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ORIGINAL ARTICLE

Differences in functioning of individuals with tetraplegia and paraplegia according to the International Classification of Functioning, Disability and Health (ICF)

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Study design: Cross-sectional, multicenter study.
Objectives: To identify and quantify the differences in functioning of individuals with tetraplegia versus paraplegia using the International Classification of Functioning, Disability and Health (ICF) as a frame of reference.
Setting: International.
Methods: Functional problems of 1048 participants with spinal cord injury in 16 study centers in 14 countries were recorded using ICF categories. The level of significance and odds ratios (OR) for experiencing each of these functional problems were reported for individuals with tetraplegia and paraplegia. Regression models were adjusted for age, age squared, early post-acute or long-term context, gender and for world regions.
Results: Persons with tetraplegia are more at risk than persons with paraplegia to have difficulties in 36.4% categories of the component *body functions*. In the component *body structures*, 40% of the categories show significant differences. Individuals with tetraplegia indicate problems in three categories, whereas individuals with paraplegia are more likely to indicate problems in one category. Most categories indicating difficulties (56.6%) for persons with tetraplegia were found for the component *activities and participation*. The component with the highest congruency was the *environmental factors*. Overall, 3.7% categories (of the persons with tetraplegia as experienced, 2.4% of the categories as barriers, whereas 4.9% were experienced to be facilitators) obtained OR, indicating individuals with tetraplegia having more difficulties.
Conclusion: The logistic regression analysis identified a variety of differences in functional problems in individuals with tetraplegia compared with individuals with paraplegia. The ICF has the potential to indicate the differences in health conditions.
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Keywords: spinal cord injury; tetraplegia; paraplegia; rehabilitation; ICF; regressions analysis

Introduction

Spinal cord injury (SCI) is a devastating medical condition, which has life-changing consequences on numerous aspects of human functioning and participation.[1] Persons with SCI are confronted with functional difficulties, including motor and sensory impairments, bladder and bowel emptying,[1] respiratory or blood pressure problems, which frequently result in limitations in *activities and participation* like, in mobility, in self-care, in communication and in domestic life.[1–3] *Environmental factors*, which cover physical, social and attitudinal environments such as mobility, equipment, transportation, support and relationships, as well as services, systems and policies[4] can significantly influence the level of functioning and disability.

The level of the spinal cord lesion also has a major impact on functioning. Persons with paraplegia when compared with persons with tetraplegia mostly experience hand function deficits,[5] respiratory problems and problems in communication.[2] Moreover, the availability of personal assistance and choice of residence[6] have an immense impact on individuals with tetraplegia.

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A variety of instruments are used to assess functioning and disability in people with SCI. Most of these are aiming to capture a specific aspect of the overall health condition in SCI; in addition, they vary enormously in their conceptualization, contents, and moreover in psychometric characteristics.[7]

A complementary approach to the existing assessments and health-status measures has been recently implemented based on the International Classification for Functioning, Disability and Health (ICF). This classification provides a comprehensive and universally accepted framework to concretize and describe the concept of functioning, disability and health in people with all kinds of diseases or conditions. Its content is structured hierarchically starting with chapters, which constitute the first level of precision and which contain categories on higher levels (for example, from second to fourth level). For example, the third-level ICF category *d4401 Grasping* is one item of the second-level category *d440 Fine hand use*. This category is imbedded in the chapter *Mobility*, which itself is one element of the ICF component *activities and participation*.

To facilitate its implementation in SCI clinical practice and research the so-called ICF Core Sets, for SCI for individuals with SCI in the early post-acute[8] and the long-term contexts,[9] have been developed.

Although several studies are available that compare the problems in functioning experienced by persons with tetraplegia versus paraplegia, these studies commonly focus on specific health aspects, for example, hand function or do not adjust for relevant covariables when analyzing the prevalence of problems. Furthermore, these studies are limited to people with SCI in few countries. Consequently, a study investigating the entire scope of functioning and disability of people with tetraplegia versus paraplegia from an international perspective is missing.

Thus, the specific aim of this study was to explore the differences in functioning in persons with tetraplegia versus paraplegia in six world regions using the ICF as a comprehensive framework.

Materials and methods

Study design
This cross-sectional, multicentre study was performed within the international project 'Development of ICF core sets for spinal cord injury' to describe functioning and health of individuals with SCI using the ICF.[10] Data were elicited in 16 specialized study centres managing SCI individuals in 14 countries.

Study population
The study population included adults of minimum 18 years of age with SCI, with an acute onset (tetra- or paraplegia) in the early post-acute or long-term context. Tetraplegia refers to cervical spinal cord lesion, whereas paraplegia imply lesion to thoracic, lumbar and sacral segments of the spinal cord, secondary to damage of neural elements within the spinal canal.[11] According to the working definition, the post-acute context commences with multidisciplinary, comprehensive rehabilitation after the acute SCI and finalizes with its completion. The subsequent phase is the long-term context. Exclusion criteria were traumatic brain injury or mental disorders in addition to SCI.

Data collection
Health professionals in each study center recruited participants and collected data. ICF case record forms were used to elicit functional problems of the participants in individual computer-assisted interviews. In self-administered case record forms, participants indicated their general health and well-being. Health professionals entered these ratings into an electronic database. Demographic and clinical characteristics were obtained from medical records.

Measures
The case record forms comprised 264 ICF categories on the second level of classification out of four components. For the components *body functions, body structures* and *activities and participation* the rating 0 for 'no impairment/limitation' and 1 for 'impairment/limitation' was used. The categories of the component *environmental factors* were graded with 0 = no facilitator and no barrier, +1 = facilitator but no barrier, −1 = barrier but no facilitator, ±1 = barrier and facilitator. In addition, for all components, '8' was used in case the available information was not sufficient and '9' if a particular category was not applicable.

