Subsequently, average O*NET relevance values ranging from 0 to 100 were calculated for the occupations' demands and characteristics, both in general and stratified by injury-related factors.

Results: The 1549 study participants indicated a total of 717 job titles and were primarily employed in administrative and management occupations (22.1% and 16.4%, respectively). The participants' occupations predominantly required verbal abilities (average relevance [AR]=68.4) and complex problem solving skills (AR = 55.8) and were characterized by conventional work tasks (AR = 62.9) and social relationships (AR = 58.6). Both the occupations' frequency distribution as well as the average relevance levels of their demands and characteristics differed by SCI severity.

Conclusions: Individuals with SCI perform a broad range of occupations that are mainly characterized by cognitive and communicative demands, while physical demands are of minor importance. By informing the development of job matching profiles for vocational guidance, our study facilitates the determination of well-matching jobs for persons with SCI and may contribute to a more sustainable return to work of the affected persons.

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INTRODUCTION

Sustaining a spinal cord injury (SCI) is an incisive life event that commonly confronts affected individuals with the challenge of finding and settling into a new job that matches their capabilities, preferences and values. Employment rates typically decrease after SCI onset,¹ ranging internationally from 11.5 to 74.0%.² For Switzerland, an employment rate of 53.4% has recently been reported, which is roughly 30% points lower compared with the general population.³ Like in the general population, the labor market participation of individuals with SCI is influenced by sociodemographic factors such as age or education, but beyond that also by injury-related factors such as SCI severity or age at injury.⁴

Because work represents an important path to social participation and quality of life for persons with SCI,⁵ work reintegration is a major goal of SCI rehabilitation.⁶ Establishing well-matching jobs for persons with SCI in the context of vocational guidance requires adequate knowledge on occupations that are successfully performed post SCI. For the purpose of the present study, we refer to the term 'occupation' to describe both paid employment as well as unpaid work such as, for instance, sheltered employment. Studies from various countries indicate that individuals are predominantly used in administrative, clerical, professional and social service occupations after SCI onset.^{7–12}

Yet with the exception of Hwang *et al.*¹³ who linked occupations of US individuals with SCI to the Standard Occupational Classification (SOC-2010),¹⁴ these studies do not make use of an international job classification standard, which precludes useful comparisons with the general population, or across countries. Furthermore, most previous studies fall short of providing comprehensive information on the effective demands and characteristics of post SCI occupations. While Sinden *et al.*¹⁵ offered interesting insights into physical and sensory demands as well as educational requirements, they did not examine the cognitive demands, required skills and knowledge, typical work context, prevailing work style or interest pattern of post SCI occupations, all of which are important aspects for determining a person-job match in vocational guidance.^{16,17}

To address these gaps in previous research, the present study draws on the Occupational Information Network (O*NET),^{18–20} which represents the currently most up-to-date standardized occupational information system available. The O*NET is based on the SOC-2010 and hierarchically organizes 1110 occupational titles of the US labor market into 23 major groups (e.g., 29-0000 *Health-care practitioners and technical occupations*), 97 minor groups (e.g., 29-1000 *Health diagnosing and treating practitioners*), 461 broad occupations (e.g., 29-1060 *Physicians and surgeons*) and 841 detailed occupations

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(e.g., 29-1062 *Family and general practitioners*). Moreover, the O*NET provides a comprehensive set of demands (i.e., required abilities, skills, knowledge, work styles and work activities) and characteristics (i.e., prevailing interest pattern, work values and work context) for these occupations. This set is hierarchically arranged into supercategories (e.g., cognitive abilities), subcategories (e.g., verbal abilities) and specific descriptors (e.g., oral comprehension), of which the latter are equipped with values indicating their relevance for each O*NET occupation on a scale from 0 to 100.

In the present study, we used the O*NET to determine the key demands and characteristics of occupations performed by individuals with SCI living in Switzerland. More specifically, we aimed:

1. (a) to identify occupations of individuals with SCI and link them to occupational titles from the O*NET, and (b) to calculate the frequency of these O*NET titles stratified by sociodemographic and injury-related factors;
2. (a) to determine the relevance of the O*NET demands and characteristics across the identified occupations, and (b) to compare their relevance across occupations of individuals with different SCI severities and walking abilities.

MATERIALS AND METHODS

Design and participants

The present study applied a descriptive design involving a qualitative and quantitative analysis of cross-sectional data from the basic module of the Swiss SCI Cohort Study (SwiSCI) community survey^{21,22} conducted between late 2011 and early 2013. The SwiSCI community survey covered Swiss residents with a traumatic or non-traumatic SCI who were aged 16 years and more at the time of the survey.²² Excluded were congenital conditions leading to SCI (e.g., spina bifida), new SCI in the context of palliative care, neurodegenerative disorders (e.g., multiple sclerosis) and Guillain-Barré syndrome. The SwiSCI study was approved by the responsible ethical committee. Details on its design and recruitment strategy has been published previously.²¹ For the purpose of the present study, we focused on participants reporting at least one job title at the time of the survey. We first classified the indicated job titles to occupational titles from the O*NET and then determined the frequency of the O*NET titles and the relevance of their demands and characteristics.