Data preparation
The present data analysis is based on 142 ICF categories on the second level of classification, which are contained in the comprehensive ICF core set for SCI in the early post-acute[8] or long-term context.[9]

ICF categories for all components were recorded: if they were coded '9' (not applicable) they were set to '0' (no difficulty) and if they were coded '8' (not specified) they were set to a missing value. For each of the ICF categories from the ICF component *environmental factors*, two dichotomous variables were defined. They were recoded if they held the information to be a barrier (1 = barrier but no facilitator or barrier and facilitator, 0 = no barrier no facilitator, 0 = facilitator but no barrier) or as a facilitator (0 = no barrier no facilitator or barrier but no facilitator and 1 = facilitator but no barrier or barrier and facilitator).

Statistical analysis
To identify differences in functioning between tetraplegia and paraplegia, while controlling for other confounders, logistic regression models were performed in an exploratory data analysis. Each of the dichotomous ICF categories were used as dependent variables in separate models. The level of injury (tetraplegia versus paraplegia), the age of the participants, age squared, gender and world regions: African region, Eastern Mediterranean region, European region, region of Americas, South-east Asia region, Western-Pacific region, contexts (early post-acute versus long-term) were used as independent variables. As age showed a nonlinear relationship

to the response for some ICF categories, it additionally entered the model as a squared term to allow for a more flexible relationship. The reference category for level of injury was tetraplegia, for gender it was female, for world regions it was South-east Asia region and for context it was post acute. The number of cases available for each model, *P*-value, odds ratio (OR), confidence interval and responses for level of injury are detailed (Tables 2–6). The level of significance ($P<0.05$) was adjusted for multiple testing (183 tests) to $P<0.0003$.

Statement of ethics

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research. The study was approved by ethics committees in charge of the respective study centers involved and was performed in accordance with the Declaration of Helsinki.

Results

Data from 1052 persons with SCI were collected between June 2006 and January 2008. In total, 475 persons with tetraplegia and 573 with paraplegia met the inclusion criteria. Table 1 shows the sample characteristics.

Study centers of the South-east Asia region provided 30.2% of the participants, followed by 19.2% from the regions of Americas, 15.3% from Western-Pacific region, 14.9% from Eastern Mediterranean region, 14.1% from the European region and 6.4% from the African region.

Differences in functioning of persons with tetraplegia versus paraplegia are shown in Tables 2–4. *Environmental factors* are presented separately as barriers or facilitators (Tables 5 and 6).

In 36.4% of ICF categories from the component *body function* (Table 2), persons with tetraplegia had a significantly higher risk of having a problem compared with persons with paraplegia. Regarding *b265 Touch functions* and *b270 Sensory functions* the risk of persons with tetraplegia was twofold (ORs 2.2 and 2.3). An immense difference was found in the ICF category *b310 Voice functions*, in which individuals with tetraplegia showed a 15-fold risk of experiencing a problem, and were well related to the five- to sevenfold higher risk of respiratory problems. Significant differences with four- to sevenfold increased risks for persons with tetraplegia were obtained for functions concerning *b420 Blood pressure* (OR 4.1), *b440 Respiratory muscle* (OR 6.9) and *b450 Additional functions* (OR 5.5), *b455 Exercise tolerance functions* (OR 2.15) and *b550 Thermoregulatory functions* (OR 4.8).

In 50% of the ICF categories assigned to the chapter '*Neuromusculoskeletal and movement-related functions*', up to fourfold higher risks of experiencing problems were found for persons with tetraplegia. Finally, *b830 Other functions of the skin* was found to be more frequently impaired in individuals with tetraplegia (OR 1.9).

In the component *body structures* (Table 3), individuals with tetraplegia showed a higher risk of having problems in three ICF categories regarding '*Structures related to movement*'. The largest difference was found in the ICF category *s710*

Table 1 Sample characteristics stratified by SCI level

	Tetraplegia (n = *475*)	*Paraplegia* (n = *573*)
Age	42.61 (18.0; 82.3)	41.85 (18.1; 83.5)
Gender		
Female	93 (8.9%)	143 (13.6%)
Male	382 (36.5%)	430 (41.0%)
Context		
Early post acute	242 (23.1%)	247 (23.6%)
Long-term	233 (22.2%)	326 (31.1%)
World region		
SEAR[a]	116 (11.1%)	200 (19.1%)
AMRO[b]	106 (10.1%)	95 (9.1%)
WPRO[c]	98 (9.4%)	62 (5.9%)
EMRO[d]	61 (5.8%)	95 (9.1%)
EURO[e]	64 (6.1%)	84 (8.0%)
AFRO[f]	30 (2.9%)	37 (3.5%)
Living alone		
Yes	77 (7.3%)	107 (10.2%)
No	396 (37.8%)	465 (44.4%)
Unknown	2 (0.2%)	1 (0.1%)
Current occupation		
Paid work	134 (12.3%)	168 (16.0%)
Self-employed	49 (4.7%)	104 (9.9%)
Non-paid work	9 (0.9%)	8 (0.8%)
Student	36 (3.4%)	33 (3.1%)
Housemaker	13 (1.4%)	21 (2.0%)
Retired	48 (4.6%)	75 (7.2%)
Unemployed	178 (17.0%)	160 (15.3%)
Unknown	1 (0.1%)	1 (0.1%)
Other	7 (0.7%)	3 (0.3%)
Impairment grading AIS		
Complete (AIS, A)	189 (18.0%)	296 (28.2%)
Incomplete (AIS, B)	267 (25.5%)	177 (16.9%)
Not available	19 (1.8%)	100 (9.5%)
ASIA scale		
A	189 (18.0%)	296 (28.2%)
B	69 (6.6%)	49 (4.7%)
C	100 (9.5%)	68 (6.5%)
D	98 (9.4%)	60 (5.7%)
Unknown	19 (1.8%)	100 (9.5%)
FIM 18–126 = absolutely dependent–completely independent[g]		
Sum-score	75.9 (29; 126)	103.3 (44,126)
General functioning 0–10 = no problem–complete problem[h]		
Self-rating	6.3 (0.0; 10.0)	4.7 (0.0; 10.0)
Health professionals rating	6.5 (0.0; 10.0)	4.6 (0.0; 10.0)
General health 0–10 = excellent–poor[i]		
Self-rating	4.1 (0.0; 10.0)	3.7 (0.0; 10.0)
Health professionals	5.9 (0.0; 10.0)	6.6 (0.0; 10.0)

Abbreviations: AFRO, African region; AIS, American Spinal Injury Association (ASIA) impairment scale; AMRO, region of Americas; EMRO, Eastern Mediterranean region; EURO, European region; FIM, functional independence measure; SCI, spinal cord injury; WPRO, Western-Pacific region.
[a]SEAR (India, Malaysia, Thailand and Vietnam).
[b]AMRO (Brazil, Canada and USA).
[c]WPRO (Australia, New Zealand).
[d]EMRO (Israel).
[e]EURO (Denmark, Germany and Switzerland).
[f]AFRO (South Africa).
[g]FIM
[h]Self-rating question, 'Please rank the magnitude of the problems in your functioning in every day life'. Health professional question, 'Please rank the magnitude of problems in functioning of the patient in every day life'.
[i]Question, 'In general, would you say your health is'.
Nominal variables are documented as number of observations and percentages. Numeric variables are documented as median and minimum/maximum.

Table 2 ICF categories of the component body function in persons with tetra- and paraplegia

ICF code	*ICF category title*	*Descriptive analysis: prevalence of problems %*		*Logistic regression: tetraplegia/paraplegia*		
Body functions		*Tetraplegia (n = 475) (%)*	*Paraplegia (n = 573) (%)*	n	P-*value*	*OR (95% CI)*
	Chapter 1: Mental functions					
b126	Temperament and personality functions	21.9	16.4	1.023	0.0205	1.48 (1.06; 2.06)
b130	Energy and drive functions	24.6	15.8	1.014	0.0046	1.62 (1.16; 2.26)
b134	Sleep functions	34.8	22.8	1.005	0.0021	1.64 (1.20; 2.24)
b152	Emotional functions	14.6	12.5	1.024	0.2435	1.26 (0.86; 1.85)
	Chapter 2: Sensory functions and pain					
b260	Proprioceptive function	78.7	72.0	1.028	0.0934	1.29 (0.96; 1.74)
b265	Touch function	89.3	77.7	1.029	0.0000	2.15 (1.49; 3.11)
b270	Sensory functions related to temperature and other stimuli	91.7	81.0	1.029	0.0000	2.32 (1.55; 3.48)
b280	Sensation of pain	94.3	84.6	1.029	0.2812	1.23 (0.84; 1.79)
	Chapter 3: Voice and speech functions					
b310	Voice functions	12.2	0.9	1.027	0.0000	15.26(5.93; 39.23)
	Chapter 4: Functions of the cardiovascular, hematological, immunological and respiratory systems					
b410	Heart functions	2.6	2.1	1.014	0.5008	1.37 (0.54; 3.47)
b415	Blood vessel functions	10.5	4.8	1.014	0.0083	2.04 (1.20; 3.46)
b420	Blood pressure function	33.8	10.7	1.024	0.0000	4.05 (2.85; 5.76)
b430	Hematological system functions	3.5	2.3	1.001	0.9400	1.03 (0.47; 2.26)
b440	Respiration functions	18.3	7.7	1.026	0.0000	2.71 (1.80; 4.08)
b445	Respiratory muscle functions	62.2	20.5	1.027	0.0000	6.92 (5.13; 9.35)
b450	Additional respiratory functions	58.3	20.8	1.028	0.0000	5.47 (4.09; 7.33)
b455	Exercise tolerance functions	57.2	30.1	977	0.0000	2.73 (2.06; 3.62)
	Chapter 5: Functions of the digestive, metabolic and endocrine systems					
b510	Ingestion functions	4.9	1.2	1.024	0.0026	3.82 (1.59; 9.14)
b515	Digestive functions	4.1	3.6	1.012	0.5797	1.22 (0.62; 2.38)
b525	Defecation functions	87.5	81.0	1.027	0.0054	1.66 (1.16; 2.37)
b530	Weight maintenance functions	32.3	19.8	989	0.0005	1.73 (1.27; 2.36)
b550	Thermoregulatory functions	61.8	27.2	1.024	0.0000	4.84 (3.60; 6.50)
	Chapter 6: Genitourinary and reproductive functions					
b610	Urinary excretory functions	15.1	12.1	1.021	0.0284	1.56 (1.05; 2.32)
b620	Urination functions	88.0	87.4	1.028	0.8898	1.03 (0.70; 1.52)
b630	Sensations associated with urinary functions	76.0	75.0	1.029	0.7956	1.04 (0.77; 1.41)
b640	Sexual functions	80.8	83.0	908	0.4878	0.88 (0.61; 1.27)
b660	Procreation functions	25.9	22.2	570	0.6683	1.10 (0.70; 1.73)
b670	Sensations associated with genital and reproductive functions	75.3	79.5	913	0.1603	0.78 (0.56; 1.10)
	Chapter 7: Neuromusculoskeletal and movement-related functions					
b710	Mobility of joint functions	73.7	50.2	1.028	0.0000	2.78 (2.05; 3.78)
b715	Stability of joint functions	59.5	44.7	1.027	0.0020	1.60 (1.19; 2.15)
b720	Mobility of bone functions	58.1	40.6	1.026	0.0008	1.66 (1.23; 2.22)
b730	Muscle power functions	99.2	97.2	1.028	0.0260	3.60 (1.17; 11.12)
b735	Muscle tone functions	95.4	84.8	1.027	0.0000	3.78 (2.29; 6.25)
b740	Muscle endurance functions	97.3	89.7	1.027	0.0000	3.67 (1.96; 6.86)
b750	Motor reflex functions	88.1	81.2	1.022	0.0003	1.98 (1.37; 2.86)
b755	Involuntary movement reaction functions	84.9	74.0	1.021	0.0000	2.47 (1.75; 3.48)
b760	Control of voluntary movement functions	83.3	78.5	1.027	0.0733	1.39 (0.97; 1.98)
b765	Involuntary movement functions	81.5	71.0	1.021	0.0000	2.08 (1.48; 2.92)
b770	Gait pattern functions	84.2	81.4	1.025	0.8816	0.97 (0.64; 1.46)
b780	Sensations related to muscles and movement functions	85.4	82.6	1.028	0.7205	1.07 (0.75; 1.53)
	Chapter 8: Functions of the skin and related structures					
b810	Protective functions of the skin	37.3	38.9	1.024	0.9411	1.01 (0.76; 1.34)
b820	Repair functions of the skin	30.7	31.0	1.018	0.6158	0.93 (0.68; 1.25)
b830	Other functions of the skin	42.5	26.4	1.018	0.0000	1.90 (1.41; 2.55)
b840	Sensation related to the skin	67.8	67.0	1.028	0.6593	1.06 (0.81; 1.40)