Measures

The participant's *job title* was determined by a free-text response format question (i.e., 'What is the name or title of your current main job?'). *Sex*, *age at survey* in years and *education level* in years of formal education were used as sociodemographic stratification variables. Injury-related stratification variables included *SCI severity*, *walking ability* and *age at injury* in years. SCI severity was determined as a combination between SCI level (i.e., paraplegia or tetraplegia) and SCI degree (i.e., complete or incomplete), both measured by self-report questions. In the survey, complete lesions were explained as having no motor or sensory functions below lesion level and incomplete lesions as some of the motor or sensory functions being retained below lesion level. Walking ability was measured using the item 'moving around moderate distances (10 to 100 m)' from the *Spinal Cord Independence Measure III* (SCIM-SR)²³ and dichotomized into *manual or electric wheelchair users* and *individuals who are able to walk*.

Data analysis

To systematically classify occupations of persons with SCI, the stated job titles were linked to the most precise O*NET occupational title. The linking was conducted independently by the first and the senior author; any discrepancies were discussed until resolved. Inter-rater reliability was determined based on percentage agreement. For the subsequent frequency analysis, the occupational titles were aggregated to the O*NET major group level.

To determine the relevance of the occupations' demands and characteristics, we first extracted for each identified O*NET title the relevance values of its specific descriptors from the O*NET database (<http://www.onetonline.org>). We then calculated the average relevance value of the specific descriptors and the O*NET sub- and supercategories across all identified titles. Finally, we calculated and compared the average relevance values of the sub- and supercategories across occupations of individuals with different levels of SCI severity and walking ability. Data extraction and statistical analyses were conducted using the programming software R (version 3.3.2).²⁴

RESULTS

Sample characteristics

The basic module of the SwiSCI community survey was completed by 1549 participants, representing at least 25% of the estimated total Swiss SCI adult population in 2012.²¹ As response bias was restrained, the sample can be considered representative of the Swiss SCI population. At the time of the survey, 1198 of the study participants were of employable age (the statutory retirement age in Switzerland is 64 years for women and 65 years for men). Of these, 671 (56.0%) were gainfully employed.²² A total of 677 participants reported at least one job title and represented thus our study sample, whose sociodemographic and injury-related characteristics are presented in Table 1. The present study not only considered job titles of gainfully employed participants but also of participants engaged in unpaid work such as, for instance, sheltered employment.

Occupations performed by individuals with SCI

Participants reported a total of 717 job titles, of which 701 could be linked to 237 different O*NET titles. Sixteen unclassifiable job titles (e.g., 'employee') were excluded. Inter-rater reliability was 80.9% on the O*NET major group level and 58.8% on the detailed occupation level.

Table 2 presents the frequencies of the occupational titles across O*NET major groups and stratified by sociodemographic and injury-related factors. The participants' occupations covered all 23 major groups except *Military Specific Occupations*. *Office and Administrative Support Occupations* (22.1%), *Management Occupations* (16.4%) and *Architecture and Engineering Occupations* (10.4%) were most frequently reported, whereas crafts occupations such as *Construction and Extraction Occupations* (1.4%), *Transportation and Material Moving Occupations* (1.7%) or *Production Occupations* (4.0%) were stated less frequently.

The stratified analysis for *sex* revealed that males worked more commonly in *Management Occupations* (19.2% vs 6.9%) and *Architecture and Engineering Occupations* (12.4% vs 3.8%) than females, but less frequently in *Office and Administrative Support Occupations* (17.7% vs 36.9%) and *Education, Training and Library Occupations* (4.4% vs 16.9%). When stratifying for *age at survey*, we found a decreased frequency of *Office and Administrative Support Occupations* and *Architecture and Engineering Occupations* with older age (i.e., from 37.9% in the age group 16–24 years to 15.6 and 4.8% in the group 55–63/64 years), whereas *Management Occupations* were more prevalent in older participants (i.e., 19.7% in the age group 55–63/64 years vs 6.9% in the group 16–24 years). Finally, individuals with a university *education level* worked more commonly in *Education, Training and Library Occupations* (13.2% vs 0.0–7.1%) and *Health-care Practitioners and Technical Occupations* (10.1% vs 0.0–1.9%) than participants with a lower education.

When stratifying for *SCI severity*, a more narrow range of occupations covering only 15 out of 23 O*NET major groups became evident

Table 1 Sociodemographic and injury-related characteristics of the study participants (n= 677)

Parameter (n)	n (%)
Sex (677)	
Male	524 (77.4)
Female	153 (22.6)
Age at survey (years) (677) ^a	
16–24	30 (4.4)
25–39	161 (23.8)
40–54	326 (48.2)
55–63/64	144 (21.3)
≥64/65 ^b	16 (2.4)
Education level (664) ^a	
Compulsory (≥9 years)	25 (3.8)
Vocational (10–12 years)	116 (17.5)
Secondary (13–16 years)	349 (52.6)
University (≤17 years)	174 (26.2)
SCI severity (668)	
Complete paraplegia	245 (36.7)
Incomplete paraplegia	237 (35.5)
Complete tetraplegia	70 (10.5)
Incomplete tetraplegia	116 (17.4)
Walking ability (661)	
Wheelchair user	426 (64.4)
Able to walk	235 (35.6)
Age at injury (years) (665) ^a	
< 16	58 (8.7)
16–24	265 (39.8)
25–39	224 (33.7)
40–54	95 (14.3)
55–63/64	20 (3.0)
≥64/65 ^b	3 (0.5)
Continuous variables	Median (IQR)
Age at survey (years)	46.0 (16.0)
Age at injury (years)	25.0 (17.0)
Time since SCI (years)	15.4 (18.0)
Years of education	14.0 (4.0)

Abbreviations: IQR, interquartile range; SCI, spinal cord injury.
 Note: Percentages are calculated based on the number of non-missing cases. The amount of missing values was below 2.4% across all parameters.
^aGrouped according to Reinhardt et al.³ to account for the educational and occupational context of Switzerland.
^bStatutory retirement age in Switzerland is 64 years for women and 65 years for men.

for complete tetraplegics. They were comparatively often employed in *Architecture and Engineering Occupations* (15.1% vs 7.4–11.4%) and *Legal Occupations* (9.6% vs 0.8–3.3%), but less frequently in *Management Occupations* (8.2% vs 16.5–19.8%) and *Production Occupations* (0.0% vs 2.5–7.3%). Similarly, wheelchair users worked less often in *Production Occupations* than individuals who are able to walk (1.8% vs 7.8%), but more often in *Office and Administrative Support Occupations* (26.5% vs 13.1%). Finally, individuals with the youngest age at injury (<16 years) were more commonly engaged in *Office and Administrative Support Occupations* (34.4% vs 8.0–25.0%), but less frequently in *Production Occupations* (1.6% vs 3.0–7.0%) and *Construction and Extraction Occupations* (0.0% vs 0.0–3.4%) than participants aged 16–63/64 years at injury.

Demands and characteristics of occupations performed by individuals with SCI

The average relevance levels of the O*NET super- and subcategories reflecting the demands and characteristics of our participants' occupations are presented in Table 3. Table 4 shows the differences in the average relevance levels of the super- and subcategories across occupations of individuals with different levels of SCI severity and walking ability.

Demands of the occupations.

Abilities: *Cognitive abilities* (M=45.6), in particular its subcategories *verbal and idea generation and reasoning abilities* (M=68.4 and M=57.2), represented the most relevant ability demands, whereas *physical and psychomotor abilities* (M=10.5; M=19.8) appeared least relevant, with particularly low values in occupations of individuals with complete lesions (M=6.2 and M=15.8 for complete tetraplegics; M=8.6 and M=17.8 for complete paraplegics) and wheelchair users (M=8.3; M=17.4).

Skills: *Basic skills* (M=54.4) with its subcategories *process- and content-related basic skills* (M=54.9; M=53.8) were generally more relevant than *cross-functional skills* (M=42.2), although the latter's subcategories *complex problem solving* and *social skills* (M=55.8; M=51.1) showed comparably high relevance values too. *Complex problem solving skills* were particularly important in occupations of complete tetraplegics (M=58.3). The subcategory *technical skills* was least relevant (M=17.3) and showed particularly low values in occupations of wheelchair users (M=16.2).

Knowledge: *Business and management* (M=46.1) and *education and training* (M=45.4) were the most relevant knowledge demands, whereas *health services* (M=17.4) and *manufacturing and production* (M=19.0) were least relevant. Knowledge on *manufacturing and production* showed a particularly low relevance in occupations of complete tetraplegics (M=14.3) and wheelchair users (M=17.6).

Work styles: *Conscientiousness* (M=86.5) appeared most relevant across the work style domain, while *social influence* (M=68.1) and *practical intelligence* (M=69.4) were least relevant. Yet *practical intelligence* showed a higher relevance in occupations of complete tetraplegics (M=72.4) and wheelchair users (M=70.4).

Work activities: *Mental processes* (M=61.1) and *information input* (M=60.7), in particular their subcategories *looking for and receiving job information* (M=69.3) and *reasoning and decision making* (M=62.3), were the most relevant work activities demands. *Work output* (M=35.6) with its subcategory *performing physical and manual work activities* (M=30.6) appeared least relevant, especially in occupations of complete tetraplegics (M=32.2) and wheelchair users (M=34.4).

Characteristics of the occupations.

Occupational interests: *Conventional* (M=62.9) and *enterprising interests* (M=55.6) were most relevant across the occupational interest domain, while *realistic interests* (M=44.2) appeared particularly important in occupations of individuals who are able to walk (M=50.6). *Artistic* and *investigative interests* were generally least important (M=22.1 and M=34.8), but *investigative interests* were especially relevant in occupations of complete tetraplegics (M=44.8).

Work values: *Human relationships* (M=64.7) were most and *recognition* (M=48.9) least relevant among the work values. Yet *recognition* showed higher relevance values in occupations of persons with tetraplegia (M=53.9 for complete tetraplegics and M=51.4 for incomplete tetraplegics).