Abbreviations: CI, confidence interval; ICF, International Classification of Functioning, Disability and Health; OR, odds ratio.
Logistic regression analysis, adjusted for gender, age, age squared, world regions and, early post-acute and long-term context. OR > 1 indicate higher risk for problems in persons with tetraplegia; OR < 1 indicate higher risk for problems in persons with paraplegia. Significant ICF categories $P < 0.0003$ (adjusted for multiple testing) are highlighted.

Table 3 ICF categories of the component body structures in persons with tetra- and paraplegia

ICF code	*ICF category title*	*Descriptive analysis: prevalence of problems %*		Logistic regression: tetraplegia/paraplegia		
Body structures		*Tetraplegia (n = 475) (%)*	*Paraplegia (n = 573) (%)*	n	P-*value*	*OR (95% CI)*
	Chapter 1: Structures of the nervous system					
s120	Spinal cord and related structures	99.8	98.4	1.028	0.0725	6.78 (0.84; 54.83)
	Chapter 4: Structures of the cardiovascular, immunological and respiratory system					
s430	Structure of respiratory system	16.0	7.8	1.017	0.0008	2.02 (1.34; 3.05)
	Chapter 6: Structures related to the genitourinary and reproductive systems					
s610	Structure of urinary system	38.9	28.1	1.013	0.0533	1.35 (1.00; 1.84)
	Chapter 7: Structures related to movement					
s710	Structure of head and neck region	70.7	12.4	1.027	0.0000	23.76 (16.12; 35.4)
s720	Structure of shoulder region	30.7	10.7	1.023	0.0000	3.27 (2.26; 4.72)
s730	Structure of upper extremity	35.3	10.7	1.026	0.0000	4.44 (3.08; 6.41)
s740	Structure of pelvic region	27.9	22.6	1.024	0.5289	0.90 (0.64; 1.26)
s750	Structure of lower extremity	35.0	33.7	1.028	0.0097	0.64 (0.46; 0.90)
s760	Structure of trunk	35.9	49.7	1.028	0.0000	0.41 (0.31; 0.54)
	Chapter 8: Skin and related structures					
s810	Structure of areas of skin	50.2	42.8	1.024	0.0338	1.33 (1.02; 1.74)

Abbreviations: CI, confidence interval; ICF, International Classification of Functioning, Disability and Health; OR, odds ratio.
Logistic regression analysis, adjusted for gender, age, age squared, world regions and early post-acute and long-term contexts. OR > 1 indicate higher risk for problems in persons with tetraplegia; OR < 1 indicate higher risk for problems in persons with paraplegia. Significant ICF categories $P < 0.0003$ (adjusted for multiple testing) are highlighted.

Structure of head and neck region in which persons with tetraplegia had a 23-fold risk of being impaired. Of interest, individuals with tetraplegia reported significantly less problems regarding the ICF category *b760 Structure of trunk* (OR 0.4).

In the ICF component *activities and participation* (Table 4) 51.6% of categories could be identified, in which persons with tetraplegia were more at risk of being impaired. Essential differences were obtained for ICF categories addressing hand use, including communication and self-care with 26- to 95-fold higher risk of having problems, such as *d345 Writing messages* (OR 55.8), *d360 Using communication devices and techniques* (OR 26.2), *d440 Fine hand use* (OR 94.9) and *d445 Hand and arm use* (OR 66.3).

Categories from the chapter *Self-care* were found to be more frequently problematic for persons with tetraplegia, especially *d550 Eating* (OR 29.9) and *d540 Drinking* (OR 26.7). In addition, most of the ICF categories from the chapter *Domestic life* showed two- to fivefold higher risk of impairment among persons with tetraplegia, such as *d630 Preparing meals* (OR 5.0) and *d650 Caring for household objects* (OR 4.00). In contrast, persons with tetraplegia did not differ from individuals with paraplegia regarding difficulties in *Interpersonal interactions and relationships, Major life areas and Community, Social and Civic life*.

From the component *environmental factors*, 3.7% of the ICF categories were of more hindrance for persons with tetraplegia. Two categories were found to be facilitators (Table 5), more often for persons with tetraplegia compared with paraplegia, namely *e340 Personal care providers and personal assistants* (OR 2.0) and *e440 Attitudes of Personal care providers and personal assistants* (OR 1.7). Finally, *e125 Products and technology for communication* (OR 3.1) indicated to be more often a barrier (Table 6) for persons with tetraplegia.