Work context: *Interpersonal relationships* (M=58.6) appeared most relevant, mainly due to its subcategories *communication* (M=73.8)

Table 2 Frequency of the reported occupational titles (n = 701) aggregated to O*NET major groups and stratified by sociodemographic and injury-related factors

Parameter	O*NET major groups and corresponding code (n; %)																					
	35-0000 Food Preparation and Serving Related Occupations	33-0000 Protective Service Occupations	45-0000 Farming, Fishing and Forestry Occupations	39-0000 Personal Care and Service Occupations	31-0000 Health – care Support Occupations	37-0000 Building and Grounds Cleaning and Maintenance Occupations	47-0000 Construction and Extraction Occupations	53-0000 Transportation and Material Moving Occupations	41-0000 Sales and Related Occupations	23-0000 Legal Occupations	49-0000 Installation, Maintenance and Repair Occupations	21-0000 Community and Social Service Occupations	19-0000 Life, Physical and Social Science Occupations	27-0000 Arts, Design, Entertainment, Sports and Media Occupations	29-0000 Health – care Practitioners and Occupations	51-0000 Production Occupations	15-0000 Computer and Mathematical Occupations	25-0000 Education, Training and Library Occupations	13-0000 Business and Financial Operations Occupations	17-0000 Architecture and Engineering Occupations	11-0000 Management Occupations	43-0000 Office and Administrative Support Occupations
Total	155 (22.1)	96 (17.7)	59 (11)	115 (16.4)	73 (10.4)	115 (16.4)	115 (16.4)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)	155 (22.1)
Sex																						
Male	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)	96 (17.7)
Female	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)	59 (11)
Age at survey (years)																						
16–24	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)	11 (37.9)
25–39	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)	35 (20.6)
40–54	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)	83 (24.6)
55–63/64	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)	23 (15.6)
≥ 64/65 ^a	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)	3 (16.7)
Education level																						
Compulsory (>9 years)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)	5 (23.8)
Vocational (10–12 years)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)	45 (39.1)
Secondary (13–16 years)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)	87 (23.9)
University (≤17 years)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)	14 (7.4)

Table 2 (Continued)

Parameter	O*NET major groups and corresponding code (n; %)	
	00-0000 Management Occupations	10-0000 Business and Financial Operations Occupations
35-0000 Food Preparation and Serving Related Occupations	0	0
33-0000 Protective Service Occupations	1	1
45-0000 Farming, Fishing and Forestry Occupations	1	1
39-0000 Personal Care and Service Occupations	1	1
31-0000 Health – care Support Occupations	2	2
37-0000 Building and Grounds Cleaning and Maintenance Occupations	0	0
47-0000 Construction and Extraction Occupations	1	1
53-0000 Transportation and Material Moving Occupations	0	0
41-0000 Sales and Related Occupations	6	6
23-0000 Legal Occupations	2	2
49-0000 Installation, Maintenance and Repair Occupations	8	8
21-0000 Community and Social Service Occupations	8	8
19-0000 Life, Physical and Social Science Occupations	5	5
27-0000 Arts, Design, Entertainment, Sports and Media Occupations	6	6
29-0000 Health – care Practitioners and Occupations	7	7
51-0000 Production Occupations	6	6
15-0000 Computer and Mathematical Occupations	17	17
25-0000 Education, Training and Library Occupations	19	19
13-0000 Business and Financial Operations Occupations	24	24
17-0000 Architecture and Engineering Occupations	29	29
11-0000 Management Occupations	42	42
43-0000 Office and Administrative Support Occupations	69	69
SCI severity		
Complete	27.2 (27.2)	24 (9.4)
paraplegia	11.4 (11.4)	14 (5.7)
Incomplete	23 (23.3)	14 (5.7)
paraplegia	16.7 (16.7)	5 (2.0)
Complete	6 (6.0)	5 (2.0)
tetraplegia	8.2 (8.2)	5 (2.0)
Incomplete	24 (24.0)	9 (3.6)
tetraplegia	19.8 (19.8)	9 (3.6)
Walking ability		
Wheelchair user	67 (67.0)	37 (14.6)
Able to walk	15.2 (15.2)	14 (5.7)
Age at injury (years)		
<16	7 (7.0)	3 (1.2)
16–24	38 (38.0)	22 (8.8)
25–39	46 (46.0)	18 (7.2)
40–54	17 (17.0)	9 (3.6)
55–63/64	4 (4.0)	0 (0.0)
≥64/65 ^a	1 (1.0)	0 (0.0)

Abbreviations: O*NET, Occupational Information Network; SCI, spinal cord injury.
Note: A detailed list of the specific O*NET occupations we identified in our study can be received by the first author upon request.
^aStatutory retirement age in Switzerland is 64 years for women and 65 years for men.