Compared with the numerous differences in functioning of persons with tetraplegia and paraplegia, the covariables, which were included in the regression models demonstrated significant effects only in a few ICF categories. Compared with persons in the long-term context, persons in the early post-acute context showed fewer problems in functioning in 30 ICF categories. Higher age was significantly associated with a smaller extent of impairments regarding the ICF category *b670 Sensations associated with genital and reproductive functions* and women had a lower risk of having problems regarding *b640 Sexual functions*. The observed differences between the six world regions are complex and is a subject of another publication.[12]

Discussion

The differences in functioning in persons with tetraplegia compared with persons with paraplegia were examined in this international study. The ICF was used as a reference, as it provides a comprehensive framework and common language. In general, the results indicate a higher risk for functional impairments of persons with tetraplegia.

A number of problems in *body functions* were identified, which are more common in persons with tetraplegia. First of all, impaired sensation is an important problem to both individuals with tetra- and paraplegia, that is, *b265 Touch function* and *b270 Sensory functions related to temperature and other stimuli* give percentages as high as 80–90%, but are still significantly higher for those with tetraplegia. One reason for this finding may be that the individuals with tetraplegia have even greater challenges in preventing the pressure sores because of more impaired mobility. In addition, difficulties in thermoregulatory functions,[12] including cooling and

Table 4 ICF categories of the component activities and participation in persons with tetra- and paraplegia

ICF code	*ICF category title*	*Descriptive analysis: prevalence of problems %*		*Logistic regression: tetraplegia/paraplegia*		
Activities and participation		*Tetraplegia (n = 475) (%)*	*Paraplegia (n = 573) (%)*	n	P-*value*	*OR (95% CI)*
	Chapter 1: Learning and applying knowledge					
d155	Acquiring skills	17.3	6.5	1.016	0.0000	3.09 (2.01; 4.75)
	Chapter 2: General tasks and demands					
d230	Carrying out daily routine	43.1	24.9	1.019	0.0000	2.34 (1.76; 3.10)
d240	Handling stress and other psychological demands	28.5	21.9	1.017	0.0465	1.35 (1.00; 1.82)
	Chapter 3: Communication					
d345	Writing messages	79.5	4.6	1.024	0.0000	55.83 (35.12; 88.74)
d360	Using communication devices and techniques	52.0	4.2	1.022	0.0000	26.21 (16.38; 41.95)
	Chapter 4: Mobility					
d410	Changing basic body positions	87.0	64.5	1.029	0.0000	3.22 (2.30; 4.51)
d415	Maintaining a body position	81.1	63.0	1.029	0.0000	2.30 (1.71; 3.09)
d420	Transferring oneself	87.6	64.6	1.029	0.0000	3.65 (2.61; 5.10)
d430	Lifting and carrying objects	92.0	0.7	1.025	0.0000	5.47 (3.60; 8.33)
d435	Moving objects with lower extremities	93.5	90.2	1.028	0.1266	1.45 (0.90; 2.35)
d440	Fine hand use	89.5	9.8	1.028	0.0000	94.85 (60.28; 149.23)
d445	Hand and arm use	87.4	11.7	1.028	0.0000	66.29 (43.18; 101.77)
d450	Walking	90.5	87.4	1.029	0.2896	1.28 (0.81; 2.00)
d455	Moving around	94.5	88.5	1.029	0.0021	2.16 (1.32; 3.54)
d460	Moving around in different locations	93.9	87.3	1.029	0.0010	2.18 (1.37; 3.47)
d465	Moving around using equipment	77.6	67.4	1.026	0.0001	1.87 (1.36; 2.56)
d470	Using transportation	76.0	68.2	990	0.0027	1.62 (1.18; 2.21)
d475	Driving	73.0	51.3	965	0.0000	2.53 (1.91; 3.35)
	Chapter 5: Self-care					
d510	Washing oneself	88.0	52.8	1.024	0.0000	6.61 (4.70; 9.30)
d520	Caring for body parts	86.7	47.8	1.026	0.0000	7.59 (5.45; 10.58)
d530	Toileting	88.0	58.3	1.029	0.0000	4.67 (3.34; 6.54)
d540	Dressing	89.2	57.9	1.028	0.0000	5.49 (3.87; 7.78)
d550	Eating	70.9	7.5	1.028	0.0000	29.86 (20.37; 43.76)
d560	Drinking	63.7	6.3	1.028	0.0000	26.65 (17.82; 39.86)
70	Looking after one's health	63.4	31.9	1.008	0.0000	4.16 (3.14; 5.52)
	Chapter 6: Domestic life					
d610	Acquiring a place to live	37.6	38.4	989	0.7947	1.04 (0.79; 1.37)
d620	Acquisition of goods and services	63.5	69.6	988	0.0000	1.91 (1.45; 2.50)
d630	Preparing meals	82.2	50.5	991	0.0000	4.98 (3.66; 6.78)
d640	Doing housework	83.5	67.5	987	0.0000	2.80 (2.02; 3.89)
d650	Caring for household objects	84.6	61.2	986	0.0000	4.00 (2.87; 5.58)
d660	Assisting others	71.2	53.3	984	0.0000	3.00 (2.21; 4.08)
	Chapter 7: Interpersonal interactions and relationships					
d720	Complex interpersonal interactions	9.3	9.0	1.017	0.8673	1.04 (0.67; 1.62)
d750	Informal social relationships	10.8	10.1	1.018	0.8245	1.05 (0.69; 1.59)
d760	Family relationships	9.5	9.2	1.029	0.8759	0.97 (0.62; 1.50)
d770	Intimate relationships	33.1	34.5	957	0.9541	0.99 (0.75; 1.32)
	Chapter 8: Major life areas					
d810	Informal education	13.7	8.6	984	0.0046	1.85 (1.21; 2.83)
d820	School education	8.9	7.6	984	0.2403	1.34 (0.82; 2.17)
d825	Vocational training	16.4	11.8	976	0.0122	1.64 (1.11; 2.42)
d830	Higher education	13.2	12.0	979	0.3396	1.22 (0.81; 1.84)
d840	Apprenticeship (work preparation)	0.3	26.1	967	0.0652	1.35 (0.98; 1.86)
d845	Acquiring. Keeping and terminating a job	43.0	38.5	960	0.0162	1.40 (1.06; 1.85)
d850	Remunerative employment	48.0	42.2	968	0.0122	1.42 (1.08; 1.87)
d870	Economic self-sufficiency	41.7	38.2	974	0.1486	1.24 (0.92; 1.67)
	Chapter 9: Community, social and civic life					
d910	Community life	49.0	41.7	968	0.0668	1.29 (0.98; 1.68)
d920	Recreation and leisure	66.2	55.9	978	0.0250	1.38 (1.04; 1.83)
d930	Religion and spirituality	18.5	15.1	983	0.0172	1.56 (1.08; 2.25)
d940	Human rights	21.4	20.3	917	0.6143	0.92 (0.65; 1.29)