Table 3 Average relevance levels of the O*NET super- and subcategories reflecting the demands and characteristics of the occupations indicated by the study participants

<i>O*NET domain</i>	<i>O*NET supercategory</i>	<i>Average relevance level super-category (mean; s.d.)</i>	<i>Average relevance levels of O*NET subcategories (mean; s.d.)^a</i>
<i>Demands</i>			
Abilities	Cognitive abilities	45.6 (14.1)	Verbal abilities (68.4; 4.2), idea generation and reasoning abilities (57.2; 7.0), attentiveness (45.8; 7.2), quantitative abilities (44.4; 1.6), perceptual abilities (42.3; 4.5), memory (36.6; 8.3), spatial abilities (24.7; 24.2)
	Sensory abilities	31.5 (9.0)	Auditory and speech abilities (37.8; 25.5), visual abilities (25.2; 23.2)
	Psychomotor abilities	19.8 (11.6)	Fine manipulative abilities (32.6; 7.8), control movement abilities (16.6; 8.1), reaction time and speed abilities (10.2; 2.3)
	Physical abilities	10.5 (2.4)	Physical strength abilities (12.0; 7.3), endurance (11.7; 15.0), flexibility, balance and coordination (7.7; 4.5)
Skills	Basic skills	54.4 (0.8)	Process-related (54.9; 7.9), content-related (53.8; 19.1)
	Cross-functional skills	42.2 (15.2)	Complex problem solving skills (55.8; 12.0), social skills (51.1; 4.8), systems skills (47.6; 8.8), resource management skills (39.4; 13.7), technical skills (17.3; 9.6)
Knowledge	—	—	Business and management (46.1; 13.0), education and training (45.4; 16.8), law and public safety (38.9; 0.1), engineering and technology (30.9; 12.9), communications (30.2; 5.0), mathematics and science (25.5; 14.7), arts and humanities (24.6; 25.4), transportation (22.9; 15.3), manufacturing and production (19.0; 17.6), health services (17.4; 3.6)
Work styles	—	—	Conscientiousness (86.5; 0.6), adjustment (77.2; 0.7), independence (74.6; 8.4), achievement orientation (73.7; 2.2), interpersonal orientation (72.4; 8.6), practical intelligence (69.4; 4.4), social influence (68.1; 14.4)
Work activities	Mental processes	61.1 (1.7)	Reasoning and decision making (62.3; 9.2), information and data processing (59.9; 5.2)
	Information input	60.7 (12.1)	Looking for and receiving job-related information (69.3; 16.6), identify and evaluating job-relevant information (52.2; 13.2)
	Interacting with others	48.6 (8.2)	Communicating and interacting (56.9; 12.9), coordinating, developing, managing and advising (48.4; 3.3), administering (40.6; 12.2)
	Work output	35.6 (7.0)	Performing complex and technical activities (40.5; 27.2), Performing physical and manual work activities (30.6; 5.9)
<i>Characteristics</i>			
Occupational interests	—	—	Conventional (62.9; 27.0), Enterprising (55.6; 30.7), realistic (44.2, 33.5), social (36.2; 31.6), investigative (34.8; 29.0), artistic (22.1, 26.5)
Work values	—	—	Relationships (64.7; 18.3), independence (58.6; 20.4), support (56.4; 13.2); achievement (56.0; 21.6); working conditions (55.3; 19.9), recognition (48.9; 21.3)
Work context	Interpersonal relationships	58.6 (16.4)	Communication (73.8; 22.8), role relationships (70.6, 9.1), responsibility for others (50.9; 6.9), conflictual contact (39.2; 22.6)
	Structural job characteristics	56.0 (11.8)	Criticality of position (67.5; 13.8), routine vs challenging work (63.7; 22.9), competition (50.9; 14.3), pace and scheduling (41.7; 33.3)
	Physical work conditions	24.3 (7.9)	Work setting (33.5; 26.5), body positioning (31.4; 20.9), environmental conditions (21.7; 13.8), work attire (20.6; 11.5), job hazards (14.6; 5.1)

Abbreviation: O*NET, Occupational Information Network.

^aSupplementary Information for Table 3 including the definitions of the subcategories and examples for their descriptors is available at *Spinal Cord's* website. A detailed list of the specific O*NET descriptors we extracted for each occupation of our study participants can be received by the first author upon request.

Table 4 Differences in the average relevance levels of the O*NET super- and subcategories across occupations of study participants with different SCI severities and walking abilities