Abbreviations: CI, confidence interval; ICF, International Classification of Functioning, Disability and Health; OR, odds ratio.
Logistic regression analysis, adjusted for gender, age, age squared, world regions and early post-acute and long-term contexts. OR > 1 indicate higher risk for problems in persons with tetraplegia; OR < 1 indicate higher risk for problems in persons with paraplegia. Significant ICF categories $P < 0.0003$ (adjusted for multiple testing) are highlighted.

Table 5 ICF categories of the component environmental factors–facilitators in persons with tetra- and paraplegia

ICF code	*ICF category title*	*Descriptive analysis: prevalence of problems %*		*Logistic regression: tetraplegia/paraplegia*		
Environmental factors facilitators (f)		*Tetraplegia (n = 475) (%)*	*Paraplegia (n = 573) (%)*	n	P-value	*OR (95% CI)*
	Chapter 1: Products and technology					
e110f	Products or substances for personal consumption	71.4	61.4	1021	0.1359	1.26 (0.9; 1.70)
e115f	Products and technology for personal use in daily living	79.0	73.8	1015	0.8365	1.04 (0.74; 1.46)
e120f	Products and technology for personal indoor and outdoor mobility and transportation	79.8	74.8	1014	0.7741	0.95 (0.66; 1.36)
e125f	Products and technology for communication	80.7	70.3	1021	0.0138	1.51 (1.09; 2.10)
e130f	Products and technology for education	43.7	39.1	990	0.1047	1.27 (0.95; 1.69)
e135f	Products and technology for employment	34.9	42.1	954	0.1238	0.80 (0.60; 1.06)
e140f	Products and technology for culture, recreation and sport	59.9	53.6	971	0.2312	1.21 (0.89; 1.64)
e150f	Design, construction and building products and technology of buildings for public use	66.5	56.5	989	0.0383	1.37 (1.02; 1.85)
e155f	Design, construction and building products and technology of buildings for private use	60.7	55.2	993	0.0615	1.30 (0.99; 1.71)
e160f	Products and technology of land development	51.1	50.9	964	0.9732	1.00 (0.76; 1.33)
e165f	Assets	71.3	66.0	996	0.4418	1.12 (0.83; 1.51)
	Chapter 3: Support and relationships					
e310f	Immediate family	91.6	86.7	1027	0.2084	1.32 (0.86; 2.02)
e315f	Extended family	78.8	75.0	1024	0.6677	1.07 (0.79; 1.46)
e320f	Friends	88.1	84.3	1026	0.7863	1.05 (0.72; 1.55)
e325f	Acquaintances, peers, colleagues, neighbors and community members	82.3	78.1	1019	0.1538	1.27 (0.92; 1.76)
e330f	People in positions of authority	66.2	61.9	1000	0.4321	1.12 (0.85; 1.47)
e340f	Personal care providers and personal assistants	75.4	63.9	994	0.0000	1.98 (1.48; 2.65)
e355f	Health professionals	94.3	91.3	1025	0.8163	1.06 (0.63; 1.78)
e360f	Other professionals	78.9	71.7	1017	0.4980	1.11 (0.81; 1.53)
	Chapter 4: Attitudes					
e410f	Individual attitudes of immediate family members	84.4	84.8	1021	0.2846	0.82 (0.57; 1.18)
e415f	Individual attitudes of extended family members	88.9	73.7	1018	0.7529	0.95 (0.71; 1.29)
e420f	Individual attitudes of friends	83.5	81.9	1017	0.5883	0.91 (0.64; 1.29)
e425f	Individual attitudes of acquaintances, peers, colleagues, neighbors and community members	78.0	74.1	1006	0.2137	1.21 (0.89; 1.65)
e440f	Individual attitudes of personal care providers and personal assistants	70.7	61.5	988	0.0002	1.73 (1.30; 2.30)
e450f	Individual attitudes of health professionals	89.6	87.9	1022	0.5731	0.88 (0.57; 1.36)
e455f	Individual attitudes of health-related professionals	76.2	72.8	1011	0.6402	0.93 (0.67; 1.27)
e460f	Societal attitudes	63.7	58.6	967	0.1575	1.22 (0.93; 1.61)
e465f	Social norms, practices and ideologies	53.0	53.9	944	0.5270	0.91 (0.69; 1.21)
	Chapter 5: Services, systems and policies					
510f	Services, systems and policies for the production of consumer goods	47.5	48.4	978	0.7167	1.05 (0.80; 1.38)
e515f	Architecture and construction services, systems and policies	54.8	52.6	970	0.4519	1.11 (0.84; 1.48)
e525f	Housing services, systems and policies	39.5	0.4	962	0.9675	0.99 (0.74; 1.33)
e530f	Transportation services, systems and policies	58.2	55.4	969	0.6490	1.07 (0.80; 1.42)
e535f	Communication services, systems and policies	69.1	64.1	982	0.1482	1.25 (0.92; 1.68)
e540f	Transportation services, systems and policies	55.6	48.4	978	0.1752	1.21 (0.92; 1.60)
e550f	Legal services, systems and policies	51.4	46.4	943	0.3053	1.16 (0.87; 1.54)
e555f	Associations and organizational services, systems and policies	53.9	51.3	944	0.4466	1.12 (0.84; 1.49)
e570f	Social security services, systems and policies	64.5	56.7	978	0.1844	1.21 (0.91; 1.61)
e575f	General social support services, systems and policies	64.0	55.7	952	0.0554	1.31 (0.99; 1.74)
e580f	Health services, systems and policies	83.1	78.0	1006	0.0069	1.64 (1.15; 2.35)
e585f	Education and training services, systems and policies	39.0	44.1	943	0.3399	0.87 (0.66; 1.15)
e590f	Labor and employment services, systems and policies	35.4	38.4	948	0.4085	0.89 (0.67; 1.18)