O*NET domain	O*NET super- or subcategories	SCI severity (mean, s.d.)				Walking ability (mean, s.d.)		
		Complete paraplegia	Incomplete paraplegia	Complete tetraplegia	Incomplete tetraplegia	Wheelchair user	Able to walk	
<i>Demands</i>								
Abilities ^a	Cognitive abilities	45.8 (5.2)	45.0 (6.5)	46.1 (5.1)	46.3 (5.7)	45.8 (5.3)	45.4 (6.5)	
	Sensory abilities	30.6 (4.5)	32.5 (6.3)	29.9 (4.8)	32.2 (5.7)	30.5 (4.5)	33.3 (6.4)	
	Psychomotor abilities	17.8 (11.5)	22.6 (14.2)	15.8 (10.7)	20.4 (13.2)	17.4 (11.1)	24.0 (14.9)	
	Physical abilities	8.6 (11.2)	13.1 (13.4)	6.2 (9.7)	11.3 (12.1)	8.3 (10.7)	14.4 (14.0)	
Skills ^b	Complex problem solving skills	55.9 (11.1)	54.4 (12.4)	58.3 (12.7)	56.8 (12.4)	56.3 (11.9)	55.2 (12.3)	
	Process-related basic skills	54.9 (9.5)	54.0 (10.5)	56.1 (10.2)	56.1 (10.2)	55.2 (9.8)	54.7 (10.6)	
	Content-related basic skills	54.4 (7.5)	52.4 (10.5)	56.0 (8.4)	54.4 (9.2)	54.6 (8.1)	52.6 (10.5)	
	Social skills	51.5 (8.9)	50.3 (10.5)	51.0 (8.8)	52.3 (10.1)	51.6 (9.1)	50.6 (10.7)	
	Systems skills	48.0 (12.2)	46.1 (13.5)	49.3 (12.2)	48.9 (13.4)	48.1 (12.4)	47.0 (13.8)	
	Resource management skills	40.1 (11.1)	38.3 (12.1)	37.5 (8.8)	41.1 (12.8)	39.5 (10.9)	39.5 (13.2)	
	Technical skills	16.9 (11.6)	18.0 (11.3)	16.3 (11.6)	17.2 (11.6)	16.2 (11.2)	19.4 (11.8)	
Knowledge ^b	Business and management	47.8 (12.8)	44.5 (14.3)	45.0 (12.0)	46.6 (13.1)	47.0 (13.0)	44.7 (14.4)	
	Education and training	45.3 (16.5)	45.5 (17.0)	44.4 (18.4)	45.8 (16.3)	44.8 (16.7)	46.3 (16.7)	
	Law and public safety	39.0 (14.0)	37.6 (13.2)	40.1 (14.5)	40.1 (12.9)	39.0 (14.1)	38.7 (12.8)	
	Engineering and technology	32.3 (19.5)	30.2 (18.1)	29.8 (19.9)	29.5 (18.9)	30.5 (19.2)	31.7 (18.5)	
	Communications	31.1 (10.7)	30.2 (12.5)	29.0 (8.3)	29.3 (10.2)	30.3 (10.4)	30.0 (12.1)	
	Mathematics and science	25.2 (10.0)	25.4 (10.6)	25.5 (11.3)	26.4 (10.5)	25.2 (10.5)	26.0 (10.4)	
	Arts and humanities	24.3 (8.9)	24.4 (10.2)	25.3 (8.7)	25.3 (9.4)	24.8 (9.0)	23.9 (9.8)	
	Transportation	22.8 (15.4)	23.3 (15.7)	18.3 (13.0)	24.8 (15.6)	21.4 (14.5)	25.5 (16.6)	
Work styles ^b	Manufacturing and production	18.6 (13.7)	20.1 (13.6)	14.3 (11.4)	19.9 (17.6)	17.6 (13.5)	21.8 (15.3)	
	Health services	16.5 (18.3)	17.9 (19.4)	18.2 (21.9)	18.5 (20.3)	17.1 (19.3)	18.0 (19.8)	
	Conscientiousness	87.1 (5.0)	85.6 (6.6)	87.3 (5.5)	87.0 (5.1)	87.1 (5.0)	85.4 (6.7)	
	Adjustment	77.8 (7.5)	76.6 (8.7)	76.8 (8.0)	77.7 (8.2)	77.5 (7.6)	76.6 (8.9)	
	Independence	75.0 (8.2)	73.6 (8.4)	75.8 (7.7)	75.2 (9.1)	75.1 (8.2)	73.5 (8.8)	
	Achievement orientation	74.0 (8.2)	72.9 (9.7)	75.0 (8.7)	74.1 (9.0)	74.0 (8.6)	73.4 (9.3)	
	Interpersonal orientation	72.9 (10.0)	72.1 (10.8)	70.4 (12.3)	73.2 (10.1)	72.5 (10.6)	72.1 (10.7)	
	Practical intelligence	70.2 (8.9)	67.6 (11.2)	72.4 (8.8)	69.4 (10.1)	70.4 (9.2)	67.7 (11.1)	
Work activities ^a	Social influence	68.8 (13.5)	67.2 (15.7)	67.2 (13.3)	69.0 (14.3)	68.1 (13.8)	68.4 (15.5)	
	Mental processes	61.6 (10.1)	60.1 (10.9)	62.6 (10.1)	61.2 (10.5)	61.6 (10.2)	60.5 (10.9)	
	Information input	60.3 (9.7)	61.3 (10.1)	59.7 (9.2)	60.7 (9.8)	59.8 (9.6)	62.6 (9.9)	
	Interacting with others	49.0 (10.8)	48.4 (11.7)	47.1 (10.4)	49.4 (11.4)	48.8 (10.7)	48.7 (11.2)	
<i>Characteristics</i>	Work output	35.1 (9.7)	36.9 (10.9)	32.2 (10.2)	35.9 (11.8)	34.4 (9.9)	37.9 (11.7)	
	Occupational interests ^b	Conventional	65.6 (27.4)	60.4 (25.5)	63.6 (26.8)	61.5 (29.1)	64.7 (27.8)	59.7 (24.9)
	Enterprising	57.7 (30.1)	53.2 (31.7)	50.8 (29.5)	59.3 (29.9)	57.0 (29.3)	54.2 (33.2)	
	Realistic	42.5 (31.6)	47.5 (36.0)	40.3 (31.7)	43.6 (32.9)	40.7 (31.4)	50.6 (36.4)	
	Social	35.8 (31.0)	36.2 (31.8)	36.0 (32.7)	38.4 (32.2)	36.2 (31.2)	36.2 (32.3)	
	Investigative	35.0 (28.9)	32.5 (28.9)	44.8 (30.7)	33.7 (27.8)	36.1 (29.5)	32.3 (27.8)	
Artistic	20.1 (25.2)	22.2 (26.9)	26.7 (27.0)	24.0 (27.7)	22.4 (26.7)	21.1 (25.5)		
	Work values ^b	Relationship	64.8 (18.3)	64.7 (18.6)	62.5 (18.3)	65.8 (18.1)	65.2 (18.3)	63.9 (18.3)
	Independence	58.5 (19.1)	56.8 (21.6)	60.0 (19.2)	61.7 (21.3)	58.6 (19.8)	58.9 (21.7)	
	Support	57.0 (12.5)	56.2 (13.5)	56.7 (12.1)	54.9 (14.5)	56.4 (12.6)	56.4 (14.1)	
	Achievement	55.8 (20.4)	53.7 (22.9)	59.9 (20.4)	58.8 (22.2)	56.5 (21.1)	55.4 (22.7)	
	Working conditions	55.9 (18.9)	53.1 (20.9)	58.5 (18.7)	56.9 (20.5)	55.8 (19.6)	54.8 (20.7)	
Work context ^a	Recognition	48.3 (19.6)	46.8 (22.1)	53.9 (21.3)	51.4 (22.6)	49.5 (20.6)	48.3 (22.8)	
	Interpersonal relationships	58.9 (8.8)	58.2 (10.0)	57.2 (9.0)	59.8 (9.5)	58.6 (9.0)	59.1 (10.2)	
	Structural job characteristics	55.9 (6.0)	55.4 (6.9)	56.1 (6.4)	56.8 (6.7)	55.8 (6.3)	56.4 (6.9)	
Physical work conditions	22.8 (9.5)	26.5 (11.7)	20.4 (8.8)	25.3 (11.7)	22.3 (9.3)	28.1 (12.4)		