Abbreviations: CI, confidence interval; ICF, International Classification of Functioning, Disability and Health; OR, odds ratio.
Logistic regression analysis, adjusted for gender, age, age squared, world regions and early post-acute and long-term contexts. OR > 1 indicate higher risk for problems in persons with tetraplegia; OR < 1 indicate higher risk for problems in persons with paraplegia. Significant ICF categories $P < 0.0003$ (adjusted for multiple testing) are highlighted.

sweat reaction[13] are well known in tetraplegic individuals, and accordingly a more prominent issue for them than for individuals with paraplegia.

Respiratory function is much more affected in tetraplegic individuals, which is due to impairment or loss-of-function of most or all respiratory muscles.[14] For the same reason is *b310 Voice functions* a problem significant to more persons with tetraplegia than with paraplegia.

The shared importance for both the groups is remarkable for categories of *chapter 6: Genitourinary and reproductive*

Table 6 ICF categories of the component environmental factors: barriers in persons with tetra- and paraplegia

ICF category title		*Descriptive analysis: prevalence of problems*		*Logistic regression: tetraplegia/paraplegia*		
Environmental factors facilitators (b)		*Tetraplegia (n = 475) (%)*	*Paraplegia (n = 573) (%)*	n	P-*value*	*OR (95% CI)*
	Chapter 1: Products and technology					
e110b	Products or substances for personal consumption	18.8	29.5	1021	0.0301	1.42 (1.03; 1.94)
e115b	Products and technology for personal use in daily living	30.9	20.2	1015	0.0005	1.68 (1.25; 2.26)
e120b	Products and technology for personal indoor and outdoor mobility and transportation	38.5	36.1	1014	0.5734	1.08 (0.82; 1.42)
e125b	Products and technology for communication	25.4	9.9	1021	0.0000	3.08 (2.15; 4.43)
e130b	Products and technology for education	8.8	8.9	990	0.8389	1.05 (0.66; 1.67)
e135b	Products and technology for employment	18.5	23.8	954	0.5580	0.90 (0.64; 1.27)
e140b	Products and technology for culture, recreation and sport	30.0	27.6	971	0.3020	1.17 (0.87; 1.57)
e150b	Design, construction and building products and technology of buildings for public use	60.6	61.2	989	0.6322	1.07 (0.81; 1.40)
e155b	Design, construction and building products and technology of buildings for private use	58.0	63.8	993	0.0942	0.79 (0.59; 1.04)
e160b	Products and technology of land development	47.8	49.1	964	0.7334	1.05 (0.79; 1.39)
e165b	Assets	25.2	15.6	996	0.0010	1.74 (1.25; 2.41)
	Chapter 3: Support and relationships					
e310b	Immediate family	12.8	16.1	1027	0.0626	0.71 (0.49; 1.02)
e315b	Extended family	17.4	23.6	1024	0.0223	0.68 (0.49; 0.95)
e320b	Friends	18.2	20.6	1026	0.5246	0.90 (0.64; 1.26)
e325b	Acquaintances, peers, colleagues, neighbors and community members	27.6	27.0	1019	0.7904	1.04 (0.77; 1.41)
e330b	People in positions of authority	35.9	38.4	1000	0.3103	0.87 (0.66; 1.14)
e340b	Personal care providers and personal assistants	20.9	12.9	994	0.0302	1.50 (1.04; 2.16)
e355b	Health professionals	20.8	16.6	1025	0.6157	1.09 (0.78; 1.53)
e360b	Other professionals	28.2	27.3	1017	0.6375	0.93 (0.69; 1.25)
	Chapter 4: Attitudes					
e410b	Individual attitudes of immediate family members	21.3	20.7	1021	0.4513	0.88 (0.64; 1.22)
e415b	Individual attitudes of extended family members	26.7	28.6	1018	0.2889	0.85 (0.63; 1.15)
e420b	Individual attitudes of friends	24.9	28.2	1017	0.1050	0.78 (0.57; 1.05)
e425b	Individual attitudes of acquaintances, peers, colleagues, neighbors and community members	34.7	0.3	1006	0.8446	1.03 (0.78; 1.36)
e440b	Individual attitudes of personal care providers and personal assistants	28.0	18.2	988	0.0015	1.67 (1.22; 2.29)
e450b	Individual attitudes of health professionals	28.1	0.2	1022	0.6615	1.07 (0.79; 1.45)
e455b	Individual attitudes of health-related professionals	34.3	29.5	1011	0.3305	0.87 (0.86; 1.54)
e460b	Societal attitudes	49.7	51.0	967	0.3685	0.88 (0.67; 1.16)
e465b	Social norms, practices and ideologies	47.9	51.0	944	0.1782	0.83 (0.63; 1.09)
	Chapter 5: Services, systems and policies					
e510b	Services, systems and policies for the production of consumer goods	32.2	28.9	978	0.2319	1.19 (0.89; 1.59)
e515b	Architecture and construction services, systems and policies	53.7	56.7	970	0.5344	0.92 (0.70; 1.20)
e525b	Housing services, systems and policies	46.6	52.8	962	0.1827	0.83 (0.63; 1.09)
e530b	Transportation services, systems and policies	40.4	42.8	969	0.5812	0.92 (0.69; 1.24)
e535b	Communication services, systems and policies	32.0	25.7	982	0.0957	1.31 (0.95; 1.81)
e540b	Transportation services, systems and policies	60.3	60.7	978	0.8923	1.02 (0.77; 1.35)
e550b	Legal services, systems and policies	40.3	45.8	943	0.1626	0.82 (0.62; 1.08)
e555b	Associations and organizational services, systems and policies	24.7	28.0	944	0.9417	0.99 (0.72; 1.36)
e570b	Social security services, systems and policies	48.3	52.5	978	0.1076	0.80 (0.61; 1.05)
e575b	General social support services, systems and policies	43.3	48.1	952	0.1471	0.82 (0.62; 1.07)
e580b	Health services, Systems and policies	43.4	44.7	1006	0.5850	0.93 (0.71; 1.22)
e585b	Education and training services, systems and policies	21.5	26.6	943	0.4444	0.88 (0.64; 1.22)
e590b	Labor and employment services, systems and policies	35.8	44.7	948	0.2891	0.86 (0.64; 1.14)