Abbreviations: O*NET, Occupational Information Network; SCI, spinal cord injury.
^aIn this O*NET domain, average relevance levels were calculated for the supercategories.
^bIn this O*NET domain, average relevance levels were calculated for the subcategories.

and role relationships ($M=70.6$). Physical work conditions were least relevant ($M=24.3$), especially in occupations of individuals with complete lesions ($M=20.4$ for complete tetraplegics and $M=22.8$ for complete paraplegics) and wheelchair users ($M=22.3$).

DISCUSSION

The present study used the O*NET to analyze the demands and characteristics of occupations of individuals with SCI living in Switzerland. Participants worked in a broad range of occupations covering almost all O*NET major groups and mainly performed administrative, management, architecture and engineering occupations, but less often crafts occupations. While cognitive abilities, social and problem solving skills, a conscientious work style and work activities involving mental processing represented the occupations' key demands, conventional interests as well as work values and a work context related to social relationships turned out to be the occupations' key characteristics. Both the occupations' prevalence as well as their demands and characteristics varied across different SCI severities and walking abilities.

Occupations of individuals with SCI

Our finding that individuals with SCI are predominantly employed in administrative, management and academic occupations but hardly in the crafts sector corroborates previous research.^{10,13,15} In a current study based on the International Standard Classification of Occupations (ISCO-08),²⁵ we found that compared with the Swiss general population individuals with SCI work more frequently in office, management and academic occupations, but less commonly in crafts, service and sales occupations.²⁶ Our present findings that managerial occupations post SCI are more prevalent in males and individuals with an older age or a higher education and clerical and teaching occupations are more common in females also reflect the situation of the general population.^{26,27}

The injury-related differences we established in the occupations' prevalence indicate that certain occupations may be more and others less suitable for particular SCI groups. For instance, the narrow range of occupations and the low frequency of crafts and management occupations in complete tetraplegics on the one hand, and the high prevalence of academic occupations on the other, indicate restricted vocational opportunities compared with less severely injured individuals. They also suggest a particular suitability of non-manual occupations that are cognitively demanding and often require a higher education, which is in line with Schwegler *et al.*²⁸ who showed that complete tetraplegics with a physically demanding pre-injury job tend to switch to academic occupations post SCI. The low prevalence of management occupations may be due to the severe mobility limitations and secondary health conditions of complete tetraplegics preventing them from working full time.¹

Key demands and characteristics of occupations of individuals with SCI

Idea generation, reasoning and problem solving, and also verbal abilities and social skills were highly relevant across our study participants' occupations. Together with the high relevance of knowledge on business, management, education and training, and of work activities involving mental processing and information input, this implies a particular suitability of cognitively and communicatively demanding occupations for persons with SCI. With regard to the importance of communicative demands, our results are thus in line with Sinden *et al.*¹⁵ In addition, the finding that physical and psychomotor abilities, manual work activities, technical skills and knowledge on manufacturing and production were least relevant

across our participants' occupations reflects the low prevalence of physically demanding occupations in our sample.

In accordance with the importance of social and communicative demands, we established social relationships to be key characteristics in both the work values and the work context domain. This finding may be explained by the importance of social interactions in managerial occupations that are highly prevalent in our sample, and also reflects the key role social contacts have as incentives to work for persons with SCI.²⁹ The work value recognition was a common characteristic of occupations of tetraplegics, which might be attributed to occupations requiring a higher education (e.g., academic occupations) that were frequent among tetraplegics and that typically address this particular work value. Moreover, we established conventional and enterprising interests to be of general importance across our participants' occupations and investigative interests of particular relevance for the chiefly academic occupations of complete tetraplegics. These findings represent an interesting contrast to Krause *et al.*³⁰ who found that US males with recent-onset SCI have primarily realistic and females mainly social, enterprising and conventional occupational interests, but that both sexes score low on investigative interests. Based on these differences, it appears that individuals with SCI return to occupations that may well match their disability-specific needs and limitations but not always their original occupational interests. For a sustainable return to work, this may be counterproductive as interest congruence predicts job satisfaction^{31,32} and future occupational tenure.³³

A comparison with the general population shows that the key demands of our participants' occupations broadly reflect the O*NET requirements of college graduates' typical occupations of the twenty-first century.²⁰ This indicates a suitability of such rather cognitively demanding occupations for those individuals with SCI who have the intellectual capability to complete a higher education. Furthermore, it appears that the twenty-first labor market of developed countries with its increasing computerization of manual tasks and its growing service sector will favor cognitive, communicative and social skills over physical abilities.³⁴⁻³⁶ Although Kaye³⁷ showed that individuals with mobility impairments in the United States are still underrepresented in cognitively and communicatively demanding occupations, such a future labor market would meet the disability-specific needs and limitations of persons with SCI and offer additional career opportunities for affected individuals.

Practical implications

Establishing a suitable vocational solution requires the determination of occupations whose demands and characteristics match an individual's capabilities and characteristics.¹⁷ By providing general information on the key demands and characteristics across the most prevalent occupations of individuals with different SCI severities, our study supports the initial screening towards a first selection of well-matching occupations in vocational guidance. After completing such an initial screening, vocational counselors should evaluate on an individual level how well the demands and characteristics of these preselected occupations match with the client's capabilities and characteristics. In doing so, counselors may rely on the set of specific O*NET descriptors (e.g., memorization abilities or writing skills) we extracted for each of our participants' occupations. By specifying the particular demands and characteristics of an occupation, the O*NET descriptors identified in our study can serve as a basis for developing standardized job matching profiles for vocational guidance. Returning to a well-matched occupation after injury could help persons with SCI to realize their vocational potential, and also promote their job satisfaction, job

performance and healthy employment,¹⁷ all of which are key indicators for a sustainable return to work. To truly establish the potential of O*NET-based job matching profiles, however, both their applicability in vocational guidance and their contribution toward a sustainable return to work should be tested in future research.

Study limitations

Our study is subject to a number of limitations. First, owing to the lack of a standardized occupational information system for Switzerland, we relied on the O*NET that was originally developed for the US labor market. Although the O*NET descriptors are deemed applicable across countries,³⁸ some O*NET titles were not fully congruent with the occupational titles in Switzerland. This might have slightly affected the validity of the identified demands and characteristics in the context of the Swiss labor market.

Second, as our study was community-based, we relied on self-report questions on SCI level and degree instead of using the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI)²² for determining SCI severity. Although explanations were added to the question on SCI degree, it may be that the item was not sufficiently understandable for all participants, which could have led to incorrect answers. To address this potential source of error, we complemented the information on SCI severity by using walking ability as an additional, less error-prone stratification variable.

Third, our study focused on occupations of participants who were employed at the time of the survey. We neither considered occupations performed by the participants between SCI onset and time of the survey nor previous occupations of participants who were unemployed at the time of the survey. Including these occupations would have changed both the occupations' prevalence and the average relevance values of their demands and characteristics. Moreover, it would have provided information on potentially less suitable occupations from which individuals dropped out. Future research should study the career trajectories of individuals with SCI to establish those occupations that are successfully performed and satisfying in the long term and those with an increased risk for dropouts.

Finally, the meaningfulness of the differences we found in the average relevance levels of the demands and characteristics across the occupations of individuals with different SCI severities and walking abilities is unclear. This is mostly because of the absence of practical experience with O*NET relevance values in the context of vocational guidance. Future research should thus start testing their practical significance.

CONCLUSION

The present study identified occupations performed by individuals with SCI living in Switzerland and established their demands and characteristics. While the demands and characteristics differed by SCI severity, our participants generally worked in cognitively and communicatively demanding occupations involving conventional work tasks and social relationships. The set of occupation-specific O*NET demands and characteristics we identified could inform the development of standardized job matching profiles and facilitate the determination of customized vocational solutions towards a more successful and sustainable return to work of individuals with SCI.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Supplementary Information accompanies this paper on the Spinal Cord website (<http://www.nature.com/sc>)