Abbreviations: CI, confidence interval; ICF, International Classification of Functioning, Disability and Health; OR, odds ratio.
Logistic regression analysis, adjusted for gender, age, age squared, world regions and early post-acute and long-term contexts. OR > 1 indicate higher risk for problems in persons with tetraplegia; OR < 1 indicate higher risk for problems in persons with paraplegia. Significant ICF categories $P \leqslant 0.0003$ (adjusted for multiple testing) are highlighted.

functions. Specifically, persons with tetra- and paraplegia reported problems with *b620 Urinary functions* and *b630 Sensations associated with urinary functions*. There is evidence in literature that bladder management is critical in rehabilitation of SCI (that is, neurogenic bladder). For example, catheterization or pharmacological options is either aiming to assist bladder emptying or to enhance bladder capacity. Complications, such as urinary tract infections, stones, strictures and autonomic dysreflexia, are common in both the groups.[15,16]

There is higher risk of persons with cervical SCI of experiencing blood pressure problems that includes low-

resting blood pressures as well as orthostatic hypotension problems,[17] and not least sudden very high blood pressures related to autonomic dysreflexia.[18,19] Furthermore, because of the higher lesions with motor loss in the upper extremities in persons with tetraplegia, they naturally showed a higher risk for difficulties in a number of neuromusculoskeletal and movement-related functions, which are interconnected with the hand and arm use.[19] Limitations in *d440 Fine hand use* and *d445 Hand and arm use* are related with limitations in self-care activities and in domestic life, specifically *d550 Eating* and *d560 Drinking* and the structural correlates *s720 Structure of shoulder region* and *s730 Structure of upper extremity*. Thus, treatment effects regarding hand function will become apparent not only in the body function itself but also in the related activities and environmental factors. The tremendous effects of an impaired hand and arm function as demonstrated in this study also highlights the need to restore this function as far as possible.[20]

Although our study indicated huge differences between persons with tetra- and paraplegia regarding mobility, self-care and domestic life, it is remarkable that no significant differences regarding interpersonal interactions and relationships, major life areas including education and employment, as well as community, social and civic life were found.

Variables, such as age, gender, race, educational level and coping, could influence functioning and disability after SCI.[21] In our study, we have adjusted for age, gender and regional effects.

In addition, regarding the ICF component *environmental factors*, the congruency between persons with tetra- and paraplegia was very high, only three ICF categories indicating differences. The ICF categories *e340 Personal care providers and personal assistants* and *e440 Attitudes of personal care providers and personal assistants* were identified as being more frequently facilitators for persons with tetraplegia, and this is not least because of the fact that many more with tetraplegia than paraplegia need personal assistance. They have a central role in functioning as they are to be seen as an indicator for independency[6] and are interacting with the difficulties indicated in the ICF chapters *d4 Mobility,* especially fine hand and arm use, *d5 Self-care* and *d6 Domestic life*.

Finally, only one ICF category was identified, namely *s760 Structure of the trunk,* where a higher risk for persons with paraplegia was evident. As the categories in our analysis are reported on the second level, we cannot specify whether these problems are in muscles, ligaments or in fasciae of the trunk or in the vertebral column. Although an interpretation of this finding is difficult, it may be because of the fact that for the tetraplegic individuals the trunk is part of the paralyzed body, in which the major concern is the remaining function of the upper extremities, including the hands, whereas for a person with paraplegia the lesion level means a lot for stability of the trunk and balance, and thereby for functioning in a wheelchair, during transfers and so on.[22,23]

Some limitations of this analysis should be considered. First, the ICF categories were applied on second level, and in consequence this leads to a reduced specification. Second, the countries are not distributed equally in the sample. Owing to the overrepresentation of industrialized countries, the external validity may be limited. Finally, only a limited number of potential confounders were taken into account in the logistic regression models. To sum up, in our study we have demonstrated that irrespective of age, gender, early post-acute or long-term context and world regions, the level of SCI significantly influences the functioning of affected persons. Using the ICF core sets for SCI, it was possible to gain a comprehensive description of the differences in functioning, experienced by persons with tetraplegia versus paraplegia. It is relevant for health policy and systems and health service research to do further research in the application of the ICF framework.

Conflict of interest

The authors declare no conflict of interest.

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